Winnipeg | Water and Waste
Eaux et déchets

AUG 28 2019

Cordella Friesen, M.P.A.
Acting Director and Assistant Deputy Minister
Environmental Approvals Branch
1007 Century Street
Winnipeg, MB R3H 0W4

Client File No.: 3205.00
Our File Nos.: S-734, EMS
020-17-08-11-00
020-17-08-11-0N

Dear Madam,

RE: ENVIRONMENT ACT LICENCE NO. 3042

The City of Winnipeg is pleased to submit the enclosed CSO Master Plan. This submission complies with Clause 11 of Environment Act Licence No. 3042 and the associated November 24, 2017 letter from Manitoba Sustainable Development.

The CSO Master Plan sets out the roadmap for implementing a long term program that will meet the control target objective of 85 Percent Capture in the Representative Year. The program will require significant financial commitment from the City of Winnipeg and other levels of government to achieve the objective. The submission is arranged into three main parts:

- Part 1 – Abstract is a summary of the CSO Master Plan.
- Part 2 – Technical Report documents the approach used for the project selection and master plan development.
- Part 3 – CSO Master Plan details are presented in three parts:
    - Part 3A – CSO Master Plan Summary provides specific details and is intended to be updated to current conditions on an ongoing basis.
    - Part 3B – District Engineering Plans (DEPs) are provided for all 43 combined sewer districts, including site-specific information and proposed project details.
    - Part 3C – Standard Details provides information and assumptions for the implementation of technologies common to multiple districts.

Should you have any questions on this report, please contact Mr. Duane Griffin, P.Eng., at 204-986-4483 or by email at dgriffin@winnipeg.ca.

Sincerely,

Chris W. Carroll, P. Eng., MBA
Manager of Wastewater Services Division

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Attachment

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City of Winnipeg
Water and Waste Department
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August 22, 2019

Subject: Combined Sewer Overflow Master Plan

Dear Patrick Coote:

Jacobs is pleased to submit the enclosed CSO Master Plan. This submission completes the final phase of our services for the assignment made to us on February 8, 2013. We have provided a recommended set of proposed projects for each of the combined sewer districts located in the City of Winnipeg. Once all projects are complete, the objective control target of 85 Percent Capture in the Representative Year will be achieved.

The CSO Master Plan sets out the roadmap for implementing a long term program that will meet the intent of the Environment Act No 3042 Licence. The program will require a significant financial commitment from the City of Winnipeg and other levels of government to achieve the objective in the prescribed timeline. The submission is arranged into three main parts:

- Part 1 – Abstract is a summary of the CSO Master Plan.
- Part 2 – Technical Report documents the approach used for project selection and master plan development.
- Part 3 – CSO Master Plan Details is presented in three parts:
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    - Part 3B – District Engineering Plans (DEPs) are provided for all 43 combined sewer districts, including site-specific information and proposed project details.
    - Part 3C – Standard Details provides information and assumptions for implementation of technologies common to multiple districts.

We appreciate the opportunity to provide these services and look forward to continuing to work with the City of Winnipeg through the implementation of the CSO Master Plan.

Please do not hesitate to contact John at 403.640.8065 or Stephen at 204.488.2214 ext. 73069, if you have questions regarding our submission.

Sincerely,

Jacobs Engineering

John Berry

Stephen Godon

John Berry, P. Eng.
Project Manager

Stephen Godon, P.Eng.
Assistant Project Manager

JACOBS

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08/22/2019

APEGM

Certificate of Authorization

CH2M HILL Canada Ltd.

No. 1441

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Water and Waste Department • Service des eaux et des déchets

Combined Sewer Overflow Master Plan

Part 1 – Abstract

Environment Act Licence No. 3042
Clause 11

Prepared for

Manitoba Sustainable Development

August 2019

CSO Master Plan – Part 1 – Abstract

Project No: 470010CH
Document Title: CSO Master Plan – Part 1 – Abstract
Revision: 05
Date: August 8 2019
Client Name: City of Winnipeg
Project Manager: John Berry
File Name: CSO_MP_Part_1_Abstract_Final_CO1MP_08082019

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Document History and Status

Revision	Date	Description	By	Review	Approved
0	02/15/2019	Draft	ES	DJT / JB	
1	04/17/2019	2nd Draft	SG	PP / DJT / BM / JB	
2	05/22/2019	3rd Draft	SG	JB / DJT	
3	06/10/2019	4th Draft	SG	JB	DJT
4	07/10/2019	5th Draft	SG	JB / DJT	DJT
5	08/08/2019	Final Submission for CSO Master Plan	MF	JB	DJT

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Acronyms and Abbreviations

AACE	American Association of Cost Engineers (AACE International)
CEC	Clean Environment Commission
City	City of Winnipeg
CS	combined sewer
CSO	combined sewer overflow
DEP	District Engineering Plan
EA No. 3042	Environment Act Licence No. 3042
GI	green infrastructure
LDS	land drainage sewer
MSD	Manitoba Sustainable Development
O&M	operations and maintenance
Preliminary Proposal	CSO Master Plan Preliminary Proposal
Province	Province of Manitoba
RTC	real time control
SAC	stakeholder advisory committee
SRS	storm relief sewer

1. Introduction

The City of Winnipeg (City) is proceeding with a major infrastructure upgrade program, called the Combined Sewer Overflow (CSO) Master Plan, which will reduce the amount of combined sewer flow entering our rivers from combined sewers.

Combined sewer overflows (CSOs) have been an issue in Winnipeg for many years. These types of sewers are a legacy from the past; while they have served us well, they no longer meet modern day standards for environmental protection.

After the enactment of the Manitoba Environment Act in 1988, the Province of Manitoba (Province) requested that the Clean Environment Commission (CEC), which was established under the Act, hold hearings on protecting Winnipeg's rivers and waterways. The hearings, which concluded in 1992, recommended that a CSO study be commissioned and work should start on reducing CSOs. The City completed the CSO study in 2002 and reported back to the CEC in 2003. The report included several recommendations for CSO management.

The operation of the combined sewer system in Winnipeg is governed by Environmental Act Licence No. 3042 (EA No. 3042), issued by the Province (through Manitoba Sustainable Development or MSD) in September of 2013. The City of Winnipeg's Combined Sewer Overflow Master Plan development project complies with all of the EA No. 3042 licence requirements.

EA No. 3042 required the City to submit a Preliminary Proposal for a master plan by December 31, 2015, followed by an updated plan by December 31, 2017.

The City submitted its Preliminary Proposal on December 18, 2015. It included the plans, costs, evaluation criteria and recommendations for the following five control options:

1) 85 percent Capture in a Representative Year
2) Four Overflows in a Representative Year
3) Zero Overflows in a Representative Year
4) No More than Four Overflows per Year
5) Complete Sewer Separation

The Preliminary Proposal recommended that the CSO control limit be "Control Option No. 1 – 85 percent Capture in a Representative Year." This option has the lowest capital cost of all the options, estimated at $1.3 billion in terms of 2014 dollar values, and is a major step forward for CSO management. Figure 1-1 illustrates the CSO Master Plan Timeline.

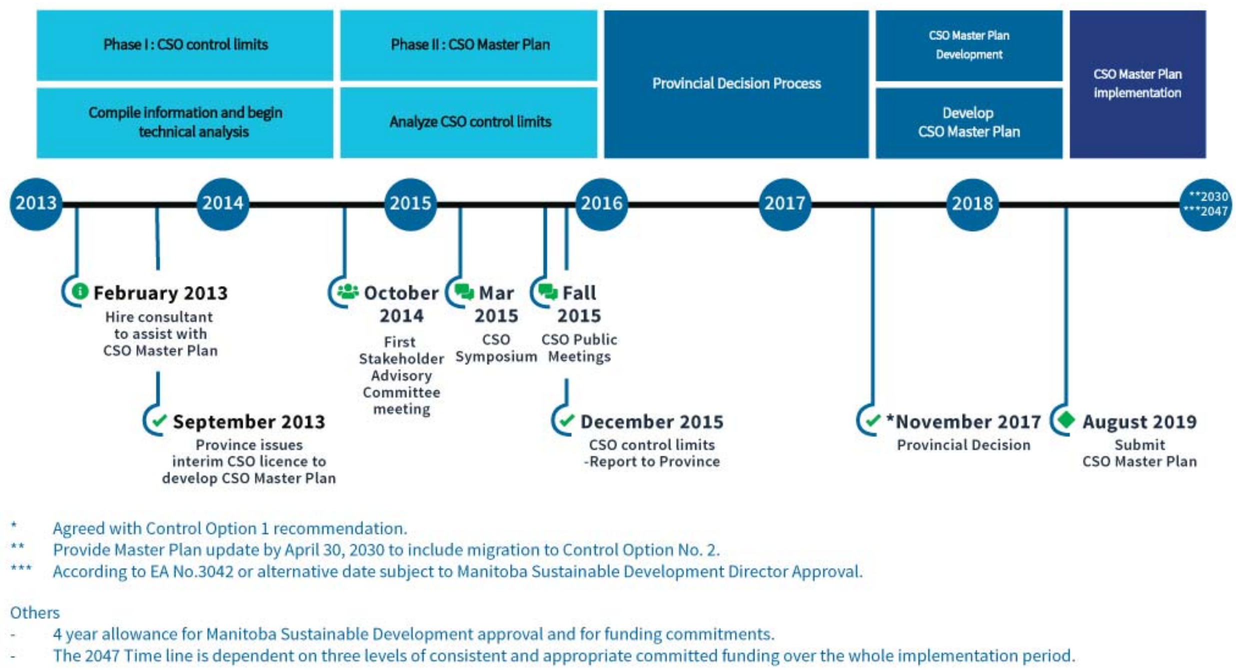

Figure 1-1 CSO Master Plan Timeline

In November 2017, MSD approved the Preliminary Proposal under the following conditions:

- Control Option No. 1 is to be implemented in such a way that the Master Plan can be expandable, allowing for the possibility of Control Option No. 2 – Four Overflows in a Representative Year, to be phased in.
- A CSO Master Plan, for Control Option No. 1, is to be submitted by August 31, 2019.
- An updated CSO Master Plan for Control Option No. 2 is to be submitted by April 30, 2030.
- The CSO Master Plan for Control Option No. 1 is to be implemented by December 31, 2045, unless otherwise approved by the Director of MSD.

The Master Plan's future control options will also be percent capture based to ensure there are no wasted investments and the program is expandable.

The City has continued work on the combined sewer system since the 2002 study and during the CSO Master Plan study and review periods. Since 2013, the City has invested over $90 million in systems and infrastructure in the combined sewer system. The work and associated costs are as follows:

- CSO Master Plan study and development - $5.4 million
- Interceptor Monitoring - $1.0 million
- District Flow Monitoring - $2.5 million
- Sewer Instrumentation - $0.5 million
- InfoWorks ICMLive (hydraulic sewer system model) - $0.4 million
- Sewer Separation
  - Cockburn - $53.0 million land drainage sewer (LDS) separation

  - Ferry Road - $13.0 million LDS separation
  - Jefferson East - $8.0 million LDS separation
- Latent Storage Dewatering Stations - $5.0 million
- Mission sewer cleaning - $0.9 million
- Bannatyne – North East Exchange Sustainable Drainage System - $0.5 million

Planned and committed work will continue until the CSO Master Plan is accepted and implementation begins. Once accepted, the objective is to continue on a percent capture reduction basis until the water quality objective is met.

The CSO Master Plan provides a roadmap for this large, long-term infrastructure program. The program will include several types of construction projects across all 43 combined sewer districts at a total estimated 2019 capital cost in excess of $2 billion. Cost sharing between the three levels of government (federal, provincial and city) will be necessary to maintain affordability and to complete the implementation close to 2045. The implementation timeline will be impacted if no, or reduced, federal or provincial funding, or both, is made available.

2. Our Submission

This CSO Master Plan provides a roadmap for this large, long-term infrastructure program. The program will include several types of construction projects across all 43 combined sewer districts. It is compliant with EA No. 3042 and meets the conditions outlined by MSD's approval of the Preliminary Proposal in November 2017.

The Plan describes the technical approach used for project evaluation and selection, scheduling of projects, and potential risks and opportunities.

The CSO Master Plan is arranged into three main parts:

Part 1 – Abstract is a summary of the CSO Master Plan.

Part 2 – Technical Report documents the approach used for project selection and master plan development.

Part 3 – CSO Master Plan Details is presented in three parts:

- Part 3A – CSO Master Plan Summary provides specific details and is intended to be updated to current conditions on an ongoing basis.
- Part 3B – District Engineering Plans (DEPs) are provided for all 43 combined sewer districts, including site-specific information and proposed project details.
- Part 3C – Standard Details provides information and assumptions for implementation of technologies common to multiple districts.

The entire report has been prepared in compliance with the EA No. 3042 request for submission of a CSO Master Plan including DEPs, proposed monitoring plans, and an implementation schedule for Control Option No. 1 – 85 Percent Capture in a Representative Year.

3. Background on Winnipeg Combined Sewers

Combined sewers were installed from the late 19th century until the early 1960s. They collect wastewater from homes, businesses, and industries, as well as surface runoff from rainstorms and snow melt in a single piping system. The sanitary sewage is diverted from the combined sewers to sewage treatment plants during dry weather. During wet weather, however, the system can be overwhelmed with a combination of sanitary sewage and high volumes of storm runoff. The diluted wastewater collected in the combined sewers overflows to our local rivers in order to protect residents from basement flooding. These overflows are also known as CSOs. Typical CSO and storm relief sewer (SRS) arrangements are shown on Figure 3-1. Additionally, the City has a series of videos and graphics on its website.

The combined sewer system services about one-third of Winnipeg. It consists of 43 combined sewer districts, as shown on Figure 3-2. All but two sewer districts have an outfall located on the banks of either the Assiniboine or Red Rivers. There are a total of 76 CSO outfall locations including 41 primary outfalls located at each primary diversion and 35 secondary outfalls to divert excess flows that occur during large rainfall and reduce the risk of basement flooding.

Winnipeg's combined sewer system is continually upgraded. Diversion weirs were installed in the 1930s to collect sewage for Winnipeg's first sewage treatment plant, the North End Wastewater Pollution Control Centre. This marked a monumental improvement in river water quality. As our city grew and modernized, the frequency of basement flooding increased. The City responded by adding capacity to the combined sewer districts. This additional capacity was gained through the installation of a SRS in parallel to the existing combined sewers. Interconnections between the two sewer types and the diversion of road drainage into the SRS led to a reduction in basement flooding.

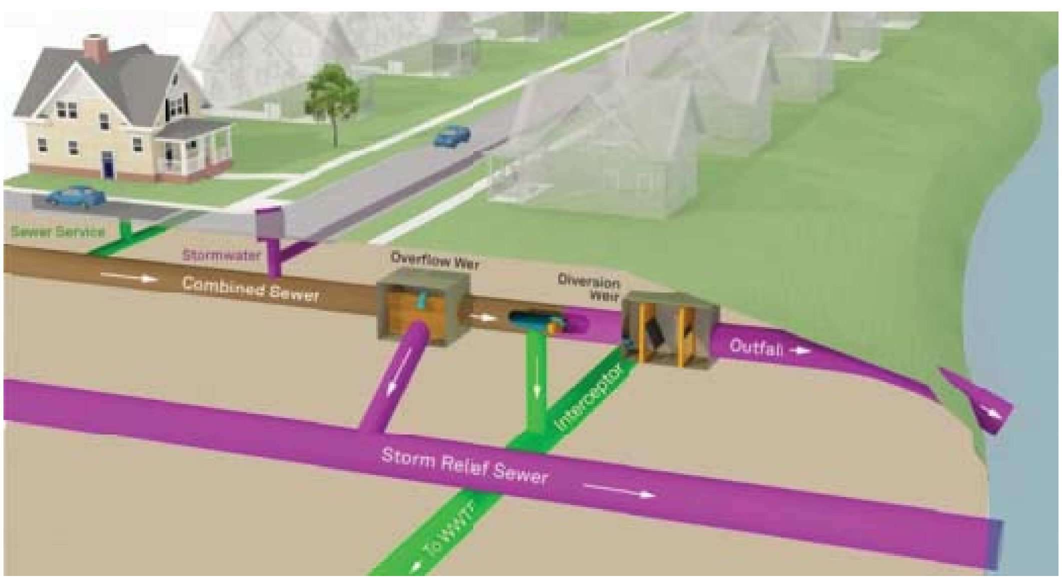

Figure 3-1 Typical CSO and SRS Arrangement

Basement flooding continues to be a concern for combined sewer districts. They are particularly susceptible because of the direct connection of the service line from basements to the combined sewers. Basement flood protection is taken into account as part of all combined sewer district improvement projects.

Water quality is a key driver behind the CSO Master Plan. Water quality was assessed as part of a two year program to collect and evaluate the contribution of nutrients and bacteria from CSOs to the rivers and Lake Winnipeg. The results, which are included in the Preliminary Proposal, indicate that CSOs contribute approximately 0.3 percent of Total Phosphorus and 0.1 percent of the Total Nitrogen that enters Lake Winnipeg.

Bacteria levels in the rivers spike during snowmelt and CSO events, with CSOs representing a minor portion of the overall contribution. The bacteria value is highest during the initial flush of the sewers and subsequently decreases back to the normal level over the two to three days following a wet weather event. The Preliminary Proposal water quality analysis indicates 44 exceedance days per year for both the baseline and Control Option No. 1. The CSO program will only have a marginal impact on the number of days when bacteria levels will exceed regulatory guidelines.

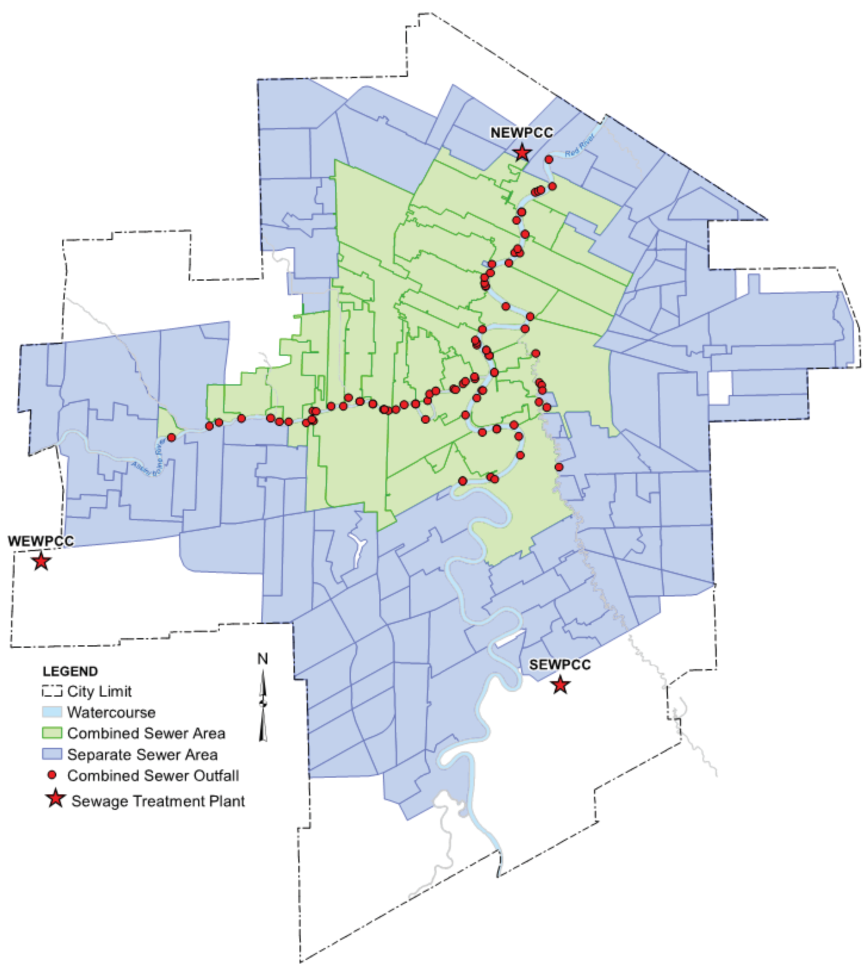

Figure 3-2 Sewer Areas and Outfalls

4. Stakeholder Engagement

The impacts of the CSO Master Plan are widespread, and the importance of open and transparent stakeholder engagement is essential to its success. The City engaged with MSD, environmental groups, and Winnipeg residents and will continue to do so, when appropriate, throughout implementation.

4.1 Regulatory Engagement

The City and MSD worked together to develop the CSO Master Plan. This included a regulatory liaison group (comprising of senior managers) and a regulatory working group.

The City met with the two groups on several occasions to report on progress and discuss issues. A clarification document was prepared to track issues and resolutions. Some of the key clarifications addressed include definitions for Representative Year, Overflow, and Percent Capture Calculation[1].

Additional requirements of EA No. 3042 were reviewed and addressed through parallel submissions and meetings. Some of these additional items included a public education plan, interim monitoring plan, notification plan and annual reporting. EA No. 3042 and related submissions can be found on the MSD website.

4.2 Public Engagement

Public engagement has and will continue to play a role in the CSO Master Plan. In the early stages, when the City needed public input on control options, it focused on public education and consultation. Some of the tools the City utilized in this early phase included a blog that was open for public comments, an email Q&A option, a CSO learning video, media interviews and public meetings.

Three public meetings were held to gather input and receive feedback. A stakeholder advisory committee (SAC) was setup to review the study methods and objectives and provide advice on their delivery.

Word cloud from 2015 CSO Symposium (word size is based on frequency of use)

The SAC provided advice and direction as to how to value and evaluate the information gathered at these events, from blog comments and email comments. The information gathered helped build the Preliminary Proposal.

For this phase of the CSO Master Plan, with the decision of control limit being made by the regulators and the CSO Master Plan focusing on engineering solutions, public engagement has focused on public education. The City is developing new communication tools and products, including a series of CSO videos, infographics (see the example on Figure 4-1), and an updated website that includes a notification tool which will monitor the CSO Master Plan's progress. The City will release the tools early in the CSO Master Plan's implementation.

1 Licence Clarifications. Environment Act Licence No. 3042. City of Winnipeg. October 2015

Figure 4-1 Infographic: Combined Sewer Size

5. Master Plan Development

The CSO Master Plan provides a roadmap for achieving the system wide performance objective of 85 Percent Capture in the Representative Year. The CSO Master Plan includes DEPs, cost and performance estimates, and an implementation schedule for the proposed CSO control solutions.

5.1 Design Basis

The CSO Master Plan is designed to take the current sewer system from an estimated 74 percent capture rate to an 85 percent capture rate (based on a 1992 Representative Year). This equates to an additional 2.3 million cubic metres of wastewater being captured and treated on average every year. The Representative Year was affirmed as 1992 following an assessment of historical rainfall records.

The Representative Year is applied as a uniform rainfall across the entire combined sewer system. Using this metric, computer modelling could then help us plan ways to further manage CSOs to meet our 85 percent capture goal.

Combined sewers are located in older neighbourhoods, where some changes relating to infill housing and redevelopment are expected. However, any changes will need to comply with EA No. 3042 Clause 8, which states that new developments cannot cause increases to CSOs. Therefore, cost estimates do not include an allowance to account for the potential cost of redevelopment. The 2037 development estimates for the impact of growth from separated sewer areas that experience high rates of new development are considered conservative even for 2045.

Percent capture is the key metric for program design and compliance. Percent capture is calculated as the volume of wet weather flow treated in comparison to the total volume of wet weather flow collected. The calculation incorporates the definitions as stated in EA No. 3042 and as agreed to with MSD during the development for the CSO Master Plan.

Compliance reporting for Control Option No. 1 will be based on the Representative Year and measured by Percent Capture.

5.2 CSO Technologies

There are two broad classes of technologies used for CSO control—grey and green infrastructure. Grey infrastructure refers to the conventional infrastructure projects such as sewer pipes or storage tanks. Green infrastructure (GI) refers to those that use natural hydrologic processes to keep rainwater out of the sewer systems. The CSO Master Plan focuses on traditional and well established grey infrastructure, but also includes opportunities for GI components.

5.3 Project Development

The CSO Master Plan includes the assessment and evaluation of collection systems using asset and operational data to support the proposed solutions.

Control technologies were first evaluated for use alone or in combination with other technologies for each combined sewer district. After the initial selection of technologies, their performance was evaluated using computer simulations. The individual district models were combined to evaluate the system wide performance.

The CSO Master Plan includes the following types of projects:

- **Committed Sewer Separation:** Sewer separation projects with committed funding will continue in the following five sewer districts:
  - Cockburn
  - Ferry Road
  - Riverbend
  - Parkside
  - Jefferson East

  These projects were previously identified for basement flooding relief, with tangible benefits. The separation option was selected for CSO mitigation while still providing basement flooding relief. These projects encompass a large part of the implementation cost, with the existing remaining committed funding required surpassing $140 million. Nearly $100 million worth of sewer separation has been completed since 2013, and sewer separation work completed prior to 2013 is estimated to be in excess of $300 million.

- **Additional Sewer Separation:** The evaluation identified ten districts where additional sewer separation is estimated to be more beneficial than storage options. The additional sewer separation by installation of new LDSs has a higher capital cost but will have lower long-term operations and maintenance costs.
- **In-line Storage:** In-line storage accesses the storage volume already available in the existing combined sewers. It is maximized by installing a control gate that closes to store combined sewage and opens during significant rain events to avoid increasing the risk of basement flooding. In-line storage will use existing pump stations where available. For the ten districts that do not have pump stations, gravity flow controllers are recommended to control discharges to the interceptor.
- **Latent Storage:** The storage volume already available in relief sewers with separate outfalls is referred to as latent storage. This type of storage requires a new pump station to pump captured flows back to the combined sewer system. Latent storage has been identified for 13 locations.
- **Off-line Storage:** Off-line storage is new sewer infrastructure that adds additional storage capacity to the system. Off-line tank and tunnel storage were both considered in the evaluations. Tunnel storage was identified as the preferred option of the two off-line storage options.
- **Floatables Screening:** A reduction in the volume of floatables reaching the rivers may be achieved by adding screens at each of the outfall locations where floatables are found to be an issue. An off-line screen is installed at every primary outfall when hydraulic and operational considerations would allow for it**.** This off-line approach for first-flush screening has been included at 25 locations.

5.4 Cost Overview

A conceptual level Class 5 estimate was developed for the CSO Master Plan. A Class 5 estimate is defined by the American Association of Cost Engineers International (AACE) Cost Estimate Classification System[2] as having a project definition of zero to two percent to be used in a conceptual study with an expected range of accuracy from -50 percent to +100 percent. Estimating methods for a Class 5 estimate include historical comparisons, parametric models and judgment based on experience.

Capital costs were primarily based on local cost estimates for readily available items such as sewer pipes and chamber installations. Standard unit rates based on sewer length were used to quantify and estimate the sewer separation work. A cost estimation spreadsheet was used to generate costs for technologies with which the City had little experience (less than 20 percent of the total plan capital costs). This spreadsheet looked at projects completed in other cities and applied factors to adjust to Winnipeg conditions.

The capital cost in 2019 dollar values for the CSO Master Plan program is listed in Table 5-1.

2 AACE International. 1997. Cost Estimate Classification System – As Applied In Engineering, Procurement, and Construction for the Process Industries. AACE International Recommended Practice No. 18R 97

A breakdown of the cost for each control technology applied in the CSO Master Plan is shown on Figure 5-1. The cost estimates presented in Table 5-1 and on Figure 5-1 do not include the following:

- Investments made since 2013 in projects that provide basement flooding relief and reduce CSO's.
- Upgrades to the sewage treatment facilities to accommodate wet weather flows.
- Future operations and maintenance costs for CSO program upgrades.

The upper range of the Class 5 estimate (+100 percent) is used for budgeting purposes, giving a total estimated capital cost of $2.3 billion in 2019 dollars.

Table 5-1 CSO Master Plan Program Capital Cost Estimate (2019 Dollars)

Item	Program Cost
Estimated Capital Cost	$1,045,800,000
Green Infrastructure Allowance	$104,600,000
Subtotal – Capital Cost Estimate	**$1,150,400,000**
Class 5 Estimate Range of Accuracy: -50% to +100%	$575,200,000 to $2,300,800,000
Total Capital Cost for Budgeting Purposes	**2,300,800,000**

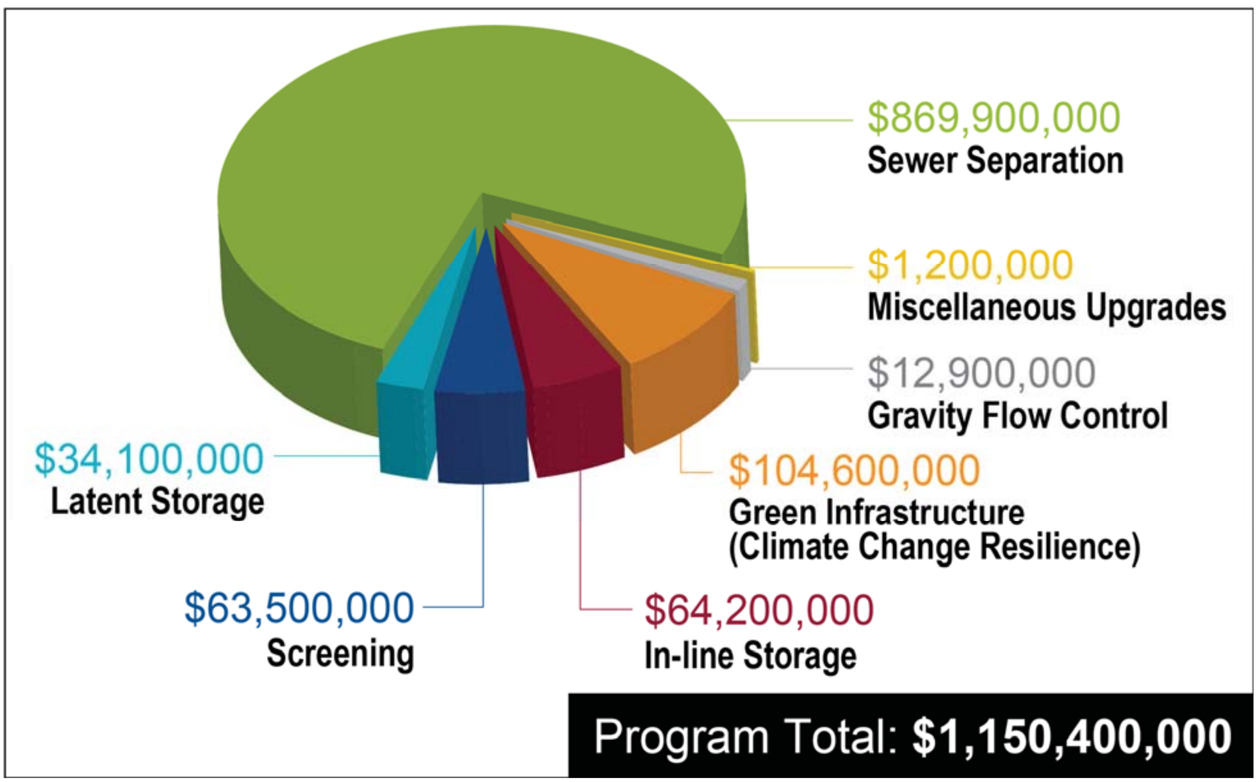

Figure 5-1 CSO Master Plan Capital Cost Summary (2019 Dollars)

5.5 Changes in Capital Cost Estimates

The CSO Master Plan capital cost estimate was developed to a Class 5 level of estimate with an expected range of accuracy from -50 percent to +100 percent. In the Preliminary Proposal, a different approach was used, whereby a range of -30 percent to +50 percent was applied to the base estimate and the total capital cost was reported as having an upper limit of $1.3 billion.

If the same approach being applied now was used in the Preliminary Proposal phase, the resulting upper end of the estimated costs would equate to $1.7 billion, which is about 30 percent higher than that reported for the Preliminary Proposal.

Table 5-2 provides a comparison between the Preliminary Proposal and CSO Master Plan project level capital costs. It shows the variance in projects selected and the impact on overall program cost.

Table 5-2 Project Selection Comparison – Preliminary Proposal and CSO Master Plan

Control Option	Preliminary Proposal 2014 Dollar Values		Master Plan 2019 Dollar Values	
	Number of Districts	Total Costs	Number of Districts	Total Costs
Latent Storage	11	$23,600,000	13	$29,300,000
Flap Gate Control	0	N/A	2	$4,800,000
Gravity Flow Control	0	N/A	10	$12,900,000
Control Gate	10	$77,400,000	24	$64,200,000
Screen			25	$63,500,000
Off-line Storage	8	$112,800,000	0	N/A
Storage Tunnel	4	$96,600,000	0	N/A
Sewer Separation	5	$519,100,000	15	$869,900,000
Additional	0	N/A	3	$1,300,000
SUBTOTAL	**24**	**$829,500,000**	**41**	**$1,045,800,000**
Green Infrastructure	N/A	N/A	41	$ 104,600,000
SUBTOTAL		**$829,500,000**		**$1,150,400,000**

This difference in estimated cost shown for the Preliminary Proposal and the CSO Master Plan in Table 5-2 is attributed to the following:

- A change in the City's use of the classification range of accuracy for cost estimating. For the Preliminary Proposal, +50 percent of capital cost was used to represent the budget estimating amount. In 2015, the City moved to the AACE classification system, and the top end of the accuracy range was increased to +100 percent of capital cost.
- GI was as accounted for by applying an allowance to the capital cost estimate of 10 percent for the CSO Master Plan. GI was not included in the Preliminary Proposal.
- Construction cost escalation from 2014 to 2019 equating to about 16 percent.
- An increase in the amount of sewer separation projects selected for control options, which have a higher capital cost, but lower operating costs.

Table 5-3 provides a comparison of the capital cost associated with the 2015 Preliminary

Proposal and the CSO Master Plan. These values reflect a Class 5 estimating range.

Table 5-3 Capital Cost Summary – Preliminary Proposal and CSO Master Plan

Program Scenario	Preliminary Proposal 2014 Capital Costs	Master Plan 2019 Capital Costs
Class 5 Estimated Capital Costs	$829,500,000	$1,045,800,000
Green Infrastructure Allowance	Not Included	$104,600,000
Subtotal – Capital Cost Estimate	**$829,500,000**	**$1,150,400,000**
Class 5 Estimate Range of Accuracy: -50% to +100%	($414,750,000) $829,500,000	($575,200,000) $1,150,400,000
Total Capital Cost Range	$414,750,000 to $1,659,000,000	$575,200,000 to $2,300,800,000

Table 5-4 provides a secondary comparison of the capital cost for each submission. In this comparison, the 2014 estimate is inflated to 2019 dollars using an annual inflation rate of 3 percent. The GI costs associated with the CSO Master Plan are excluded to show a more representative comparison.

Operations and maintenance (O&M) is not included in capital costs. They would be over and above the costs shown in Table 5-3. The high cost of the program raises concerns about affordability, and program funding considerations are presented in the following section.

Table 5-4 Capital Cost Comparison – Preliminary Proposal and CSO Master Plan

Item	Preliminary Proposal 2014-Capital Costs	Preliminary Proposal 2019-Capital Costs	Master Plan 2019- Capital Costs (March MP)
Base Construction with Markup	$829,500,000	$962,000,000	$1,045,800,000
Base Cost + 50% Estimating Allowance	$1,245,000,000 *	$1,444,200,000	$1,568,700,000
Base Cost + 100% Estimating Allowance	$1,659,000,000	$1,924,000,000	$2,091,600,000

5.6 Financial Considerations

The current method for funding the CSO Master Plan is through the sewer utility on a user-pay basis. The rates have been steadily rising for several years and are expected to continue to rise because of obligations to make major infrastructure upgrades.

Rate studies suggest that the upper threshold of affordability is $30 million per year for the Combined Sewer Overflow and Basement Flood Management Strategy capital program. With the City's commitment to current sewer separation projects (average annual capital costs of $30 million); implementing the CSO Master Plan within the timeframe identified in EA No. 3042 may be financially unsustainable even with support from other levels of government.

The City carried out an affordability assessment documented in the Preliminary Proposal based on current and future utility rates to assess the impacts of the Plan; the Plan was found to be unaffordable to complete in accordance with EA No. 3042 using City funding only. One of the recommendations from the CEC hearings was to share the cost with the federal and provincial governments.

The CSO Master Plan was developed with three funding scenarios:

- **Scenario 1** – Tri-level funding agreement between the Government of Canada, Manitoba Government, and the City of Winnipeg. For the purposes of this scenario, funding was capped at $30 million per year each, with a total estimated capital expenditure of $90 million per year (2019 dollars).
- **Scenario 2** – Bi-level funding agreement between the City of Winnipeg and either the Manitoba Government or the Government of Canada, at $30 million per year each, with a total estimated capital expenditure of $60 million per year (2019 dollars).
- **Scenario 3** – City-only funding with a total estimated capital expenditure of $30 million per year (2019 dollars).

5.7 Program Development

The CSO Master Plan will allow flexibility to manage the many projects within the defined annual budget.

A series of assumptions were included to facilitate the development of the program as follows:

- Three percent inflation per year for annual funding
- Three percent inflation per year for construction costs
- A four-year startup period at beginning of program: this includes a two-year allowance for any major alteration of EA No. 3042 and a two-year allowance to secure federal and provincial funding commitments
- Funding arrangements are consistent for the entire implementation period

Additional details are included in Part 2 – Technical Report. The phasing and scheduling of the projects was kept the same for each scenario. The different annual budgets for each scenario were then applied to determine total costs and timelines. The City will seek funding from the federal and provincial governments per the 2003 CEC recommendations. Reduced or delayed funding, any changes to inflation rates, or the failure to increase annual budgets to match assumptions will result in cost increases and a longer implementation timeline. The impacts of the three funding scenarios are shown in Table 5-5.

Annual cost escalation at three percent for construction is a significant risk. If committed funding is less than forecasted, it could result in four times the capital costs and take three times longer to implement. To put cost escalation into context, construction of the Shoal Lake Aqueduct cost approximately $17 million in 1919 dollars. That same project, if completed in 2019, would see project costs escalate to over $1.15 billion.

Table 5-5 CSO Master Plan Funding Scenario Evaluation Results (2019 Dollars)

Program Scenario	Description	Funding by	Annual Budget	Timeline
Scenario 1	3 Levels of Funding 3 x $30 Million	Tri-level Government of Canada, Manitoba Government and the City of Winnipeg	$90 Million	27 years (2047)
Scenario 2	2 Levels of Funding 2 x $30 Million	Bi-Level City of Winnipeg and either the Manitoba Government or the Government of Canada	$60 Million	39 years (2059)
Scenario 3	1 Level of Funding 1 x $30 Million	One Level City Only	$30 Million	75 years (2095)

As seen in Table 5-5, only Scenario 1 would allow the CSO Master Plan to be completed near the 2045 deadline, as directed by the Province. In contrast, Scenario 3 is estimated to be complete by 2095 (75 years). Scenarios 2 and 3 are intended as guides to illustrate impacts on implementation with reduced funding.

The City will begin implementing the CSO Master Plan when directed by the Province in order to meet this legal requirement, regardless of what funding the City may or may not receive from other levels of government. The fallback position (in case the other levels of government do not participate in funding the program) will be to follow either Scenario 2 or Scenario 3, depending on the number of funding sources and amounts.

6. Risks and Opportunities

There are a number of risks and significant consequences with a plan of this size and scope. Individual project risk responses and contingency allowances were not directly identified at this conceptual design stage, but recognition and general allowance for risk is included in the upper end of the range of cost estimates (i.e., +100 percent AACE estimating contingency). Risks are managed on a project by project basis.

The following risks and opportunities may impact the CSO Master Plan.

6.1 Risks

6.1.1 Program Implementation

A number of significant factors associated with funding and scheduling during implementation must be considered as follows:

- **Funding:** There is a risk that funding from other levels of government will not be available over the life of the CSO Master Plan. To mitigate this risk, the City will continue its work with the allocated $30 million annual budget. The City will also continue to request funding from the federal and provincial governments.

- **Cost:** There are many sources of cost risks. For example, some of the proposed technologies are new and may not have been used in environments like Winnipeg. To mitigate risks like these, the City will take advantage of experience and knowledge from other jurisdictions to verify that we are making smart decisions as the CSO Master Plan evolves.

- **Schedule:** There are many sources of schedule risks. Major delays may result from funding shortages or high bid costs. Existing limitations of engineering and construction service capacity or extended project approvals may cause delays to implementation plans. This risk will be mitigated by streamlining bidding techniques and providing early notice to the design and construction industries regarding CSO Master Plan projects.

6.1.2 Migration to Control Option No. 2

The regulatory requirement for the Master Plan to be expandable, shifting from Control Option No. 1 to Control Option No. 2, represents a significant risk to the CSO Master Plan. Expanding to Control Option No. 2 would increase costs and likely increase the timeline in order to implement the CSO Master Plan in an affordable manner. This risk can be mitigated through continued work with MSD and further technical analysis. Specific detail on the complexities of mitigating this risk can be found in Section 5 of the Part 2 – Technical Report.

Control Option No. 2 was the second highest level of control considered in the Preliminary Proposal, with a performance metric of four overflows in a representative year. The main impacts associated with upgrading to Control Option No. 2 are as follows:

- The performance metric changes from a system-wide to a district-based limit, meaning that each district would be required to meet a four overflow limit for the Representative Year. To achieve this, the configuration of projects changes for Control Option No. 2. This reconfiguration is not directly aligned with the project configuration for Control Option No. 1, and projects completed as part of meeting 85 percent capture would not necessarily be useful in meeting the long-term water quality objective.
- It would require a higher level of control, increasing to an equivalent level of capture of approximately 98 percent as compared to 85 percent for Control Option No. 1. The exact percentage needs to be confirmed and agreed with MSD prior to the 2030 submission and needs to meet the equivalent water quality bacterial performance reduction as Control Option No. 2 presented in the Preliminary Proposal.

The City has concerns with the cost and affordability of upgrading to a higher level of control in a further accelerated timeline, especially considering the limited additional river use benefits.

The City understands that the future expandability of the program is critical to meeting future regulatory requirements; therefore, the City has chosen to move ahead with a plan that will maintain Percent Capture as the performance measure. The required Percent Capture target needed to meet the regulatory water quality objective will be determined prior to the 2030 master plan update submission. Any analysis required to demonstrate equivalent water quality performance will be reported on in the 2030 update.

6.1.3 Climate Change

The increase in extreme weather events is a potential risk to the performance of the CSO program.

The program is based on a 1992 Representative Year, which could become less representative if rainfall events increase over time. Increased rainfalls would not change the 1992 performance estimates, but the frequency of actual overflows could gradually increase and not meet desired outcomes.

The Preliminary Proposal showed an increase in the frequency of small rainfall events, but an unchanged trend for larger events. Because the CSO control system will capture the smaller events, this trend would not be detrimental to the program performance. However, there is a high degree of uncertainty in the long-term trends, and the opposite effect would occur if the frequency of large events increases.

The CSO Master Plan includes a provision for a response to climate change through the use of GI, rather than more complex and costly changes to the planned grey infrastructure. A 10 percent funding allowance is included in the budget for GI, which is over and above the Preliminary Proposal estimate.

The CSO Master Plan prioritizes sewer separation work upfront; this makes our system more resilient to climate change, as runoff will primarily be directed to LDSs.

6.1.4 Program Feasibility and Sustainability

Aside from the funding requirements and affordability issues, there are a number of other factors to be considered regarding the feasibility of completing this work by 2047. These considerations are described as follows:

- **Affordability:** The City's Water and Waste Department finances its capital and operating budgets for the sewer utility on a user-pay basis through sewer rates. The City takes a longer-term view of rates to provide stability for its rate payers. The rates have steadily been rising for several years and are expected to continue to rise because of major obligations for wastewater treatment plant upgrading and replacement and refurbishment of aging infrastructure; however, continuous increases are not sustainable.
- **Public impact:** Sewer separation projects are planned throughout the combined sewer system and will encompass large sections of the sewer districts. These projects can take several years to complete, resulting in extended periods of impact on residents and businesses.
- **Construction capacity:** The local construction industry is committed to assisting the City with its objectives. While it is assumed that the industry will add resources to meet the City's needs, it is expected that there would be a delay in the ability of the industry to adjust to the additional number and types of projects.
- **City delivery capacity:** To meet the 2047 implementation timeline, the City would have to triple the size of its current capital delivery program from $30 million to $90 million with increased work associated with implementing key aspects of the CSO Master Plan. To achieve this would require additional resources and time to expand.
- **O&M**: New infrastructure will be added that will require additional employees and resources. Some of this infrastructure will be new to the City and will require additional training and supplier support.

- **Other City services impact:** Coordination with other City services will be needed to minimize impacts and identify planning overlap. Services that will be impacted include Transit, Public Works, and Fire Paramedic and Police. Aligning with street renewals will be difficult, but necessary. Coordinating sewer work with street renewals will avoid unnecessary re-work, so that newly renovated streets already have the required sewer work completed.

- **Project overlap:** There are multiple competing infrastructure needs within the City to consider (e.g., sewage treatment plant upgrades) as well as the possibility of additional requirements in the future that cannot be forecast.

- **Proof of concept:** A period of time for technology evaluations and pilot studies is intended to validate and gain comfort in the control option selections. This implies that there is a possibility of rejection, which may lead to the need for more costly substitutes.

6.1.5 Basement Flooding

A major objective of the CSO Master Plan is to avoid compromising basement flooding protection or system operability through the modification of infrastructure, or installation and operation of new equipment. These risks can be mitigated by identification of alternative technologies for control gates, latent storage, screening, and real time control (RTC), followed by completing pilot studies to prove and validate the installations prior to implementing across several districts.

6.2 Opportunities

Opportunities to improve or enhance the CSO Master Plan were identified during its development. These can be realized in several different ways and are described in the following subsections.

6.2.1 Engineering Refinements

Value engineering provides a structured method for reviewing the costs and benefits of conceptual plans, from the perspective of adding value. Value engineering exercises should be carried out early in the conceptual design stage to achieve best value for money in the projects.

The DEPs for each of the combined sewer districts has been developed to a conceptual level. As shown on Figure 6-1, the DEPs will be further developed through the value management, additional studies and through design to construction.

Figure 6-1 Key Design Stages in Life of a CSO Project

6.2.2 Public Engagement

The CSO Master Plan will impact all residents directly through an increase in sewer rates, and traffic disruption. If the CSO Master Plan is implemented under Scenario 1, it could potentially triple the current amount of annual sewer separation work. The public's opinion and buy-in is important to the actual and perceived success of the program and can best be managed through a structured communication program. Communicating what is going on in neighbourhoods and why, as well as managing expectations, are essential to the success of the CSO Master Plan.

6.2.3 Real Time Control

RTC involves installing flow monitors and flow control structures in the sewer system to optimize the capacity during wet weather events, reducing the volume of CSO discharge to the rivers, while still protecting against basement flooding. RTC provides for an increased capture rate by adjusting the operation of the system based on real time data collection. RTC has the potential to offset the grey infrastructure requirements by optimizing the existing system. The City is currently adding instrumentation and sensors to collection systems to better understand the sewer operation. The next stage is to refine the communication link between sensors and control elements to add enhanced operator control. In this way, flow from one part of the system can be controlled to free up capacity in other parts of the system during localized wet weather events. The collection system can be balanced, and flow to the sewage treatment plants can be controlled to reduce peaks. This is a significant change in the way the collection system will be operated. By undertaking the sewer separation project earlier in the implementation, runoff will be removed from the combined sewer system, creating more capacity to store flows using RTC.

6.2.4 Green Infrastructure

CSO GI projects get their designations primarily because of their use of natural systems to reduce runoff. Some examples of GI include porous pavements, bio retention, and rain harvesting. An example of a rain garden installed at a commercial property is shown on Figure 6-2.

Figure 6-2 Rain Garden

The CSO Master Plan recommends that GI demonstration or pilot projects are undertaken to gain experience with the technologies and to confirm performance in Winnipeg's cold climate and heavy clay soils. Issues such as its initial performance and ability to recover after a storm event, freeze-thaw durability, maintenance requirements, and long-term sustainability require further investigation. GI or low impact development standards may be developed to lead the direction of the GI investments.

A budget of 10 percent of the capital program is included in the CSO Master Plan budget, with implementation to commence after a trial and testing period. This later schedule for implementation of GI would still allow it to be considered as a response to the impacts of climate change.

6.2.5 Alternative Floatables Management Approach

The floatables management approach in the CSO Master Plan is based on outfall screening. Screening is not the most effective approach for many of our sewer districts due to many factors including the surrounding environment and the sewer system set-up.

The City has identified an alternative approach to floatables management, which is similar to a successful program run by the City of Ottawa. This proposed new approach targets source control as a potential alternative to screening. This is expected to achieve similar or better results while eliminating end-of-pipe screening.

The alternative floatables management plan provides a significant opportunity to achieve the intended results, while avoiding the high capital and long-term O&M costs of screening facilities.

6.2.6 Industry and Community Collaboration

A program of this scope will create opportunities for partnerships and collaboration with industry and community groups to create mutually positive benefits.

Trends suggest that industry is moving toward greener practices, such as seeking opportunities to create environmentally positive partnerships and promoting the green aspects of their organizations through environmentally positive initiatives. As such, industry may be willing to invest in technologies that could benefit the CSO Master Plan through storm water reduction or other site-specific means.

There are community groups like Save Our Seine, who are aware of the environmental benefits of including GI in the CSO Master Plan program and who already promote green technologies. The City will continue to engage with these groups on the CSO Master Plan.

6.2.7 Project Innovation

The CSO Master Plan was completed at a conceptual planning level for project optimization and cost-effectiveness evaluations. One of our key objectives was to use tried and true technologies and approaches and avoid riskier options. As part of finding opportunities for innovation and cost-effectiveness, it is essential that the proposed control options and selected technologies are revisited as new information becomes available during the implementation of the CSO Master Plan.

7. CSO Master Plan Implementation under Scenario 1

To achieve implementation close to the 2045 deadline, the City will assume that Scenario 1 funding will be in place: that is, three-way shared funding with two other senior levels of government. The CSO implementation plan will comply with EA No. 3042, meeting Control Option No. 1 – 85 Percent Capture in a Representative Year and be completed by December 31, 2047. Two years are included for a major alteration of the licence, plus two years for funding commitments. If combined licence alteration/approval and funding commitments are achieved in less than four years, then the implementation timeline will be correspondingly improved.

The implementation plan details for this recommendation are summarized in Part 3A of this report, and the corresponding DEPs are included in Part 3B.

The program will gradually reduce the volume of CSOs from an estimated average of 5.2 million cubic metres per year in the year 2013 to 2.9 million cubic metres per year by program completion in 2047, based on the Representative Year (Figure 7-1). This corresponds to an increase in capture percentage from 74 percent in 2013 to 85 percent in 2047. The CSO volume reduction is calculated at 2.3 million cubic metres for the Representative Year.

Annual budgeting for this plan requires three-way shared funding of $30 million per year per funding party, based on 2019 dollar values. Budgets will require annual increases for inflation for the full implementation period to meet the 2047 implementation timeline.

An example implementation schedule is shown as Figure 7-2.

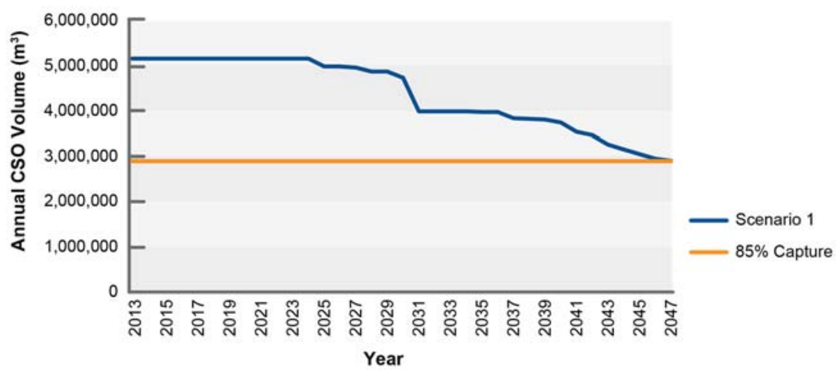

Figure 7-1 CSO Volume Reduction Timeline

Figure 7-2 Example Implementation Schedule

8. Next Steps

The CSO Master Plan sets out a path forward to reduce the volume of combined sewer overflows by 2.3 million cubic metres for the representative year. Acceptance of the CSO Master Plan will require the City to implement this large and costly long-term program impacting about one-third of the serviced sewer area in the City.

Once complete, the CSO Master Plan will increase the estimated level of capture of combined sewage from 74 to 85 percent. The program will demonstrate environmental stewardship and achieve a level of control in compliance with EA No. 3042 and a level of control recognized by the U.S. Environmental Protection Agency for the protection of rivers and lakes.

While the program objective is to improve water quality, the program is defined by overflow volumes and is not based on water quality metrics at this time. Reducing the volume of overflow has a corresponding reduction in any water quality detriment caused by CSOs. The program will reduce the amount of diluted sanitary sewage discharged to the Red and Assiniboine Rivers, improving the rate of compliance with bacterial limits and providing a reduction of floatables material. There will be a minimal reduction in nutrient loading to the rivers.

8.1 Implementation

Following submission of the CSO Master Plan, the City will continue with the committed sewer separation projects and annual CSO results reporting as required by EA No. 3042. The scope of work will be expanded once the CSO Master Plan is approved and the City receives direction from MSD. This will include CSO Master Plan progress reporting and implementation of the Master Plan.

The City has experience with sewer separation, and existing plans (in Cockburn, Ferry Road, and Jefferson sewer districts) will continue. These projects are extensive, and the construction impacts will be significant. Many sewers and large diameter tunnels will be required. An example of a large diameter tunnel shaft is shown on Figure 8-1.

Figure 8-1 Tunnelling Shaft for Jacking Pipe on Taylor Avenue - Cockburn District

8.1.1 Secure Funding

The City has assessed the program costs and has determined that carrying out the CSO program concurrent with its other commitments is unaffordable to its utility rate payers. Assistance from the senior levels of government will be required to complete the program based on Control Option No. 1 in accordance with EA No. 3042. Funding and cost sharing arrangements should be reassessed following selection of the implementation period. Consideration of the CEC recommendation for one-third shared funding from each level of government will be required.

The program implementation has assumed a startup period of four years following submission of this CSO Master Plan to allow for a major alteration and decision from MSD and for multi-year committed tri-government funding agreements to be put in place.

An increased future commitment for migration to Control Option No. 2 will make the financial situation more extreme and require increased commitments from the other levels of government.

The Water and Waste Department will transition from the master planning phase to program management for the implementation phase following acceptance by the Province of the CSO Master Plan recommendations and confirmation of funding commitments. If the City is directed to proceed with the CSO Master Plan without any funding assistance or with reduced funding commitments from the other levels of government, the City will comply. However, the program completion timeline will be based on the City's current maximum affordability limit of $30 million per year.

8.1.2 2030 CSO Master Plan Update

The CSO Master Plan will be implemented in a way that allows for continual improvement and adaptation to changes. Currently an updated CSO Master Plan is required in 2030. The update will report on findings from the multiple studies and pilot projects planned to occur during the initial implementation period. The results of the investigations will add further certainty regarding the risks and opportunities identified in Section 6. Close collaboration with MSD on regulatory issues will be required throughout the evaluation period to arrive at manageable and practicable solutions.

8.1.3 Annual Progress Reporting

Clause 13 of EA No. 3042 triggers annual progress reporting to begin after the MSD has accepted the proposed CSO Master Plan. This includes a summary of planned and completed projects and an estimate of the system performance for the 1992 Representative Year.

CSO Master Plan

PART 2 – Technical Report

Revision 02

August 2019

City of Winnipeg

CSO Master Plan

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Executive Summary

Technical Background

This document presents the final submission for the City of Winnipeg's (City's) Combined Sewer Overflow (CSO) Master Plan. The CSO Master Plan started as a three-phased study in 2013. The first two phases were completed and reported on in the CSO Master Plan Preliminary Proposal (Preliminary Proposal). The first phase identified and developed potential plans for five alternative CSO control limits. The benefits and costs of each alternative were evaluated and ranked through a scoring process in the second phase with "Control Option No. 1 – 85 Percent Capture in a Representative Year" being ranked the highest. A Preliminary Proposal based on the first two phases was submitted to Manitoba Sustainable Development (MSD) before the December 31, 2015, submission date, with a recommendation to proceed with Control Option No. 1.

Following its review and further clarifications, the Preliminary Proposal was approved by MSD on November 24, 2017. This initiated the third phase of the CSO Master Plan, requiring submission of a CSO Master Plan by August 31, 2019, and completion of the program implementation by December 31, 2045.

The November 24, 2017 response from MSD included additional conditions for phasing in Control Option No. 2 – Four Overflows in a Representative Year. This will have significant impacts on the overall program in the future. Migration to Control Option No. 2 was included in this CSO Master Plan submission as a high-level descriptive review.

Technical Approach

The CSO Master Plan will provide a road map for implementation of a long-term program to reduce CSOs. As a planning document, it provides initial concepts and high-level costing. It is intended to be a living document that will be revised with updated planning information and more detailed engineering evaluations as the program proceeds. The district engineering plans (DEPs) meet the intent of the detailed engineering plans requested in the Environment Act Licence No. 3042 (EA No. 3042) and are included as Part 3B. The DEPs are considered planning level from an engineering and cost estimating perspective.

Design Basis

The CSO Master Plan is designed to take the current sewer system from an estimated 74 percent capture rate to an 85 percent capture rate based on the 1992 Representative Year. This has been modelled to be equal to an additional 2.3 million cubic meters of combined sewage being captured and treated based the 1992 Representative Year. The major considerations in the design of a CSO Master Plan that meets the requirements of EA No. 3042 are identified in the following subsections.

Baseline Conditions

The CSO Master Plan was developed with 2013 as the baseline year. This included existing hydraulic models and relevant reports. The hydraulic model was initially developed as part of the Preliminary Proposal with this 2013 baseline data. Updates were made to the hydraulic model for the CSO Master Plan development to correct errors in the data sets that were made available.

Planning Projections

Planning projections account for population growth that may affect the future performance of the CSO program. The use of combined sewers in new developments has been prohibited for over half a century, so no growth or enlargement of the contributing combined sewer area is anticipated. Growth that will impact the CSO program comes from densification and redevelopment within the combined sewer districts, and from outside the combined sewer area that affects the shared capacity of Winnipeg's three sewage treatment plants.

Planning projections for the CSO Master Plan were adopted from studies applied to the most recent sewage treatment plant upgrade projects. The available projections considered growth to 2037 and general allowances for a longer-term design horizon to 2067. The increased capture associated with the CSO Master Plan utilizes additional treatment capacity that may have been used to accommodate growth in the separated areas. The CSO Master Plan utilizes controls that provide temporary storage and controlled dewatering rates to mitigate this decrease in capacity at the treatment plants.

Clause 8 of EA No. 3042 requires no increase in the frequency or volume of CSOs in any combined sewer area due to new and upgraded land development. The City reviews all proposed new developments and proposed redevelopments in the combined sewer (CS) system to ensure that post-development peak wet weather flows (PWWF) are equal to or less than pre-development PWWF, in order to demonstrate compliance with Clause 8. In consider of this, while growth is expected to occur in combined sewer areas, there will be no impact on the flows received on CSOs. As a result, for hydraulic modelling purposes the planning projections were not applied to increase flows generated from combined sewer districts. The planning projections were instead applied to project the increase in sewage flow from the separate sewer areas alone, as they do not have these flow restrictions.

CSO Control Technologies

There are two broad classes of technologies used for CSO control—grey and green infrastructure. Grey infrastructure refers to the conventional infrastructure projects such as sewer pipes or storage tanks. Green infrastructure (GI) refers to those that use natural hydrologic processes to keep rainwater out of the sewer systems entirely. The CSO Master Plan focuses on traditional and well established grey infrastructure. The Master Plan also includes opportunities for green infrastructure, specifically to provide resiliency on potential impacts of climate change on the long term precipitation trends.

Technologies were evaluated for each combined sewer district and proposed based on CSO volume reduction and cost.

Performance Target

Control Option No. 1 – 85 Percent Capture in the Representative Year was the highest ranked of the five control options considered in the first phase and was recommended and approved by MSD for implementation. Upon implementation, it will increase the percent capture in the representative year from the current level of 74 percent to 85 percent. The parameters for Control Option No. 1 provide the basis for how the CSO projects are identified and developed into a program for long-term implementation.

Control Option No. 1 requires that 85 percent capture be achieved for a representative year on a system-wide basis. It does not set limits for the number of overflows or volume of discharge from individual districts, only that the 85 percent capture performance target be met.

Representative Year

The representative year provides the foundation for the technical evaluations, planning, design, and future compliance reporting, and it is fixed for the program duration. The long-term records of annual precipitation were reviewed during the first phase, with the year 1992 selected as the representative year. No further investigations or modifications to the representative year were made for this submission. River flows were also reviewed and 1992 was found to be within the normal range and suitable for use as the representative year river level.

The representative year is applied uniformly on a system-wide basis for the evaluations and design. This assumes uniform rainfall occurs on all districts at the same time. The representative year provides a useful analytical approach; however, because this exact pattern of precipitation will not happen in nature.

The performance of the combined sewer system in comparison to the representative year cannot be measured directly by site monitoring, and the methods for tracking and reporting compliance must be established accordingly.

The representative year rainfall is applied within the InfoWorks software for drainage system modelling. The CSO volumes have been estimated for the existing conditions by simulating the runoff from the representative year precipitation. Future performance is estimated by adding the CSO program updates to the configured model. Since actual rainfall and CSO events are not used in the analysis, or defined in the metrics, compliance with the program is tracked by the degree of project implementation. The impacts of climate change on the continued use of 1992 representative year will be evaluated through the CSO Master Plan implementation.

The river level used for evaluation of the control options was based on the normal summer water (NSWL), typically used in the design and evaluation of sewers in Winnipeg. Results from the modeling exercise using the NSWL are similar to the results using the 1992 river levels. As such, the NSWL levels were used in the evaluation of compliance with EA No. 3042.

Percent Capture Calculation

Percent capture is the key metric for the program design and compliance. Percent capture is calculated as the volume of wet weather flow (WWF) treated in comparison to the total volume of WWF collected. The calculation incorporates the definitions as stated in EA No. 3042 and as agreed to with MSD during development of the CSO Master Plan. In general, the calculation can be applied as shown in Figure ES-1.

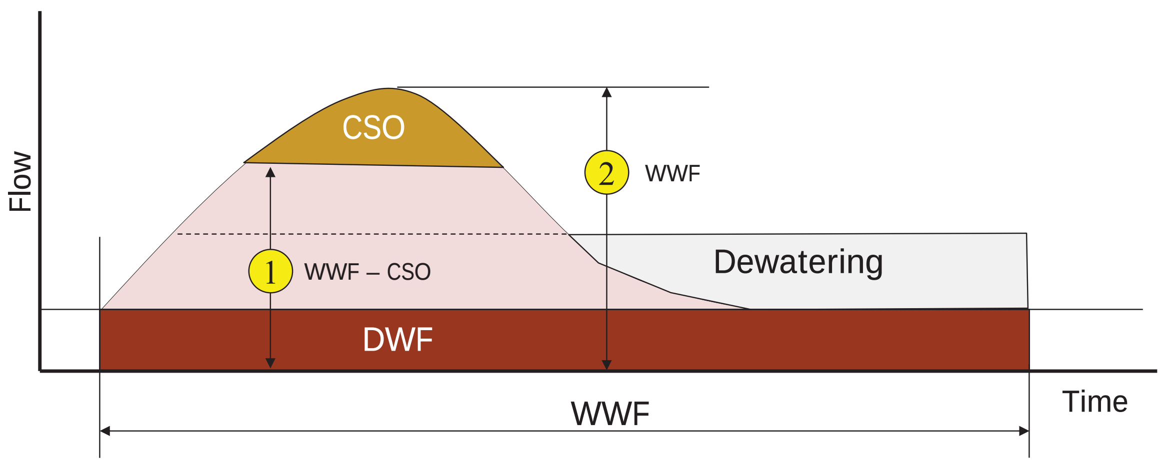

Figure ES-1. Percent Capture Representation

The concept is for the volume represented in Item 1 to be divided by the total volume represented in Item 2 of the figure, with the results represented on a percentage basis.

It should be noted that the percent capture is for WWF specifically, and not for CSO capture alone. WWF is defined as the runoff collected from precipitation along with the dry weather flow (DWF) generated over the wet weather period. CSO is the only component not treated and provides the final factor for the calculation.

The duration of the WWF event was included in the clarification and affects the volume of DWF used in the calculation. The DWF contribution begins upon the start of WWF and terminates at the end of the captured combined sewage dewatering period or WWF treatment period.

Dewatering Strategy

The CSO Master Plan will significantly change the amount and methods by which combined sewage is captured when fully implemented. The current use of diversion weirs installed in Combined Sewer (CS) trunks will be replaced by control gates and temporary storage to capture larger volumes. After the rainfall event, the captured combined sewage will be gradually released back into the interceptors and directed to the sewage treatment plants (STP). This release process is referred to as dewatering. This will be off-set by the sewer separation of select districts, where the WWF flow within the street sections of the district will be removed from the combined sewage and thus reducing the captured combined sewage volume in the corresponding interceptors and treatment systems.

Dewatering rates were determined for each district based on the CSO control options selected and the requirement for dewatering to be completed within 24 hours after a rainfall event has stopped, as required by EA No. 3042. The analysis indicated that the existing pumping stations will meet the dewatering capacity requirements. Even though there will be a larger volume pumped for some rainfall events, the maximum rate of pumping required is less than or approximately equal to what currently exists. The existing pumps will then be required to run for longer durations at a constant rate. The analysis also indicated that the gravity discharge districts meet the dewatering capacity requirements.

Collection System Modelling

The technical approach for the CSO Master Plan made extensive use of computer simulation modelling of the collection systems. This included creating representative models for the entire collection system using InfoWorks CS software. Two sewer system models were developed covering the entire CS and separate sanitary sewage collection systems. These were the Global and Regional models. The Global model included all pipes, while the Regional model is a more streamlined representation of the sewer system for modeling and analysis purposes.

The Regional model developed for Control Option No. 1 of the Preliminary Proposal formed the basis of the evaluation completed for this phase of the CSO Master Plan. The model was updated to incorporate changes the City had made to its version of the Preliminary Proposal model between 2013 and 2019. An increased level of detail was added for the control options in the hydraulic model. Additionally, minor changes identified during the control solution model evaluation and DEP development were added as appropriate.

Project Development

A project is considered an individual control option, such as an off-line tank or control gate construction, that has been proposed to increase the level of CSO capture. An evaluation was completed within the hydraulic model for each CS district to identify suitable control options. An individual district model was used for this assessment. The control options proposed for the individual districts were added to the Regional model to assess the system-wide performance. The system-wide evaluation lead to further refinements at the district level. Once the project selections were confirmed and the system-wide performance achieved 85 percent capture in the 1992 representative year, the final projects were recommended for each combined sewer district.

Control Option Selection Summary

A summary of the project selection is as follows:

- **Sewer Separation:** The sewer separation projects initiated or underway as part of the CSO and basement flood relief (BFR) program have been recommended to continue. These projects have tangible benefits, and the separation option will provide the added benefit of CSO mitigation over and above the BFR objectives. These projects encompass a large component of the total capital costs for the CSO Master Plan program. Previously committed sewer separation projects will continue in the following 5 sewer districts:

  - Cockburn
  - Ferry Road
  - Riverbend
  - Parkside
  - Jefferson East

- **Additional Separation:** The evaluation recommended 10 additional districts where the benefit/cost ratio of sewer separation was greater than that for alterative means using grey infrastructure to achieve the same level of volume capture. The additional separation has a higher initial capital cost but will have lower long-term O&M costs when structured such that a district is completely separated.
- **In-line Storage:** In-line storage accesses the storage volume already available in the existing combined sewers. It is maximized by installing a control gate that increases the interception weir height temporarily, to store additional combined sewage during rainfall events. The in-line storage control gate lowers the interception weir height to the levels currently provided during particularly high rainfall events, to avoid increasing the risk of basement flooding. The evaluation recommended 22 districts for in-line storage via control gate construction. In-line storage will use the existing pump stations where available. For the 10 districts that do not have sewage lift stations, gravity flow controllers are recommended to control gravity discharges to the interceptor.
- **Floatables Screening:** The approach used for floatables screening was to include an off-line screening facility at every primary outfall when hydraulic and operational considerations would allow for it**.** This off-line screening approach for first-flush screening has been recommended for 25 districts.
- **Latent Storage:** The storage volume currently available in relief sewers with separate outfalls is referred to as latent storage and, in most cases, can cost effectively be accessed with the addition of a lift station. The lift station will then convey the combined sewage temporarily stored in these relief sewers back to the combined sewer system. Latent storage has been recommended for 14 districts.
- **Off-line Storage:** Off-line storage is considered as new sewer infrastructure that adds additional temporary storage capacity to the system. Both off-line tank and tunnel storage were considered in the evaluations. Tunnel storage was identified as the preferred option for use where additional storage was required to reach the 85 percent capture metric. Off-line tunnel storage may be used interchangeably with off-line tank storage but has the advantages of being easier to locate and having lower O&M costs. Off-line tunnel storage was recommended for 1 district.

Program Cost Estimating

The proposed control options for each sewer district form the basis of the overall capital cost and operation and maintenance (O&M) cost estimates. Cost estimating followed the same approach as in the Preliminary Proposal, including use of a parametric estimation tool. The Program Alternative Cost Calculator (PACC) tool provided planning level costing information of commonly used CSO control technologies based on other similar completed projects. Refinements were made to the control solution cost curves and the baseline year was adjusted to 2019. The cost estimation process is further described in the Basis of Estimate Technical Memorandum included as Appendix C.

The estimates are considered to be Class 5 in accordance with the Association for the Advancement of Cost Engineering (AACE) International estimating standards. The classification is based on the level of project definition, with the CSO Master Plan being a program with multiple projects, with low levels of definition for each project.

The estimates for each control solution were based on the following general principles:

- Local costs were applied where local estimates were readily available for items such as sewer and chamber installations.
- Standard unit rates from Winnipeg experience were used to estimate and quantify the sewer separation work.

- A parametric cost estimation tool was used for generating costs for other technologies that have not been previously applied in Winnipeg. This tool utilized projects completed in other cities and applied correction factors to adjust to expected Winnipeg conditions.
- The estimate capital costs then include capital cost mark-ups of 53 percent. Program management costs are included within the construction cost markup values.
- A 10% allowance was then applied to these estimated capital costs, to provide funding for future green infrastructure projects.
- Finally, the upper range of Class 5 conceptual estimates of +100% was applied to the estimated capital costs for the program implementation planning and budget evaluations. This also provides an allowance for unknown capital costs, such as potential land acquisition, consequential works, and costs associated with risks not directly identifiable at the conceptual planning stage.

O&M costs were also estimated for the proposed control options for each sewer district. O&M costs were used for lifecycle evaluations and comparisons of different control option selections.

Program Cost Overview

The capital cost estimate for the CSO Master Plan is summarized in terms of 2019 dollar values in Table ES-1:

Table ES-1. CSO Master Plan Capital Estimate

Item	2019 Capital Cost Estimate
Class 5 Estimated Capital Costs	$1,045,800,000
Green Infrastructure Allowance/ Climate Change Resiliency	$104,600,000
Subtotal – Capital Cost Estimate	**$1,150,400,000**
Class 5 Estimate Range of Accuracy: -50% to +100%	$575,200,000 to $2,300,800,000
Total Capital Cost for Budgeting Purposes	**$2,300,800,000**

The total capital cost estimate in terms of 2019 dollar values with all markups and the GI allowance included comes to $1,150,400,000.

The expected accuracy range for a Class 5 estimate is from a low of minus 50 percent to a high of plus 100 percent. This results in the range of estimates as shown in Table ES-2.

Table ES-2. CSO Master Plan - Expected Range of Capital Costs (2019 dollar values)

Estimate	Minimum (-50%)	Maximum (+100%)
$1,150,400,000	$575,200,000	$2,300,800,000

Program costs do not include the following:

Capital investments within the CSO and BFR program committed following the Preliminary Proposal submission, and prior to the submission of this CSO Master Plan.

WWF treatment upgrades ongoing or planned at the sewage treatment plants within the City of Winnipeg.

O&M costs, except as used for net present value comparisons. O&M costs are to be budgeted separately in the City's operating budgets.

The CSO program does not include replacement or rehabilitation of the existing combined sewer infrastructure. A long-term program will be required to continue in parallel with the CSO program for it to be maintained in a condition suitable for it to function with the CSO program upgrades.

District Engineering Plans

The District Engineering Plans (DEPs) are intended to provide a summary of existing sewer district information and describe the proposed CSO Master Plan projects. The DEPs are developed to a conceptual level of detail and will provide the basis for defining the scope of work for future upgrades. It is expected that each project will undergo preliminary and detailed design prior to construction. The DEPs have been prepared as individual reports for each district, and are meant to be living documents, which will be maintained and updated throughout the program as CSO projects are completed and district information changes.

Project Data Collection and Documentation

Project information was collected, developed, and tracked from the Preliminary Proposal through to the third phase of the CSO Master Plan. Technical information has been compiled and transferred to the City in digital format including the InfoWorks model database.

Program Development

Program development is the process of defining the CSO Master Plan program details. It begins after project development, with projects meeting the performance requirements having been identified and evaluated, and capital and operational cost estimates prepared for each project. Program development considers the project sequencing approach for the long-term implementation.

Program Criteria and Constraints

The following criteria and conditions have been identified through the CSO master planning process as having a direct impact on the scenario definitions, their evaluation, and how they impact the program:

- **Regulatory Requirements:** The primary objective of the CSO Master Plan is to achieve compliance with the regulatory requirements, with the two key requirements being CSO capture and implementation schedule.
- **Water Quality:** Since all the scenarios will achieve the same water quality improvements, there is little differentiation between the scenarios. The main consideration is that the extended implementation schedule due to lower funding levels means there will be a delay in achieving the projected water quality improvements.
- **Affordability:** The City's Water and Waste Department finances its capital and operating budgets for the sewer utility on a user-pay basis through water and sewer rates. The City takes a long-term view of rates to provide stability for its rate-payers. The rates have steadily been rising for several years and are expected to continue to rise because of major obligations for sewage treatment plant upgrades, and replacement and refurbishment of aging infrastructure. However continuous increases in rates to support these capital projects are not sustainable. The City has determined that the upper threshold for the CSO program funding should be no more than $30 million per year in order to maintain affordability of water and sewer rates. This has therefore been set as a funding constraint for the CSO Master Plan program.
- **Funding:** Timeframes to achieve completion of the program are directly related to the level of funding committed. The Clean Environment Commission hearings (CEC, 2003) recommended one-third equal shared funding among the three levels of government for upgrading the City's wastewater collection and treatment systems in order to complete the work in a reasonable amount of time. Therefore, the CSO Master Plan implementation period has been evaluated with three funding scenarios representing funding commitments from either one or both of the senior levels of

government. A third scenario considering no funding from either level of government is also considered.

- **Committed Sewer Separation Projects:** Several major projects have been initiated or are well underway in CS districts for upgrading of the level of basement flooding protection with the use of sewer separation, which also reduces CSOs. These projects were part of a previously approved program and align with the CSO Master Plan.
- **Technology Validation:** The CSO program has identified several cost-effective control technologies using grey infrastructure, however many of these technologies have not yet been utilized in the City of Winnipeg. The City plans to carry out investigations and testing of these new technologies on local conditions prior to full scale commitment. They will be programmed later in the CSO Master Plan.
- **Operations and Maintenance:** The new CSO control technologies include mechanical equipment that is more labour-intensive, and with a shorter service-life than what currently exists. The City requires that this be recognized in the evaluation, with major mechanical equipment having a service life of less than the period under evaluation for life cycle comparison purposes be accounted for with periodic replacement costs.
- **Startup:** The City recognizes the potential for delays in regulatory approvals and provincial and federal funding commitments. Accordingly, the schedule has assumed a two year delay in receipt of the final regulatory licence, to allow time for a major alteration of the CSO licence and a further two year delay for the commitment of long-term provincial and federal funding. During this time all committed sewer separation projects as part of the existing CSO and BFR programs will continue to be funded and implemented by the City.
- **Integrated Benefits:** The CSO and BFR programs are to be combined into a single integrated program once the CSO Master Plan is implemented.
- **Beneficial Uses:** The river systems within Winnipeg are not recommended for recreational use in which sustained contact with the water occurs. It is not expected that improvements in percent capture with implementation of the CSO program will improve the river water quality to change these recommendations.
- **Stakeholder Expectations:** The public has been engaged during the Preliminary Proposal phase at the public events held between 2013 and 2015. Further public communications work will continue as elements of the CSO Master Plan are initiated.
- **Risks and Opportunities:** Longer implementation periods would tend to reduce many of the risks inherit to a capital program of this scale. The longer implementation period however would result in an escalation in construction costs due to inflation.

Program Scenarios

The purpose of multiple program scenarios is to provide a structure for evaluation of a broad range of program alternatives. In practice, however, the final range of scenarios was limited, because the projects were pre-selected, and the application of the criteria and constraints limited the number of variables to be considered. The program scenarios therefore specifically address different sources and levels of funding.

The program scenarios are as follows:

- **Scenario 1 – Shared Tri-Level Funding:** A tri-level funding agreement between the Government of Canada, Manitoba Government and the City of Winnipeg. The City has an expectation that the program will be equally funded through a cost-sharing arrangement with the federal and provincial governments, at one-third equal funding contributions from each level of government. This scenario places a limit of $30 million per year on funding from each of the three levels of government, totally $90 million per year.
- **Scenario 2 – Shared Bi-level Funding:** A bi-level funding agreement between the City of Winnipeg and either the Government of Canada or the Manitoba Government. As a compromise to three-way funding, the second scenario assumes that one of the two senior levels of government will not

participate in the funding arrangement. This has the effect of maintaining the same $30 million per year level of funding per year from two of the three levels of government, totally $60 million per year maximum. The reduced funding will ultimately extend the timeline for the program implementation.

- **Scenario 3 –City-only Funding:** This scenario assumes the two senior levels of government will not participate in shared funding, with the program being fully funded by the City at a limit of $30 million per year. The schedule would be extended as necessary at this fixed rate of funding to complete the program.

Program Implementation Strategy

In addition to the program criteria in the previous section, a strategy has been defined to balance risks and costs of the projects through the implementation period. Additionally, projects were scheduled to maintain a relatively uniform level of expenditure within the approximate implementation period based on the three funding scenarios.

Program sequencing was carried out for each funding scenario based on the following:

1) **Start-up**:

Funding for the first four years was limited to the City's contribution cap. The delay accounts for a two year period to allow a major alteration to the Licence and a further two year period for the other levels of government to arrange for their funding commitments.

2) **Committed Sewer Separation Projects**:

Committed projects will be carried out to completion. The City's legacy CSO and BFR program is well advanced and has contributed greatly to basement flooding reductions. Several CS districts have been identified for relief, with the preferred method of relief being sewer separation, which provides the dual benefit of flooding reduction and CSO mitigation.

3) **Additional Separation Projects:**

Sewer separation was identified for several sewer districts during the project selection process. The additional separation locations are not currently committed. It is therefore assumed they can be implemented at any time, unless noted otherwise.

4) **Partial Sewer Separation Projects:**

The partial sewer separation projects are recommended for a variety of reasons, generally because of their connection to another project:

- Ash: There is potential opportunistic separation as part the Route 90 – Kenaston corridor upgrade.
- Jessie: Southeast Jessie to be separated as part of the Cockburn CSO and BFR project.

5) **In-Line Storage, Gravity Flow Control and Latent Storage Projects:**

In-line storage, gravity flow control and latent storage generally provide the highest cost-effectiveness but concerns with operation and the reliability of the technologies must be resolved prior to their use. Because of their high cost-effectiveness, these projects are sequenced to be implemented shortly after evaluation and acceptance of the technologies.

Control gates are an integral part of floatables screening and real time control (RTC), and coordination of their implementation with in-line storage projects is required.

6) **Tunnel and Off-Line Storage Projects:**

Tunnel and off-line storage are considered similar to each other from a project sequencing perspective, with neither taking a priority over the other.

Neither tunnel nor off-line storage are being applied for basement flooding improvements, and control gates are integrated into both to maximize their performance. The implementation of these solutions will follow with the implementation of the high cost effective in-line storage, latent storage and gravity flow control projects.

7) Program Support Services:

The CSO program will require a wide range of engineering and administrative services throughout its completion to support overall program management. They are expected to include the following:

- Technology Evaluation and Pilot Studies:
    - Control Gates
    - Screens
    - Flap Gate Control
    - Green Infrastructure
    - Real Time Control
- Alternative Floatables Management Demonstration Project and Pilot Study
- In-Situ Flow Monitoring Of Districts Before and After Control Options Implemented
- RTC Instrumentation Upgrades (as required) and SCADA Integration
- 2030 CSO Master Plan Update

Project support services will include one-off investigations as well as continual annual activities. The details will be established once the program is initiated. A cost allowance for these works has not been included in the CSO Master Plan.

The City intends to complete the main technology evaluations and pilot studies within the first ten years. At that time the level of effort for support services will reduce, and recommendations from the work will be incorporated into the already budgeted capital projects. Some level of support services will continue but has not been accounted for in the CSO Master Plan estimates.

8) Green Infrastructure Projects and Climate Change Resiliency:

Green infrastructure (GI) has been addressed separately from the other control options. It has not been included in the base solutions because of unknowns and uncertainty with its application. It is recommended that the analysis of the main technology evaluations and pilot studies are completed within the first ten years. This will provide confirmation that these proposed options are appropriate and suitable for the Winnipeg sewerage system. The GI projects will provide the necessary additional performance improvements to mitigate any detrimental impacts from Climate Change on future precipitation trends An allowance of 10 percent of the total CSO Master Plan capital cost estimates has been included for its future implementation.

Scenario Evaluations

The program scenarios were evaluated with the programming workbook tool. Projects were scheduled according to the criteria and constraints identified, maintaining constant annual budget amounts in terms of 2019 dollar values. Table ES-3 provides a high level summary of the program under each funding scenario.

Table ES-3. CSO Master Plan Funding Scenario Evaluation Results (2019 Dollars)

Program Scenario	Description	Funding by	Annual Budget	Timeline
Scenario 1	3 Levels of Funding 3 x $30 Million	Tri-level Government of Canada, Manitoba Government and the City of Winnipeg	$90 Million	27 years (2047)
Scenario 2	2 Levels of Funding 2 x $30 Million	Bi-Level City of Winnipeg and either the Government of Canada or the Manitoba Government	$60 Million	39 years (2059)
Scenario 3	1 Level of Funding 1 x $30 Million	One Level City Only	$30 Million	75 years (2095)

Only Scenario 1 would allow the CSO Master Plan to be completed near the 2045 deadline, as requested by MSD. In contrast, Scenario 3 is estimated to be complete by 2095 (75 years). Scenarios 2 and 3 are intended as guides to illustrate the impact of reduced funding arrangements.

The City will proceed under the assumption that funding will be as described with Scenario 1, with three-way shared funding with the two senior levels of government. The CSO implementation plan will comply with EA No. 3042, meeting Control Option No. 1 – 85 Percent Capture in a Representative Year and be completed by December 31, 2047. Included in this time frame are two years for a major alteration of the Licence and two years for arranging funding commitments. If combined Licence alteration/approval and funding commitments are achieved in less or more than four years, then the implementation timeline will correspondingly change.

The implementation plan details for this recommendation are summarized in Part 3A of this report, and the corresponding DEPs are included in Part 3B.

Migration to Control Option No. 2

The MSD response to the Preliminary Proposal of December 24, 2017, included a condition that Control Option No. 1 - 85 Percent Capture in a Representative Year be implemented in such a way that Control Option No. 2 - Four Overflows in a Representative Year may be eventually phased in. This condition will have further financial and planning impacts.

The City raised concerns that the migration approach is not cost-effective, primarily due to the change in the metric by which performance is measured. Control Option No. 1 considers the percent capture as the metric used to measure and track performance. Control Option No. 2 moves away from the percent capture metric, and instead relies on the number of overflows at each outfall across the city as the performance tracking metric. There are several master planning impacts associated with upgrading to Control Option No. 2 and changing the performance metric during the implementation in this manner. Each of these impacts are stated further below:

- The performance metric would essentially change from a city-wide limit to a district-based limit. Under Control Option No. 2 each district would be required to meet a four overflow limit for the representative year. To achieve this the configuration of projects changes, such that only the work necessary to reduce the overflows from the district to four or less would be practical to complete. Even in the case where to continue work in a particular district to remove all overflows is the most cost effective solution at that time, it would not be completed under Control Option No. 2 as there would be no further benefit provided in completing this work to meet Control Option No. 2. With Control Option No. 1 and utilizing a volume percent capture metric across the City of Winnipeg, this is not the case. With the percent capture metric to completely remove overflows from a particular district, where it is most cost-effective to do so, continues to provide performance improvements to towards meeting the target. This reconfiguration to meet the Control Option No. 2 target and associated performance metric is not directly aligned with the project configuration currently provided for Control Option No. 1. Projects completed as part of meeting 85 percent capture would not necessarily be useful in meeting the Control Option No. 2 target, as currently defined.

- Utilizing a district based overflow metric will require that some amount of partial work would need to be completed in every district to achieve a CSO frequency of 4 or less per year. This would include work in several districts where it is not as cost-effective to complete this work compared to other districts. Utilizing a percent capture metric allows for the maximization of work available within a single district where it is cost effective to do so, in order to reduce the burden on other sewer districts where it may not be as cost-effective to have construction projects implemented.

For these reasons the City has engaged MSD as part of the Master Plan development, to discuss the issues mentioned, and to propose continuing with a volume percent capture metric. The City would continue to prepare the CSO Master Plan and the CSO Master Plan update such that the future target would be Control Option No. 2, however it would be evaluated based on an *equivalent volume percent capture target* which would provide equal or better performance. From this analysis it has initially been found that a level of volume capture of approximately 98 percent as compared to 85 percent for Control Option No. 1, would provide the same benefits on the receiving water bodies as Control Option No. 2. The exact equivalent percent capture target requires further water quality testing to confirm it meets the equivalent water quality bacterial performance reduction of Control Option No. 2 presented in the Preliminary Proposal. This level of water quality evaluation is beyond the scope of work for this CSO Master Plan submission, and would ultimately delay submission beyond the August 31, 2019 deadline if included. As part of the engagement regarding this with MSD, it was agreed that this water quality evaluation would instead be completed as part of the 2030 CSO Master Plan update submission, to determine the exact equivalent percent capture target to Control Option No. 2. This increased percent capture target would then be recommended to MSD to be applied as the future control target in which the 2030 CSO Master Plan update is evaluated. By doing so the plan continues with the percent capture metric while meeting MSD's overall goals on water quality improvements.

Monitoring and Reporting

Monitoring and reporting is a requirement of EA No. 3042 and is required during the development and implementation of the CSO Master Plan. The specific clauses listed in the Licence include the following:

- **Clause 9: Public Education Plan:** A public education program plan documenting how information on combined sewer overflows will be made available to the public
- **Clause: 10: Public Notification System:** A plan regarding the development and implementation of an internet-based public notification system for all discharges from combined sewer overflow points, including an assessment of making this notification available on a real time basis.
- **Clause 13: Annual Progress Reporting:** Upon approval of the CSO Master Plan, provide annual submissions with an indication of progress. This is to include monitoring results and the work plan for the next year.
- **Clause 14: Reporting (Director Notification):** A notification plan acceptable to the Director for each overflow event
- **Clause 15: Interim Monitoring:** A plan for water quality monitoring between May 1, 2014 and the date upon which the master plan is approved.
- **Clause 16: Record Keeping:** Maintain annual records of water quality testing results and CSO dates

Clause 9, 10, 14 and 15 will be complete and in place prior to the start of implementation. Clauses 13 and 16 relate to the annual reporting and record keeping during implementation.

The City has liaised with MSD and developed reporting protocols for the public notification system and interim water quality monitoring. Transition to the CSO Master Plan implementation will require that updated protocols be established for progress and performance monitoring and compliance reporting for the implementation program.

The reporting approach for implementation of Control Option No. 1 is dictated by use of the percent capture performance metric. Progress reporting will be based on project completion in comparison to the work scheduled in the CSO Master Plan. Annual reporting will identify construction progress in comparison to the current version of the CSO Master Plan and the work plan for the subsequent year.

Risks and Opportunities

The program planning process identified a number of potential risks with significant potential consequences. Consideration of risks and opportunities was part of the CSO Master Plan development. Individual risk responses and contingency allowances were not directly identified, but recognition and general allowance for risk is included in the upper end of the range of cost estimates which is included as part of the budget estimates. The following risks and opportunities are being highlighted as having potential impacts on the CSO program.

Risks

Risks to the successful completion of the CSO Master Plan were identified throughout the planning process. Where possible mitigation measures have been identified and are described in the following subsections.

- **Program Implementation:** The City has identified the program costs as being unsustainable to rate payers while meeting the 2045 target date. Support from both senior levels of government will be requested, with a fallback position of extending the implementation timeframe to fit with funding availability. Large capital programs are always at risk of cost uncertainty and increases. Cost monitoring as part of the program management process will be used to track market trends and adjust the program for better results. Large scale infrastructure projects take a long time from initiation to completion with the potential for delay risks. Budget restrictions and shortages of engineering and contracting capacity may also limit the rate of progress to implement the program. Program management tracking and project selections will be carried out to coordinate types of work and timing with availability of resources.
- **Migration to Control Option No. 2:** The risk of moving to a different performance metric during the implementation of the program can be reduced by demonstrating how the volume percent capture metric can be maintained. The additional cost to complete the migration is significant and must be better defined prior to the 2030 CSO Master Plan update.
- **Climate Change:** The potential for more severe weather from climate change may affect the relative performance of the CSO mitigation works. The control options will continue to capture WWF, but their performance will depend on the nature of the change. They will capture greater volumes with an increase in the number of precipitation events.
- **Program Feasibility and Sustainability:** In order to complete the program cost effectively and to minimize the risks, a number of initial studies and evaluations must be completed in the early stages to gain confidence in new technologies. This program will compete with multiple other large infrastructure projects needed in the City that will be drawing from the same pool of resources. The capacity of local industry in terms of engineering and construction services will have to adapt to the scale of the program.
- **Basement Flooding:** A major objective of the CSO Master Plan is to avoid compromising basement flooding protection or system operability through the modification of infrastructure, or installation and operation of new equipment. These risks can be mitigated by identification of alternative technologies for control gates, latent storage, screening and RTC, followed by completing pilot studies to prove and validate the installations prior to implementing across several districts.

Opportunities

The CSO Master Plan has been developed using grey infrastructure projects and has not incorporated GI and RTC optimization. These additional control options are included in the CSO Master Plan as potential program opportunities. These opportunities will provide additional capacity to meet more stringent control targets, provide resiliency to impacts from changes in precipitation patterns based on climate change, or provide a cost-effective measure to off-set the cost of grey infrastructure projects currently recommended.

Specific opportunities where there is potential for savings and added CSO volume reduction have been identified as follows:

- **Engineering Refinements:** Value engineering provides a structured method for reviewing the costs and benefits of conceptual plans, from the perspective of adding value. Value engineering exercises should be carried out early in the conceptual design stage to achieve best value for money in the projects. The DEPs for each of the combined sewer districts has been developed to a conceptual level and will be further developed through value management, additional studies and through design to construction. The timeframe of the program will require new and innovative technology be reviewed and incorporated into the program as applicable.
- **Public Education:** The public's perceived success of the program can best be managed through a structured communication program. Communicating what is going on in neighbourhoods and why, as well as managing expectations, are essential to the success of the CSO Master Plan.
- **Stakeholder Collaboration:** Working together with other stakeholders including industry and community groups will provide partnership opportunities that may provide additional benefit to the CSO Master Plan.
- **Real Time Control:** RTC provides a method of increasing system performance by improving the operation of the system by increasing the use of existing infrastructure. The topography in Winnipeg is relatively flat and allows for a potentially higher than typical utilization rate. RTC can adapt and balance the system for real precipitation events that are spatially and temporally distributed. Flow monitoring and sensing equipment will be incorporated throughout the system to provide an increased understanding of operation. These controls will provide a basis for a future system that links the sensing and control elements together with the control infrastructure. This will allow for better control on a real time basis and an optimization of flows in the system and to the treatment plants.
- **Green Infrastructure:** EA No. 3042 requires that GI be used in the design and operation of all new and upgraded storm and wastewater infrastructure. GI is applicable to both private and public property. However, the application of GI in Winnipeg must be evaluated to confirm the potential long term benefits to CSO reduction and the evaluations should be completed in the early stages of implementation. Future use of GI is most cost effective when installed as part of other capital projects including community enhancements and street work. The CSO Master Plan has included a budgetary allowance to incorporate GI in the future.
- **Floatables Management Approach:** The CSO Master Plan includes implementation of 25 screening facilities where hydraulics permit. The installation and operation of the screens will be difficult because of the limited space for construction, difficulty in access, and high O&M requirements. Screens tend to clog and increase the risk of basement flooding; therefore, they must be continually monitored and maintained.

  For these reasons the City has identified source control as a potential alternative to screen installation to provide the floatables management requirement. The investigation of source control alternatives will proceed in the early stages of the program. Districts that have been identified as being difficult to install screens are likely candidates for this evaluation as pilot projects. The comparative evaluation will be presented for replacing the screens with the program once the approach has been fully investigated and confirmed.

Next Steps and Future Considerations

The CSO Master Plan sets out a path forward to reduce the volume of combined sewer overflows by 2,300,000 m^3. Acceptance of the CSO Master Plan by MSD will require the City to adopt a long-term program impacting approximately one third of the serviced sewer area across Winnipeg. Upon completion, the estimated level of combined sewage capture will increase from 74 to 85 percent and a Control Option No. 1 target of the CSO Master Plan will be achieved.

A delayed start of 4 years has been included in the implementation to account for a startup period that would include time for regulatory acceptance of the plan and to secure program funding. In the early stages of implementation, the lower risk previously committed sewer separation projects will continue, and pilot studies and evaluations of new technologies will occur. During the first ten years, the City will further evaluate the options in moving towards the higher level of regulatory compliance established as Control Option No. 2. The evaluations for meeting the increased level of compliance and the new technologies will take place in collaboration with the regulator and will be documented as part of the 2030 CSO Master Plan update.

It is certain that future conditions and influences will change over the implementation of the program. The CSO Master Plan is able to adapt to continue achieving progress towards meeting the environment regulations set out in EA No. 3042 and accommodate future changes. A consistent approach to the monitoring and reporting of progress is necessary for a cost effective approach during implementation. A plan that balances the impact on all stakeholders through a well-managed program based on proven technologies will guide the City towards achieving compliance.

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Acronyms and Abbreviations

AACE	Association for the Advancement of Cost Engineering
ADWF	average dry weather flow
BFR	basement flood relief
$CBOD_5$	5-day carbonaceous biochemical oxygen demand
CCME	Canadian Council of Ministers of the Environment
CEC	Clean Environment Commission
CEPA	*Canadian Environmental Protection Act*, 1999
City	City of Winnipeg
CO1MP	Control Option No. 1 – Master Plan
CS	combined sewer
CSO	combined sewer overflow
DBB	design bid build
DEP	district engineering plan
DO	dissolved oxygen
DWF	dry weather flow
EA No. 3042	Environment Act Licence Number 3042
FPS	flood pumping station
GI	green infrastructure
GIM	ground infiltration module
GIS	geographical information system
HGL	hydraulic grade line
ICI	industrial/commercial/institutional
LDS	land drainage sewer
LS	lift station
MMWE	*Management of Municipal Wastewater Effluent*
MPN	most probable number
MSD	Manitoba Sustainable Development
MRST	Manitoba Retail Sales Tax
MWQSOG	Manitoba Water Quality Standards, Objectives and Guidelines
NEWPCC	North End Sewage Treatment Plant
NPRI	National Pollutant Release Inventory
NPS	national performance standards
NPV	net present value
NSWL	normal summer river water level
O&M	operations and maintenance
PACC	Program Alternative Cost Calculator
Preliminary Proposal	CSO Master Plan Preliminary Proposal
Province	Province of Manitoba
POC	pollutant of concern

PWWF	peak wet weather flow
RDII	Rainfall Derived Inflow and Infiltration
RI	Residential Indicator
RLC	Regulatory Liaison Committee
RM	Rural Municipality
RTC	real time control
RTU	remote terminal unit
RWC	Regulatory Working Committee
SCADA	supervisory control and data acquisition
STP	Sewage Treatment Plant
SEWPCC	South End Sewage Treatment Plant
SRS	storm relief sewer
TMP	transportation master plan
TSS	total suspended solids
WEWPCC	West End Sewage Treatment Plant
WSER	Wastewater Systems Effluent Regulations
WSTP	Winnipeg Sewage Treatment Program
WWF	wet weather flow
WWS	wastewater sewer

1. Introduction

1.1 Study Background

The City of Winnipeg (City) is required to develop a Combined Sewer Overflow (CSO) Master Plan to comply with the Province of Manitoba's (Province's) *Environment Act Licence Number 3042* (EA No. 3042) (Manitoba Conservation And Water Stewardship, 2013). EA No. 3042 requires the evaluation of alternative regulatory control limits to select the best approach to developing the CSO Master Plan. Control limits establish the method of measurement used to assess the performance of the CSO Master Plan. The CSO Master Plan provides the City with a long-term roadmap for CSO mitigation.

"Control option" was the original term used in the Preliminary Proposal to describe the type of technology that may be constructed to reduce CSOs. A dual definition for the term arose through the licensing process, with control option used to describe the level of performance, such as "Control Option No. 1 – 85 Percent Capture in a Representative Year." The technology reference is occasionally replaced with the term "solution" but remains in use and can be differentiated by the context of the discussion.

The CSO Master Plan assignment commenced in February 2013 with a work plan structured into a progressive three-phase approach:

1. **Phase 1: Study phase:** This phase developed a series of potential Master Plan configurations for each of the alternative control limits identified in EA No. 3042.
2. **Phase 2: Visioning and decision-making phase:** This phase focused on control limits through evaluation and rating of the merits of the potential plans developed in the first phase.
3. **Phase 3: Long-term Master Plan phase:** This phase developed a Master Plan to meet the selected control limits, which serve as an implementation roadmap and identify a series of projects that will meet the intent of the Master Plan.

The first two phases led to the development of the CSO Master Plan Preliminary Proposal (Preliminary Proposal; CH2M., 2015). The Preliminary Proposal provided a recommended approach to Manitoba Sustainable Development (MSD) for review and acceptance. The Preliminary Proposal evaluated five potential control options, described the process for the control option evaluation, and recommended the most advantageous option considering Winnipeg-specific performance measures and value criteria.

The Preliminary Proposal was submitted to MSD on December 18, 2015, with a formal response received from MSD on November 24, 2017, in which Control Option No. 1 - 85 Percent Capture in a Representative Year was accepted. A condition was added, stating that Control Option No. 1 be implemented in a way such that Control Option No. 2 (four overflows in a Representative Year) may be phased in and the implementation end date for the Master Plan was changed from 2030 to 2045 or an alternative date subject to approval by the Director of MSD.

The entirety of this CSO Master Plan document development occurred during the third phase. This CSO Master Plan is based on MSD's approval of Control Option No. 1 and includes District Engineering Plans (DEPs) for each sewer district and an overall program implementation plan.

1.2 Purpose

This Part 2 Technical Report is part of the third phase work, and documents the approach for development of the recommended CSO Master Plan and its implementation. It provides the analysis of potential control options for each sewer district used to form the Master Plan. The Part 2 report also describes the process for the evaluation and recommendation of the overall program. It also summarizes the updated program cost estimates and performance targets.

1.3 Scope

The scope of this third phase is to develop an implementation plan for Control Option No. 1, with the services as documented in Scope Change 11, CSO Master Plan – Phase 3 Updated Work Plan, approved by the City on June 20, 2018. The scope includes a descriptive evaluation of the impacts of migration from Control Option No. 1 to Control Option No. 2 but does not include a detailed evaluation and recommendations for phase in of Control Option No. 2, or for the 2030 CSO Update.

The work plan includes project development, program development and preparation of DEPs for all 43 Combined Sewer (CS) districts in order to meet the regulatory requirements for Control Option No. 1. Descriptive assessments for migration to Control Option No. 2, and descriptive assessment of opportunities such as the use of Green Infrastructure (GI) and Real Time Control (RTC), and an alternative floatables management approach are included. The opportunities will be further developed as the CSO Master Plan is implemented.

This Part 2: Technical Report is organized into the following major sections:

Section 2, Technical Background: Provides an overview of the current situation, the licensing process, and information relevant to developing the DEPs and program implementation.

Section 3, Technical Approach: Provides an overview of the approach and technical methodology used to assess existing conditions, evaluate control options, develop the DEPs and develop the overall Master Plan.

Section 4, Program Development: Describes the approach used to develop the CSO Master Plan program including decision criteria and identifying the funding scenarios being considered. It also provides a description of anticipated program management, monitoring and reporting requirements.

Section 5, Risk and Opportunities: Provides an overview of the risks and opportunities identified during the plan development. This includes GI for climate change resilience, RTC and the alternatives floatable management approach.

Section 6, Next Steps and Future Considerations: Provides an overview of the next stages and considerations for the implementation of the CSO Master Plan.

Section 7, References: Provides a summary of source documents.

2. Technical Background

This section provides an overview of the technical background for the CSO Master Plan. This includes a description of the City's collection and treatment systems, CSO regulatory history, water quality considerations, and current CSO programs, as well as an overview of the first phase of the CSO Master Plan development.

2.1 Master Plan Key Drivers

The key drivers are a major consideration in the evaluation and selection of the preferred CSO Control Option and development of the CSO Master Plan. The Master Plan takes a balanced approach to addressing the key drivers. The key drivers used for assessing the development and implementation of a Master Plan in Winnipeg are as follows:

Public Health

It is understood that the bacteria in CSOs poses a risk to human health. Infection may be possible through direct contact and ingestion of contaminated sources. The representative contribution that CSOs have in increasing this risk has been reviewed as part of the water quality analysis completed. CSOs represent only one of many contributing sources of bacteria to receiving water courses. A reduction in the volume of CSOs entering the watercourse will not eliminate this risk.

Aesthetics

The appearance of floatable material creates a negative experience for people using the river walks and those that commonly use the rivers for recreation. However, a reduction in the volume of CSOs will not materially change the appearance of the rivers in Winnipeg or the amount of visible floatable material.

Nutrients

Nitrogen and phosphorus loading to the rivers can influence the river system and the life within it. Nutrient loading from CSO discharge and the influence of these loadings on the river systems is a consideration in the development of the CSO Master Plan. The health of Lake Winnipeg is a major concern. The water quality study completed in development of the CSO Master Plan indicated that CSO discharge does not contribute significantly to phosphorus and nitrogen nutrient loading to Lake Winnipeg. For existing conditions, less than 0.3 percent of the total load of both nitrogen and phosphorus to Lake Winnipeg is from CSOs.

Aquatic Life

CSOs can change river conditions and influence its ability to sustain life. Dissolved oxygen (DO) and ammonia content are the two most important criteria for aquatic life, which may be affected by CSOs. The water quality analysis completed indicated that CSOs depress the DO level slightly, but not to a level that would impact aquatic life. Ammonia contribution from CSOs is also negligible in terms of river loading. The contribution of ammonia from dry weather flows at the sewage treatment plants (STPs) has a much greater impact than CSOs.

Public Perception

It must be understood that CSOs represent a minor impact to the overall aesthetic and health of the lakes and rivers. It is therefore, fundamentally important to continue to educate the public on the impact of CSO discharges.

Regulatory Requirements

EA No. 3042 was issued to assist the City in developing a mitigation strategy for CSOs. All options must be assessed in terms of meeting the requirements of EA No. 3042. The regulatory environment is constantly changing and a program that balances the potential changes is required.

2.2 Regulatory Background

The regulatory perspective for wastewater discharges in Manitoba has evolved significantly over the years. Treatment plant licensing has evolved to include lower effluent limits, CSO discharges are licenced and there has been an increased focus on protecting water quality.

MSD is the regulatory body that is responsible for the licensing and enforcement of the provincial *Environment Act* (Government Of Manitoba, 1988) and subsequent EA No. 3042 outlining the regulatory requirements for CSOs. The regulatory background and current perspective are described in the following section.

2.2.1 CSO Licensing History

Prior to 1988, the City had responsibility for protection of river water quality within Winnipeg and provincial licensing was not required. After proclamation of the Environment Act on March 31, 1988, responsibility was transferred from the City of Winnipeg to the Province of Manitoba. Prior this point, the City continued to make major investments in wastewater treatment.

In 1989, the Minister of Conservation instructed the Clean Environment Commission (CEC) to hold public hearings and provide a report with recommendations on water quality objectives for the Red and Assiniboine Rivers within and downstream of Winnipeg to sustain beneficial uses of the rivers.

After completion of hearings in 1992, the CEC submitted a report with 14 recommendations (CEC, 1992). With respect to CSOs, the CEC concluded there was insufficient information to advocate for CSO regulation and recommended that site-specific studies be undertaken to determine the water quality impacts and formulate remedial measures.

The CSO study undertaken by the City that followed was a comprehensive multi-year study that commenced in 1994 and was finalized in 2002; it is now referred to as the *2002 CSO Study* (Wardrop, 2002). It was undertaken in four phases, which included identification of the current situation, the effects of overflows on river water quality and river use, the potential control options and their costs and benefits, and development of an illustrative CSO control program. The study's final report was presented at CEC public hearings in 2003.

The 2003 CEC public hearings were called following a sewage spill at the City's North End Sewage Treatment Plant (NEWPCC) on September 16, 2002. The spill of 427 million L of untreated sewage into the Red River had extensive media coverage and resulted in the Minister of Conservation instructing the CEC to include both the collection and treatment systems in the public hearings.

The CEC conducted the hearings over a 9-day period between January and April of 2003, and submitted its *Report on Public Hearings. City of Winnipeg Wastewater Collection and Treatment Systems* (CEC, 2003) which includes advice and recommendations. The recommendations include:

- Nutrient Management Strategy
  - Recommendation 5 – "The City of Winnipeg should be directed to plan for the removal of nitrogen and phosphorus from its municipal wastewaters, and to take immediate steps in support of the nutrient reduction targets established for Lake Winnipeg. The City's nutrient removal plan should be a key element of a licence review hearing to be scheduled within two years."
- Combined Sewer Overflow Reduction
  - Recommendation 7 – "The City of Winnipeg should be directed to shorten the timeframe to complete its combined sewer overflow plan from the proposed 50 years to a 20 to 25-year period."
  - Recommendation 8 – "The City of Winnipeg should be directed to take immediate action to reduce combined sewer overflows by instrumenting outfalls, adjusting weirs, accelerating

combined sewer replacement, advancing the pilot retention project and undertaking other reasonable measures to reduce combined sewer overflows within two years."

- Public Notification System
  - Recommendation 9 – "The City of Winnipeg should be directed to develop and implement a notification system to inform the public whenever there is a release of raw sewage from any source into the Red and/or Assiniboine Rivers. This public notification system should be operational by the beginning of the 2004 summer recreation season."
- Financial Support
  - Recommendation 15 – "The City of Winnipeg should be directly assisted by the Province of Manitoba in efforts to secure financial support under existing and future infrastructure programs for upgrades to its wastewater collection and treatment systems."
  - "The Commission believes that the senior levels of government should assist with the cost of achieving improved nutrient management and other water quality enhancement measures. Ideally, the funding formula of one-third municipal, one-third provincial and one-third federal should be used."
- Public Education
  - Recommendation 17 – "The City of Winnipeg should be strongly encouraged to develop and implement a permanent public education program to improve awareness of Winnipeg's wastewater collection and treatment systems, and to foster public involvement in activities focusing on water conservation and pollution prevention at source."
- Public Consultation
  - Recommendation 18 – "The City of Winnipeg should be directed to prepare a public consultation plan for Winnipeg's wastewater collection and treatment systems for approval by Manitoba Conservation by April 2004."

Other findings by the CEC related to CSOs were identified in the body of the report but not included as recommendations. These were as follows:

- "However, based on concerns, consideration of the impacts only as they may relate to recreational season is insufficient. Combined sewer overflows should therefore be managed on an annual basis and not just during the summer months."
- "The Commission notes that the target of four combined sewer overflow events per year may not result in significant improvement over the present situations."

The recommendations were received and reviewed by MSD, and in response to this Environment Act Licence No. 3042 (EA No. 3042) was issued on September 4, 2013.

2.2.2 Manitoba Water Quality Standards, Objectives, and Guidelines

The 1988 Manitoba Surface Water Quality Objectives referenced in the 2002 CSO Study were replaced with the *Manitoba Water Quality Standards, Objectives and Guidelines* (MWQSOG) by the Province on November 28, 2011. Changes that impacted the CSO program were the fecal coliform standard for bacterial has been replaced with *E. coli*, and the secondary recreation river use category has been removed, with only a primary recreation standard remaining.

The 2002 CSO Study examined a wide range of pollutant types to identify pollutants of concern (POCs). Based on these analyses, fecal coliform was identified as the sole POC from the standpoint of managing CSO discharges. In the intervening years, a great deal of attention was directed towards the eutrophication of Lake Winnipeg through excessive nutrient inputs. EA No. 3042 specifies requirements for treated CSO discharges and for ambient water quality monitoring parameters, which also need to be considered when establishing POCs. The POCs identified and used in the CSO Master Plan development are described in Section 2.3.3.

2.2.3 Federal Regulations

Under federal law, Environment Canada administers two acts concerning environmental protection of surface waters: the *Canadian Environmental Protection Act* (*CEPA*) (Canada, 1999) and the *Fisheries Act* (Canada, 1985).

CEPA governs the release of toxic substances and nutrients into the environment from a broad range of contributing areas. The *Fisheries Act* protects against deleterious substances being put into water with fish populations and the destruction of fish habitat.

The Was*tewater Systems Effluent Regulations* (WSER) (Environment Canada, 2012) is under the authority of the Fisheries Act and is based on the recommendations of the Canadian Council of Ministers of the Environment's (CCME's) *Canada-wide Strategy for the Management of Municipal Wastewater Effluent* (MMWE) (CCME, 2009). The WSER requirements are further detailed in Section 2.2.4.1 below.

2.2.4 Canada-wide Strategy for the Management of Municipal Wastewater Effluent

The CCME developed the Canada-wide Strategy for the MMWE. The strategy is based on a collective agreement reached by the 14 ministers of the environment in Canada to verify that wastewater facility owners have regulatory clarity in managing municipal wastewater effluent. The strategy provides recommendations for minimum National Performance Standards (NPS) and manage site-specific effluent discharge objectives.

The recommended national standards for CSOs regarding combined and sanitary wastewater collection systems are as follows:

- No increase in CSO frequency caused by development or redevelopment, unless it occurs as part of an approved CSO management plan
- No CSO discharge during dry weather, except during spring thaw and emergencies
- Removal of floatable materials where feasible
- The NPS are consistent with EA No. 3042 (Appendix A) Clause 7, Clause 8, and Clause 12, which reads as follows:
  - Clause 7 – "The Licencee shall operate the combined sewer system and wastewater collection system such that there are no combined sewer overflows except during wet weather."
  - Clause 8 – "The Licencee shall not increase the frequency or volume of combined sewer overflows in any sewershed due to new and upgraded land development activities and shall use green technology and innovative practices in the design and operation of all new and upgraded storm and wastewater infrastructures."
  - Clause 12 – "The Licencee shall demonstrate, in the Master Plan submitted pursuant to Clause 11, the prevention of floatable materials, and that the quality of the CSO effluent will be equivalent to that specified for primary treatment to 85 percent or more of the wastewater collected in the CSO system during wet weather periods."

2.2.4.1 Wastewater Systems Effluent Regulations

The WSER is a national wastewater standard under the federal *Fisheries Act* that came into effect in June 2012. In its current form, it requires an annual report on the number of days that CSOs occur for each month and the volume of CSO discharged from each overflow point. The first annual report was submitted by the City in February 2013 in compliance with WSER, and has continued on an annual basis.

2.2.5 Provincial Regulations

2.2.5.1 Winnipeg Sewage Treatment Plant Licensing

Winnipeg's sewage treatment plants (STPs), formerly known as the water pollution control centres, are all licensed under the *Environment Act*. The majority of the CS districts contribute flows to the NEWPCC. In consideration of this, the CSO Master Plan must be developed and managed to account for the STP capacities and licence requirements. The most current versions of the STP licences are as follows:

- North End Sewage Treatment Plant (NEWPCC): Licence No. 2684 RRR, issued June 19, 2009
- South End Sewage Treatment Plant (SEWPCC): Licence No. 2716 RR, issued April 18, 2012
- West End Sewage Treatment Plant (WEWPCC): Licence No. 2669 E RR, issued June 19, 2009

An upgrading plan for the NEWPCC was submitted to MSD as required under the *Save Lake Winnipeg Act* (Government Of Manitoba, 2011). The plan was approved on June 19, 2011, under the condition that the upgrade meets the required effluent quality criteria. Criteria include the proposed new effluent quality parameters for the NEWPCC as issued on October 2, 2012. It is intended that the effluent limits form the basis of the next revision to the NEWPCC licence.

2.2.6 Environment Act Licence Number 3042

EA No. 3042 for CSOs was issued on September 4, 2013 and is the main driver for the development of the CSO Master Plan. A copy of EA No. 3042 is included in Appendix A. EA No. 3042 clauses are specific to various components of the CSO Master Plan and are defined and discussed in each of the relevant sections of this report. The licence has adopted recommendations received from the CEC following the 2003 hearings. It is structured to accommodate development of a Master Plan, and includes the following:

- It allows for the identification and evaluation of alternative control limits.
- Although the CSO Master Plan implementation is intended to be complete by 2030, it allows for an alternative implementation time period based on the study findings at the discretion of the MSD Director. This was since updated to 2045 or otherwise as approved by the Director as part of the Preliminary Proposal response from MSD.
- It expands the compliance period from the recreational season to year-round.

There are 16 individual clauses within EA No. 3042, 10 of which are specific conditions required for the CSO Master Plan. The 10 clauses specific to CSO control and the CSO Master Plan are highlighted below.

2.2.6.1 Clause 7: Avoid CSOs

> *The Licencee shall operate the combined sewer system and wastewater collection system such that there are no combined sewer overflows except during wet weather periods.*

The City operates its collection system to collect all flows during dry weather (DWF). Only during emergency situations should an overflow occur from a CSO location during DWF.

2.2.6.2 Clause 8: New or Upgraded Developments

> *The Licencee shall not increase the frequency or volume of combined sewer overflows in any sewershed due to new and upgraded land development activities and shall use green technology and innovative practices in the design and operation of all new and upgraded storm and wastewater infrastructures.*

The City reviews development on a case-by-case basis and does not allow an increase of peak wet weather flow (PWWF) to the CS system in order to demonstrate compliance with Clause 8. In districts where CS separation takes place as part of this CSO Master Plan, the remaining wet weather flow response in the CS system will be assessed by flow monitoring. If no major wet weather responses resulting in a risk of future CSOs are found, then the standard City of Winnipeg wastewater and land drainage requirements will apply to evaluation of all future infill development for the district. At this point Clause 8 will no longer apply to developments within this district.

GI will be evaluated for applicability for each project carried out under the CSO Master Plan. An allowance for its evaluation and construction has been included.

2.2.6.3 Clause 9: Public Education Plan

A public education plan is required as noted in EA No. 3042 Clause 9 and states:

> *The Licencee shall, on or before December 31, 2013, submit to the Director, a public education program plan documenting how information on combined sewer overflows will be made available to the public.*

The City completed this plan and submitted it prior to the required date.

2.2.6.4 Clause 10: Public Notification System

A public notification system is required as noted in EA No. 3042 Clause 10 and states:

> *The Licencee shall, on or before December 31, 2015, submit to the Director for approval, a plan regarding the development and implementation of an internet-based public notification system for all discharges from combined sewer overflow points, including an assessment of making this notification available on a real time basis.*

The City initiated a public notification system in 2004, which identifies the likelihood that an overflow is occurring based on in-system levels. This notification is manually updated and provided on the City's website.

The City is updating this system and developing a tool which will link with the hydraulic model for the City of Winnipeg CS system, and the permanent instrumentation at each of the 39 primary outfalls. This tool will provide a real-time indication of an overflow occurring and forecasted overflows. This notification system will indicate to the public that a CSO is occurring or is predicted to occur.

2.2.6.5 Clause 11: CSO Master Plan

The CSO Master Plan and the associated Preliminary Proposal are requirements of EA No. 3042 Clause 11 which reads as follows:

> *The Licencee shall, on or before December 31, 2015, submit a preliminary proposal for approval by the Director, pursuant to Section 14(3) of The Environment Act, for the combined sewer overflow system.*
>
> *The plan proposed above would consist of an evaluation of a minimum of the following CSO control alternatives:*
>
> - *A maximum of four overflow events per year;*
> - *zero combined sewer overflows; and*
> - *a minimum of 85 percent capture of wet weather flow from the combined sewer system and the reduction of combined sewer overflows to a maximum of four overflow events per year.*
>
> *The Licencee shall, on or before December 31, 2017, file a final Master Plan, including the detailed engineering plans, proposed monitoring plan, and implementation schedule for the approved design identified in the preliminary plan above. The Master Plan is to be filed for*

approval by the Director. The Licencee shall implement the plan by December 31, 2030, unless otherwise approved by the Director.

The City submitted the Preliminary Proposal prior to the required date and received approval from MSD to proceed on the CSO Master Plan in November of 2017. The final Master Plan submission day was revised to August 2013 to reflect the revised Preliminary Proposal approval date. The implementation date was also updated to December 31, 2045 or otherwise as approved by the Director to reflect the Preliminary Proposal approval commentary.

2.2.6.6 Clause 12: Effluent Quality Limits

The Licencee shall demonstrate, in the Master Plan submitted pursuant to Clause 11, the prevention of floatable materials, and that the quality of the CSO effluent will be equivalent to that specified for primary treatment to 85% or more of the wastewater collected in the CSO system during wet weather periods. The following effluent quality limits summarize what is expected from primary treatment:

- *five day biochemical oxygen demand (BOD_5) not to exceed 50 mg/l;*
- *total suspended solids not to exceed 50 mg/l;*
- *total phosphorus not to exceed 1 mg/l; and*
- *E. coli not to exceed 1000 per 100 ml.*

Currently, all CSO collected in the system will be conveyed to the sewage treatment plants and as such is regulated under the plant licence. This Clause also includes a requirement for the prevention of floatable materials. The CSO Master Plan incorporates floatable management through the use of screening and by including an alternative approach to floatable management. This alternative approach is described in Section 5.2.3.2.

2.2.6.7 Clause 13: Annual Progress Reporting

The Licencee shall, upon approval of the Master Plan submitted pursuant to Clause 11 of this Licence, implement the plan such that progress towards meeting the required level of treatment is demonstrated annually by submission of an annual report, due March 31 of each year for the preceding calendar year. Annual submissions shall include the progress made on the plan pursuant to Clause 11 including monitoring results and the work plan for the subsequent calendar year.

This component of the reporting will be initiated upon acceptance of the CSO Master Plan and will continue through implementation.

2.2.6.8 Clause 14: Reporting

A notification plan for each overflow event is required as noted in EA No. 3042 Clause 14 and states:

The Licencee shall, prior to December 31, 2013, develop a notification plan acceptable to the Director for each overflow event.

The City completed this plan and submitted it prior to the required date.

2.2.6.9 Clause 15: Interim Monitoring

As part of the compliance monitoring requirements noted in EA No. 3042, Clause 15, an Interim Monitoring Plan (City of Winnipeg, 2014a) was developed and carried out. Clause 15 of the licence reads as follows:

The Licencee shall by January 31, 2014 submit a plan to the Director for approval of an interim combined sewer overflow monitoring program for implementation between May 1, 2014 and the date upon which the final master plan is approved by the Director. The plan shall identify locations to be sampled, rationale for these locations, and sampling frequency. The plan also shall identify constituents to be monitored including, but not limited to:

- *organic content as indicated by the five-day biochemical oxygen demand (BOD5) and expressed as milligrams per litre;*
- *total suspended solids as expressed as milligrams per litre;*
- *total phosphorus content as expressed as milligrams per litre;*
- *total nitrogen content as expressed as milligrams per litre;*
- *total ammonia content as expressed as milligrams per litre;*
- *pH; and*
- *E.coli content as indicated by the MPN index and expressed as MPN per 100 millilitres of sample.*

This monitoring plan and the data collected serves as a basis for the water quality component of the CSO Master Plan study phase and was used to develop water quality performance for each alternative potential plan. The monitoring data provided an updated characterization of collection system discharge quality and allowed for the assessment of the impact of these discharges on receiving stream water quality. This assessment was fully reported on as part of the Preliminary Proposal submission. (CH2M, 2015).

2.2.6.10 Clause 16: Record Keeping

The City is required to maintain records for CSOs as noted in EA No. 3042 Clause 16 which states:

The Licencee shall:

a) *during each year maintain records of:*
   i. *grab sample dates and locations;*
   ii. *summaries of laboratory analytical results of the grab samples; and*
   iii. *combined sewer overflow dates;*
b) *make the records being maintained pursuant to sub-Clause 16 a) of this Licence available to an Environment Officer upon request and, within three months of the end of each year, post the results on the public notification site required by Clause 10 of this Licence.*

The City currently maintains this information on record and posts the results on its website.

2.2.6.11 Licence Clarification And Outcome

Consultation between MSD and the City took place throughout the study and development phases of the CSO Master Plan. Several licence clarifications that impact the overall Master Plan were addressed. This included the selection of the representative year, the calculation process for reporting percent capture performance, and additional consideration for regulatory conformance at the time of the Master Plan update in 2030. Details of how these clarifications apply to the implementation phase of the CSO Master Plan are described throughout this report.

The Preliminary Proposal was submitted to MSD on December 18, 2015 with a recommendation for using Control Option No. 1 – 85 Percent Capture in a Representative Year. MSD issued a formal response to the Preliminary Proposal on November 24, 2017. The response from MSD stated that the Preliminary Proposal submission met the intent of Clause 11 of EA No. 3042, and that Control Option No. 1 –

85 Percent Capture in a Representative Year, is to be implemented by December 31, 2045 or otherwise as approved by the Director, in such a way that Control Option No. 2 may eventually be phased in. The CSO Master Plan was further developed on this basis.

2.3 Water Quality

Major waterbodies impacted by the CSO Master Plan include the Red and Assiniboine Rivers and Lake Winnipeg. These surface waters are extremely important to the economical and cultural identity of Manitoba. As such, they play a pivotal role in the development of the CSO Master Plan. Figure 2-1 provides an overview of the Lake Winnipeg watershed.

Figure 2-1. Map of the Lake Winnipeg Watershed
Source: www.ec.gc.ca, accessed April 10, 2019

The waterbodies and their relation to CSOs in Winnipeg are described in the following subsections.

2.3.1 Red River and Assiniboine River Watersheds

The Red and Assiniboine Rivers drain a watershed of over 270,000 km^2, including the prairie regions of southern Manitoba, southeastern Saskatchewan, North Dakota, northern South Dakota, and northwestern Minnesota.

The rivers carry large volumes of suspended solids, which gives them their natural murky appearance. The rivers cross intensively used agricultural lands and collect nutrients and other pollutants during their natural flow towards Lake Winnipeg. Many cities, towns, and agricultural livestock operations contribute pollutant and nutrient loadings to the rivers before they reach Winnipeg.

2.3.2 Lake Winnipeg

Lake Winnipeg is suffering from an overabundance of nutrients, and the Global Nature Fund (a non-profit, private, independent international foundation for the protection of environment and nature) recognized Lake Winnipeg as the world's most "Threatened Lake of the Year" for 2013. The Preliminary Proposal details several initiatives related to the health and protection of Lake Winnipeg.

The lake provides a valuable amenity and supports a wide variety of beneficial uses. It is a popular recreational area with public beaches, water recreation, and many vacation properties. It supports a wide variety of wildlife and active sport and commercial fisheries and warrants consideration in the CSO evaluation process.

The Preliminary Proposal's water quality analysis found that CSOs contribute 0.26 percent of the total phosphorus and 0.14 percent of the total nitrogen of the overall nutrient loading to Lake Winnipeg. Although CSOs are not considered the primary contributor for nutrient loadings to Lake Winnipeg, it is prudent to include discussion of the lake in the current CSO Master Plan because of its distressed nature and the public and regulatory attention it has generated.

2.3.3 Water Quality Pollutants of Concern

POCs were identified during the Preliminary Proposal development. The identified POCs form the basis for defining the discharge controls required for compliance. In general, the POCs are focused on the water quality requirements to protect river uses and have been previously identified in the 2002 CSO Study. Additionally, specific compliance requirements listed in the MWQSOG and EA No. 3042 have been considered. For the Master Plan, the POCs are identified as follows:

- **Dissolved oxygen (DO):** CSOs were found to slightly depress DO levels in the rivers, but not to the point where the levels would fall below those required to sustain healthy aquatic life. DO depression of only about 1 mg/L was observed with significant CSO events. Therefore, DO is not considered to be a CSO issue.
- **Total Suspended Solids (TSS):** The rivers have always carried large volumes of suspended solids, which gives them their characteristic murky brown appearance, typical of prairie rivers. CSOs have little impact on the existing TSS conditions and, accordingly the TSS loadings are not considered to be a CSO issue.
- **Ammonia:** The contribution of ammonia from CSOs is minor compared to that from dry weather discharges and STPs and is not a significant CSO issue.
- **Toxic substances**: While it was recognized that there is potential for release of toxic substances, monitoring of the CSOs under the 2002 CSO Study indicated that it was not a significant CSO issue.
- **Nutrients**: CSO discharges play a minor role in nitrogen and phosphorus loads to the rivers. Analysis completed during the Preliminary Proposal found that CSOs make up approximately 0.26 percent of total phosphorus and 0.14 percent of the total nitrogen load to Lake Winnipeg. The STP discharge licences and EA No. 3042 have limits for phosphorus and nitrogen.
- **Bacteria:** CSOs are known to be a major source of bacterial contamination of the rivers under wet weather conditions, and this is a main POC for the Master Plan. *E. coli* was the main bacteriological indicator assessed for the CSO Master Plan development. The Preliminary Proposal included an analysis of the level of bacteria that could be expected at Lake Winnipeg. The analysis showed densities of about 100 to 1,000 MPN /100 mL based on average velocities and anticipated travel times in the river. The results are conservative and do not include factors for in-stream dispersion or others that may be relevant, but is considered to be a conservative approach to estimating this value. No additional studies were completed for bacteria decay as part of the Master Plan.

The Master Plan study phase included a multi-year water quality monitoring program to collect and update river and CSO water quality data. The 2014-2015 data were compared to the 2002 data to reassess and update the POCs identified previously. The data gathered during the 2014-2015 water quality program were used as the baseline for the water quality modelling and loading assessments used in the potential plan evaluations. The results of both data sets provided similar estimations of the values for each constituent. The analysis and results of the CSO Master Plan water quality monitoring work are documented in the Preliminary Proposal.

Additional information is available of the condition of Lake Winnipeg through MSD. MSD periodically publishes state of the Lake reports describing the nutrient loadings and contributing sources. Typically, these reports are issued every five years with the latest report available online. The most recent publication is *Lake Winnipeg: Nutrient and Loads, A Status Report*. (MSD, 2019).

2.3.4 River Uses and CSO Impacts

River uses are identified to determine additional upgrading requirements and potential project benefits. A detailed review of river uses were carried out under the 2002 CSO Study and, in several cases, site-specific surveys were completed. The same level of investigation was not repeated for the CSO Master Plan, since there are no indications that river uses have substantially changed since that time. Therefore, the previous studies provide a good reference for river uses, with the one exception that year-round CSO control also needs to be considered, since it has been included in EA No. 3042.

The river uses to be protected have been defined as the following:

- **Aquatic life and wildlife**: In their natural state, rivers support aquatic plants and animals. Discharging treated and untreated wastewater can change conditions in the rivers and affect the rivers' ability to support aquatic life. DO and ammonia content are two of the most important criteria for aquatic life, which are affected by CSOs. Generally, conditions that support a healthy fish population indicate good conditions for other aquatic life. Aquatic life is not considered to be significantly impacted, since the Red and Assiniboine Rivers support a highly valued sports fishery.
- **Recreational use**: The water quality objectives at the time of the 2002 CSO Study included protection of both primary and secondary recreation, with the secondary recreation use now eliminated from the MWQSOG. Primary recreation involves direct contact activities such as swimming and waterskiing where immersion is probable. Secondary recreation includes activities like fishing and boating, where immersion would be incidental or accidental. While the rivers support secondary recreational uses, the Red and Assiniboine Rivers are unsuited and have few occurrences of primary recreation. Swimming and other primary recreational activities are naturally limited because of the rivers' murky waters, dangerous currents, and steep, muddy banks.
- **Aesthetic public amenity**: The aesthetics of the rivers are adversely affected by floatable materials and oil and grease discharges from CSOs under wet weather conditions.
- **Source of irrigation water:** Prior surveys identified a number of greenhouses that use river water for irrigation, which could be adversely impacted by CSOs, and irrigation is considered as a beneficial use to be protected.
- **Domestic and industrial water consumption**: The rivers will be restricted for use as sources of consumption, but this is not a CSO control issue. Any use of river water for potable purposes would require complete treatment, even if CSOs were eliminated.

2.3.5 Current Water Quality Monitoring Procedures

Currently the City of Winnipeg maintains bi-weekly river and stream water quality monitoring for the water quality POC mentioned in Section 2.3.3. The results from this monitoring work is reported on the City of Winnipeg webpage. This process is to continue during the CSO Master Plan implementation.

2.4 Winnipeg Sewer System

Wastewater is collected and conveyed to the three STPs by three primary sewer systems: combined, sanitary, and interceptor sewers. The combined and sanitary sewers collect wastewater from the various homes and businesses across the city and convey it to the interceptor sewer system. The interceptor sewers collect the wastewater from the individual sewer districts and convey it to the STPs.

2.4.1 Sewage Treatment Plants

Winnipeg is divided into three treatment areas and serviced by three STPs; NEWPCC, SEWPCC, and WEWPCC as shown on Figure 2-2. Since construction of NEWPCC in the mid-1930s, the City has continuously increased and upgraded the treatment capacity to the present levels. The STPs all provide a minimum of secondary treatment prior to discharge to either the Red or Assiniboine Rivers.

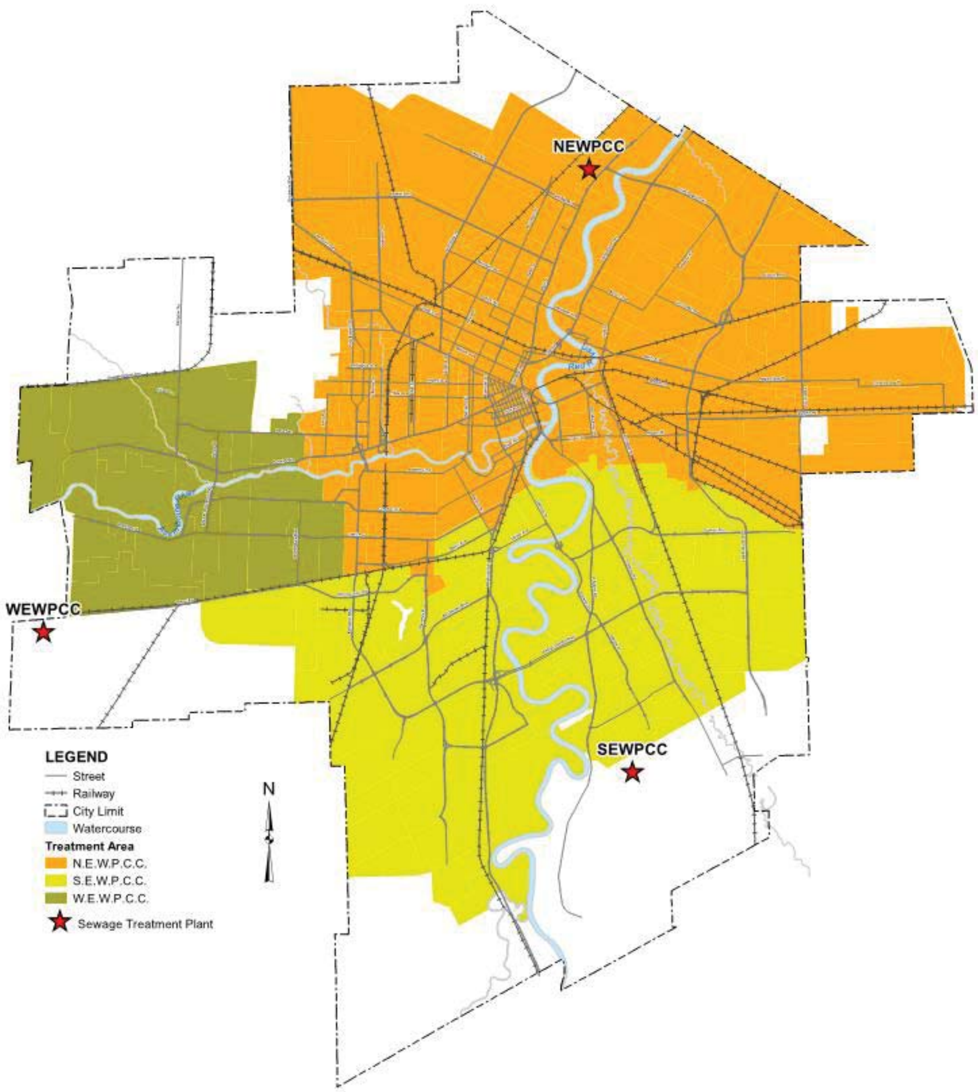

Figure 2-2. Sewage Treatment Plant Service Areas

Winnipeg's three STPs were upgraded just prior to or in parallel with the 2002 CSO Study, and the following additional upgrades have been implemented since that time:

- Ultraviolet light disinfection was added to NEWPCC in July 2006, followed by phosphorus and ammonia removal from the centrate side stream in 2008. A major upgrade for nutrient removal is in the planning phase.
- Ultraviolet light disinfection was added to SEWPCC in July 1999. A capacity expansion and upgrade for nutrient removal is currently in progress.

- The WEWPCC mechanical plant was constructed in the early 1990s and subsequently upgraded to nutrient removal in 2008. The former lagoons were retained to serve as polishing ponds and provide natural disinfection.

General information regarding the processes, capacities and other relevant STP details are summarized in Table 2-1.

Table 2-1. Sewage Treatment Plant Details

Sewage Treatment Plant	Capacities Full Treatment (2019)	Average Daily Flow	Existing Processes	Future Processes	EA Licence No.
NEWPCC	Primary: 675 MLD Secondary: 380 MLD	195 MLD	Conventional activated sludge plant Total Phosphorus & Ammonia removal from centrate side stream Dewatering UV Disinfection	Biological Nutrient removal WWF Treatment	2684 RRR, issued June 19, 2009
SEWPCC	Primary: 174 MLD Secondary: 100 MLD	58 MLD	UV Disinfection Activated sludge plant Odour Control	Biological Nutrient removal WWF Treatment	2716 RR, issued April 18, 2012
WEWPCC	Primary: 112 MLD Secondary: 54 MLD (Restricted to 40 MLD)	20 MLD	Biological Nutrient Removal Activated sludge plant	N/A	2669 E RR, issued June 19, 2009

During heavy rainfalls and high spring runoff, flows may exceed the hydraulic capacity of the biological processes and other downstream processes. The excess flow only receives primary treatment, which is blended with the plant effluent receiving secondary and tertiary treatment before being discharged to the rivers. Current plans for the SEWPCC and NEWPCC upgrades include use of high rate clarification to provide the necessary level of treatment for wet weather flows to meet regulatory limits.

2.4.2 Sewage Collection System

Within each treatment service area, the collection system consists of both combined and separate sewer areas, as shown on Figure 2-3.

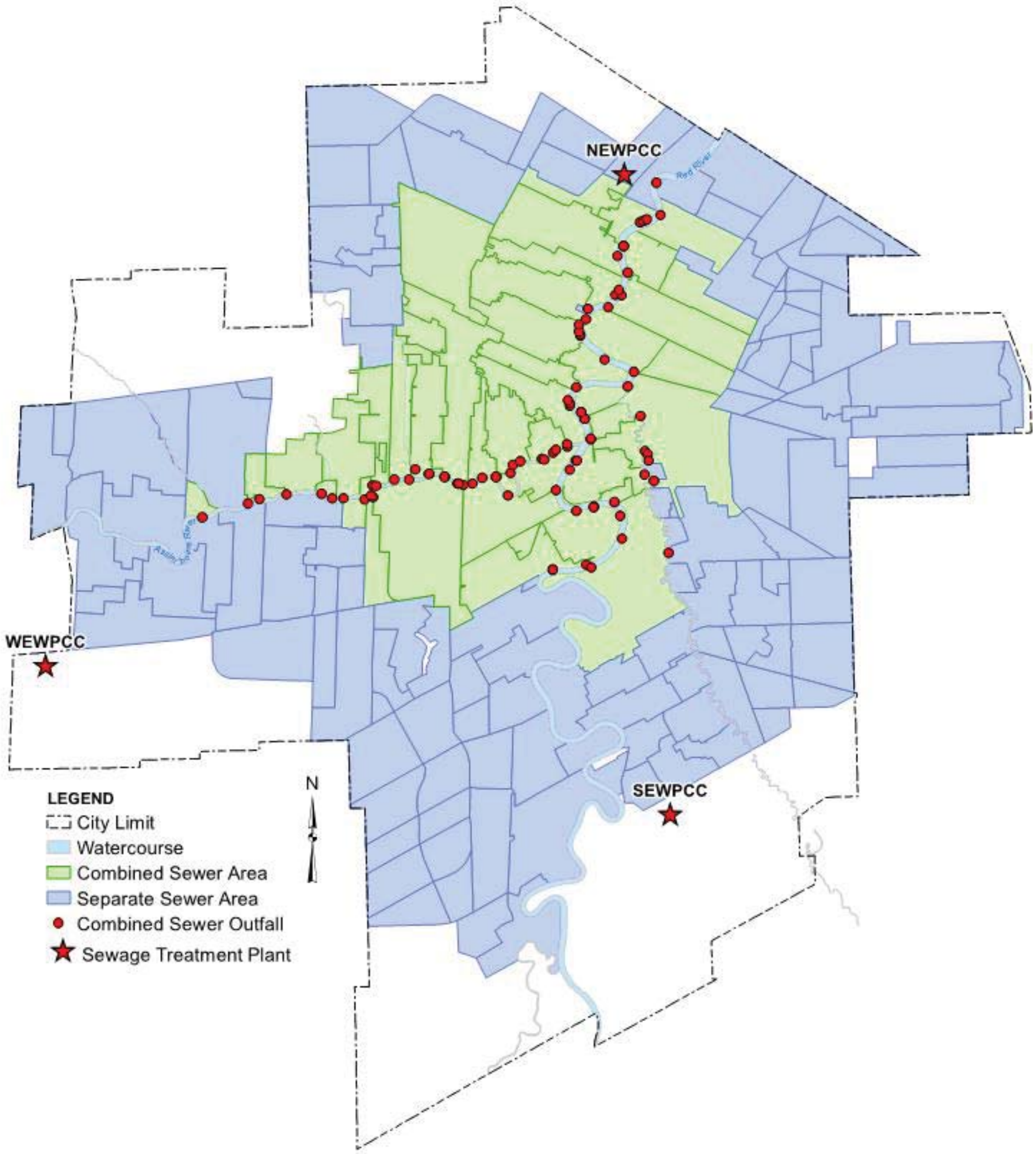

Figure 2-3. Combined and Separate Sewer Areas

The original design of combined sewers in Winnipeg was to convey both the wastewater and surface runoff flows directly to the Red, Assiniboine, and Seine Rivers. In the 1930s, interceptor sewers were built, along with associated diversion weirs and pumping stations, to intercept a portion of the wastewater and surface runoff flows discharging to the rivers and convey it to the newly constructed NEWPCC. The interceptors were designed to intercept approximately 2.75 times the Average Dry Weather Flow (ADWF), which included a nominal amount of wet weather flow (WWF). The 2.75 interception rate was consistent with general practice at the time. Combined sewers were installed in Winnipeg up to the 1960s, when separate wastewater sewer (WWS) and land drainage sewer (LDS) systems were required. As such, all new developments in the City have been serviced by these two types of sewers since the 1960s, and are considered separate sewer systems. In general, separate systems consist of the following:

- WWS systems that collect domestic, commercial, and industrial wastewater and convey it to the STPs for treatment. WWSs connect into the interceptor sewer system.

- LDS systems that collect surface runoff from rainfall or snowmelt and conveys it either directly to the rivers or to stormwater retention basins, where the water is held and then slowly released to the rivers.

2.4.3 Interceptor Systems

The interceptor systems continue to operate under the same principles today, although the interception rate at each outfall may deviate from the 2.75 times ADWF. During dry weather, all flow is captured and conveyed to the STPs. For larger wet weather events, the CS flows may exceed the interception capacity and cause the excess flow to overtop the primary weir and discharge as a CSO to the river. On average, CSOs occur approximately 22 times a year, although the numbers vary for individual districts. Discharge from one or more outfalls in a district is considered a CSO and the number of overflows for the entire area is the average of all the districts.

The interceptors are key in the ability of the system to transfer collected sewage and runoff from the sewer districts to the STPs. Sewage and runoff captured behind the diversion weirs in each sewer district flows through an off-take pipe to either a lift station wet well or directly to the interceptor. The Main, Northeast, and Northwest Interceptor systems flow to the NEWPCC, while the SEWPCC and WEWPCC each have their own independent interceptor system. These form the five major interceptor sewer systems throughout the collection system, which are shown on Figure 2-4 and are described in the following subsections.

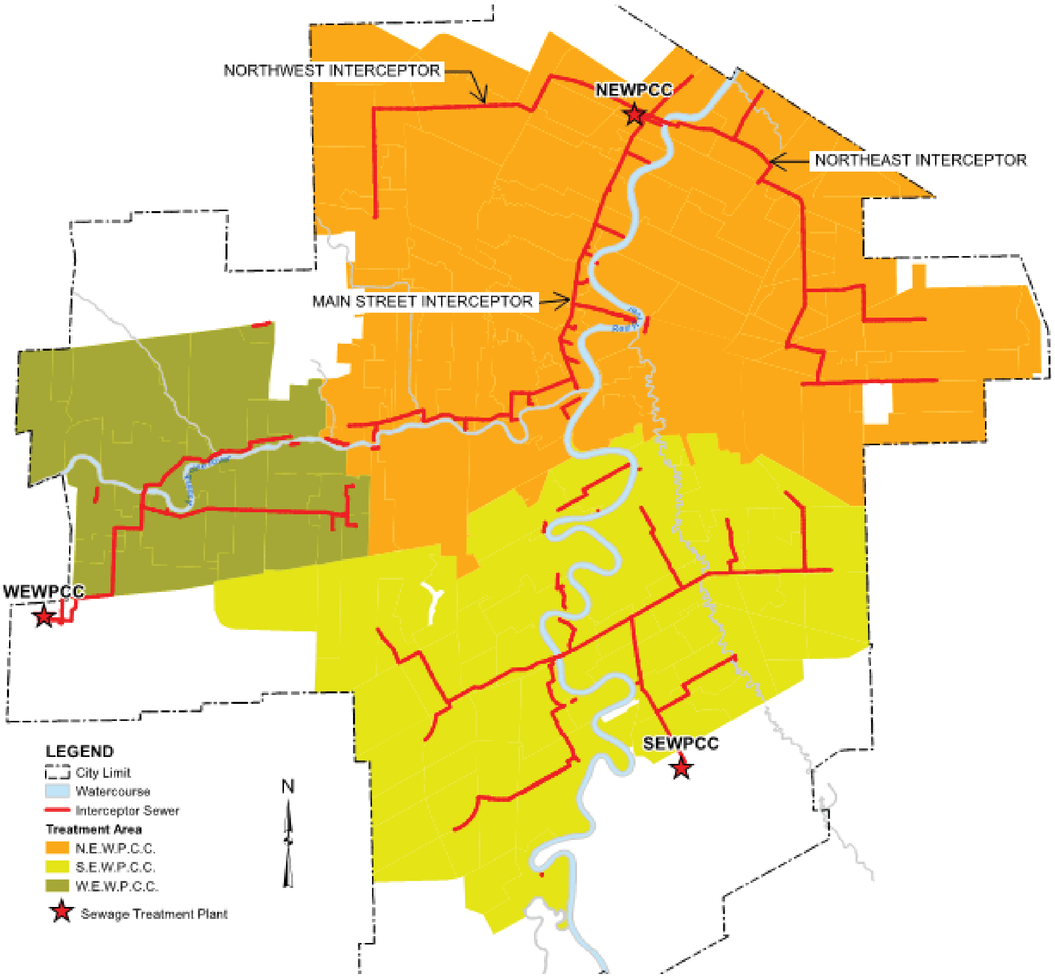

Figure 2-4. Interceptor Sewer Network

There is a wide range of flow intensities that can enter the interceptors from the individual districts during wet weather events. For interceptors with lift stations (LSs), flow is consistent based on their pumping capacity; for those with gravity diversions, the flow depends on the local conditions and can increase significantly when the levels rise in the sewers.

2.4.3.1 North End Interceptors

The Main Street Interceptor, with its north-south leg located under Main Street in parallel to the Red River, serves the older part of the City and only receives flows from CS districts and CS districts which have been separated over time. It collects flows from 35 of the 43 CS districts representing approximately 7,540 ha of the total 8,320 ha CS area in the City of Winnipeg (± 91 percent on an area basis). The interceptor has capacity beyond what is required for DWF, approximately 4 to 5 times DWF, and can convey flows from minor storm events.

The Northeast Interceptor conveys wastewater from the North Kildonan and Transcona areas in the City's northeast and east, and the Northwest Interceptor conveys wastewater from the Brooklands and Maples areas in the City's northwest to the NEWPCC. Flow received from these areas are received entirely from separate sewer districts. Flow in these interceptors are important to the CSO program evaluation process, because both the Northeast and Northwest Interceptors combine with the Main Street Interceptor prior to reaching the NEWPCC. Hence, flows from one of the interceptors will affect the flows and levels in the others, and all three of them contribute to the flows delivered to the NEWPCC and share the treatment capacity.

Two of the 76 CSO discharge locations have the functionality to allow overflows directly from the Main Street Interceptor to the Red River, located in the St. John's and Polson districts. These overflows discharge by gravity when the levels in the Main Street interceptor are excessively high and the river level is low.

2.4.3.2 South End and West End Interceptors

The South End and West End interceptor sewers convey flows from mostly separate sewer districts, with smaller fractions of CS contributions as follows:

- The South End interceptor collects separate wastewater from the Fort Garry, St. Norbert, St. Vital, and St. Boniface areas, as well as combined sewage from Cockburn/Calrossie, Baltimore, Mager, and Metcalfe CS districts.
- The West End interceptor collects separate wastewater flows from the St. James and Charleswood areas and combined sewage from Woodhaven, Moorgate, and Strathmillan CS districts.

2.4.4 Combined Sewer Districts

The City's CS area is split into a number of individual areas known as CS districts. A CS district is an area of the City that is serviced by a network of primarily CSs that convey collected sewage and runoff to the plants for treatment. CS districts have a history of basement flooding that occurs during intense summer rainfall events as the combined sewage received from the CS system in these districts fills sewer capacity and begins to back up in the system, eventually reaching homes and properties connected to the system. The City has carried out extensive work to study and alleviate basement flooding. The work to date is through use of sewer relief piping, outfall abandonment, and sewer separation on a strategic and opportunistic basis.

There are currently 43 CS districts within the City. The total area of the City of Winnipeg serviced by combined sewer systems is 8,320 ha, and the number of CSO discharge points via outfall pipes to the Red, Assiniboine, and Seine Rivers is 76. This includes 41 primary and 35 secondary outfalls. Primary outfalls are the main discharge within a sewer district and typically represent the low point of the sewer within the district. Secondary outfalls are additional outfalls within a district which are in place to relieve the CS system during high flow events. The secondary outfalls typically service only a portion of the CS district area.

The service area includes an estimated 1,000 ha reduction for greenspace areas that are not typically serviced by either combined or separate sewer systems, and an estimated 1,500 ha reduction for any areas that have been partially separated. Therefore, the total area serviced by combined sewer systems including the greenspace and partially separated combined areas is approximately 11,000 ha. There are an additional 10 outfall discharge points at Flood Pumping Stations (FPSs) in several combined sewer districts. The FPS's provide outfall capacity to relieve the system when high river levels hydraulically prevent CSO outfalls from discharging, which causes the sewer system to surcharge. These 10 discharge points with dual pipes are reported as a single outflow discharge point for this report. These outfalls are as follows:

- ID80 – Aubrey FPS
- ID81 – Clifton FPS
- ID82 – Cornish FPS
- ID83 – Despins FPS
- ID84 – Dumoulin FPS
- ID85 – Marion FPS
- ID86 – La Verendrye FPS
- ID87 – Cockburn FPS
- ID88 – Linden FPS
- ID89 – Ash FPS

In total, 41 of the districts have what is considered a primary outfall discharge that receives the majority of the combined sewage for that district, and intercepts a portion of it via the primary weir and off-take pipe at the diversion structure, with the remainder discharged to the receiving streams. The remaining 35 discharge points are secondary outfalls within the CS districts, which only discharge CS collected from a portion of the district at overflow points to provide localized basement flood relief.

The CS districts evaluated as part of CSO Master Plan are identified on Figure 2-5.

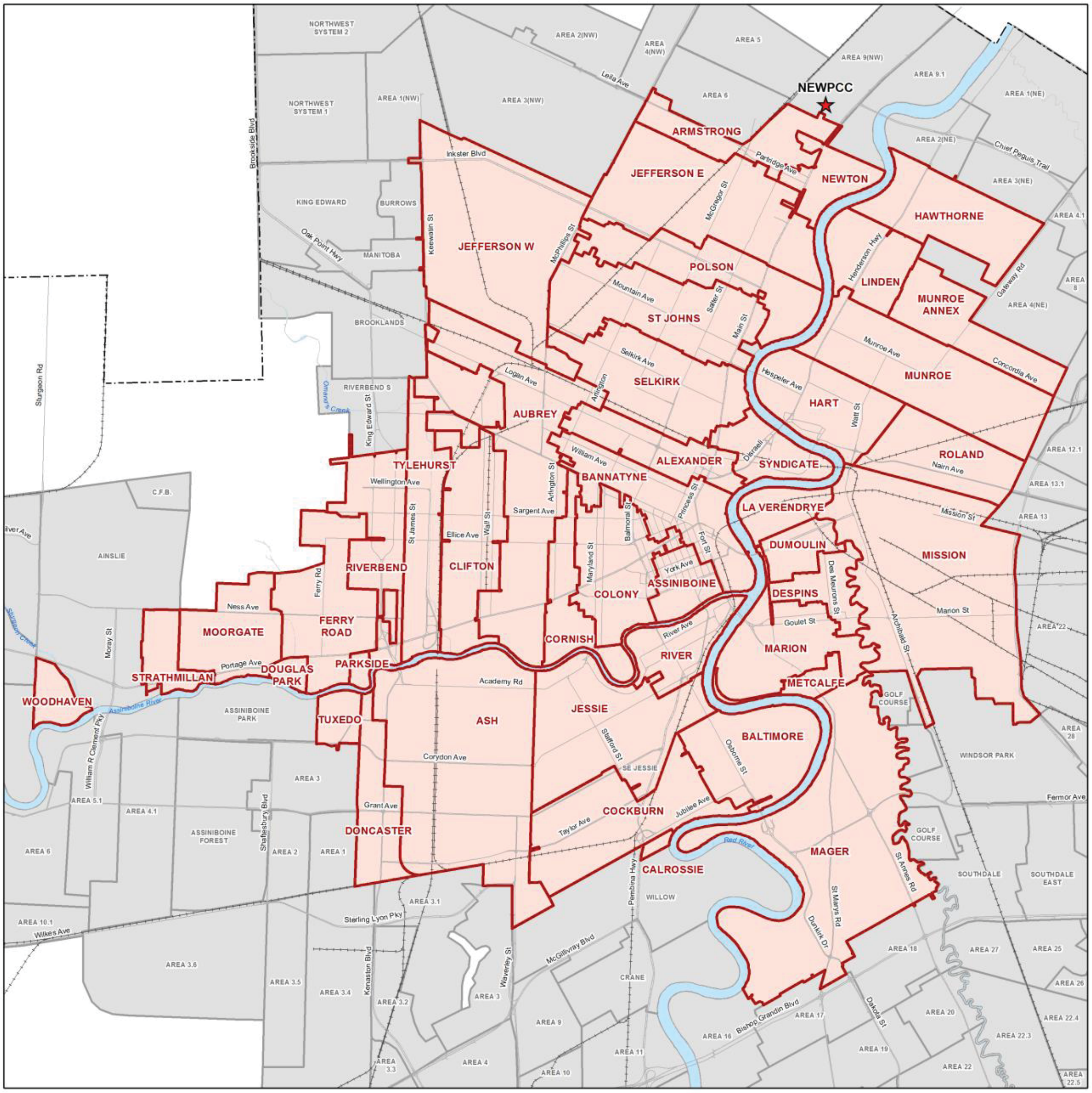

Figure 2-5. Combined Sewer Districts

DEPs have been developed for each of the combined sewer districts documenting the planned approach in that specific district to meet the CSO Master Plan regulatory requirements. The DEPs have been developed to a conceptual level of design that will require further analysis prior to implementation. It is expected that the proposed solutions will be further refined through the preliminary and detailed design phases. The Master Plan will be updated to reflect any changes required from the additional analysis. The DEPs are included in Part 3B of the Master Plan.

2.5 Current Sewer Programs

The City has progressed with improvements to its collection system through several ongoing programs. These programs are described in the following subsections.

2.5.1 Basement Flooding and Sewer Relief

Beginning in the 1960s, the City implemented a program to reduce the frequency of basement flooding in the hardest hit neighbourhoods. The program has included replacement of some smaller sewers, construction of relief sewers, and selective separation where economically feasible. The relief sewers are termed storm relief sewers (SRSs) and have been installed in many of the CS districts to increase hydraulic capacity.

Work in the program has been prioritized based on first scheduling those projects with the highest benefit/cost ratio. The program generally provides upgrading to a minimum of a 1 in 5-year level of basement flooding protection through the use of relief piping, with a longer term goal of achieving a 1 in 10-year level through supplemental measures. This means that when the CS district is subjected to a storm equal or less than a 1 in 5-year event in rainfall intensity, there should be no risk of basement flooding occurring within the homes and properties in the district. Sewer separation has been used selectively where it has been demonstrated to be cost competitive, recognizing the increased benefits to the level of basement flooding protection and to CSO mitigation.

The City has invested well over $400 million on sewer relief since 2002, with another $140 million budgeted for future investment. The districts where work is currently planned, committed and underway for the near term include the Cockburn West, Ferry Road, Riverbend, Parkside, Douglas Park, Jefferson East, Mission, and Armstrong sewer districts. A summary of the existing sewer relief work in progress is provided in Table 2-2.

Table 2-2. Current Sewer Relief Projects

Sewer District	Sewer Relief Work	Status	Dates of Construction
Cockburn West	Sewer Separation	Design and Construction	2014 – Present
Ferry Road / Riverbend	Sewer Separation	Design and Construction	2013 – Present
Parkside / Douglas Park	Sewer Separation	Design and Construction	2013 – Present
Jefferson East	Sewer Separation	Design and Construction	2012 – Present
Mission	Sewer Separation	Conceptual Design	
Armstrong	Sewer Separation	Conceptual Design	

The Basement Flood Relief (BFR) program has been underway for several decades, and most CS districts have now been provided with additional relief through both the construction of relief sewers and sewer separation in various combinations. There will be major upgrades, focusing on sewer separation, continuing for the next several years in at least three of the combined sewer districts, which will be integrated in the project sequencing recommended in this CSO Master Plan. These districts include Cockburn, Ferry Road, and Jefferson East.

2.5.2 Outfall Monitoring

The City's outfall monitoring program began in 2009 with the installation of monitoring instrumentation at the CS primary outfall points. There are presently 39 locations with permanent outfall monitoring instrumentation installed. The City collects level, flow and flap gate inclination data for the sewers to indicate if a CSO is occurring or has occurred. This data is analyzed and compared to a simulated event with the sewer system hydraulic model. The hydraulic model is continually improved based on the latest information and utilization of this outfall monitoring data. This further improves how CSOs are simulated and quantified, and improves the validation process of when CSOs have occurred and the volume of discharge.

2.5.3 Sewer Flow Monitoring

An annual sewer flow monitoring program is conducted to collect data from the collection system. Temporary flow monitors are installed at various locations in winter and summer throughout the system. The locations are targeted based on districts that are scheduled for future work. Monitors are installed prior to analysis and design of various sewer infrastructure projects within a sewer district to better understand system flows. The data collected also provides further data for calibration and validation of the hydraulic model to improve its accuracy as a tool for the planning and management of the Master Plan.

2.5.4 River Monitoring

A river water quality sampling program takes place during open river months each year. This data provides an understanding of the water quality influences impacting the Assiniboine River and Red River. Sampling occurs every second week and frequency does not change on account of the occurrence of rainfall or runoff events that may cause overflows and impact the sampled river water quality. The monitoring completed as part of the Preliminary Proposal was used to develop a profile of river water quality during dry weather (no overflows) and during wet weather (overflow recently occurred).

2.6 Preliminary Proposal

The Preliminary Proposal was submitted to MSD on December 17, 2015, with the City's recommended approach for a target level of control for the CSO Master Plan. The City recommended Control Option No. 1, 85 percent capture in a representative year as the preferred control limit. This control limit provides a higher level of performance than the existing approach and allows for continued improvement in the future if a more restrictive control limit was to be implemented. MSD accepted the City's recommendation with the added requirement to move towards the water quality performance criteria provided by Control Option No.2, four overflows in a representative year as the four overflow control option provides a further reduction to both nutrient loading and bacteria exceedance days.

The basis for the development of this CSO Master Plan is 85 percent capture in a representative year control limit and it has been developed to allow the program to adapt to meet a higher level of water quality performance in the future.

2.6.1 Preliminary Proposal Control Option Alternatives

The potential plans developed during the first two phases of the Master Plan provided the basis for evaluation of the control limits. Potential plans were developed using various CSO control technologies to meet the identified control limit. The three control limits from Clause 11 of EA No. 3042 were included, along with additional City developed control limits used elsewhere to broaden the perspective and allowed under the Clause 11 description.

The current approach to CSO control is also included (as outlined in Section 2.5.1), thereby providing coverage for the full range of possibilities from the current situation to complete separation of the combined districts. The potential plans and control limits are listed and described in Table 2-3. .

Table 2-3. Preliminary Proposal Control Option Alternatives Evaluated

Control Option Alternative	Description
Current Approach	Elimination of dry weather overflows and protection against basement flooding, with a greater focus more recently on monitoring, measuring, and controlling CSOs

85 Percent Capture in a Representative Year	85 percent volume capture for the 1992 representative year. U.S. Environmental Protection Agency presumptive approach.
Four-overflows in a representative year	A maximum of four overflows for the 1992 representative year, uniformly distributed across the CS area; this means that the fifth largest event for that year must be fully captured
Zero Overflows in a representative year	No overflows for the largest event for the 1992 representative year, uniformly distributed across the CS area
No More Than Four Overflows per year	Maximum number of overflows in any year over the long-term is limited to four; spatial distribution of rainfall is accounted for over the long-term record
Complete Sewer Separation	CSs are eliminated and, therefore, could not produce CSOs

An evaluation and decision process followed the solution development and resulted in the selection and subsequent recommendation of 85 percent capture in a representative year. This selection was carried forward in the Preliminary Proposal submitted to MSD on December 17, 2015.

The Preliminary Proposal Control Option No. 1 alternative was conceptual and is not to be considered as refined or optimized. The goal was to develop a plan that could be practically completed if selected. This approach avoids unproven technologies and unreasonable assumptions. The overall level of detail included in the Preliminary Proposal was appropriate for a planning level study. Improvements and efficiencies have taken place in the development of the final selected control limit and plan. The further development and refinement of Control Option No. 1 is described in detail throughout the following sections of this document.

2.7 Regulatory Engagement

Regulatory collaboration between the City and MSD was a large component of the CSO Master Plan. The regulatory program was included to allow for communication between the City project team and MSD. This included a regulatory liaison committee (RLC), comprising senior managers and a regulatory working committee (RWC), made up of key individuals from each group. The project timeline indicating the major milestones in the CSO Master Plan including regulatory aspects is illustrated in Figure 2-6.

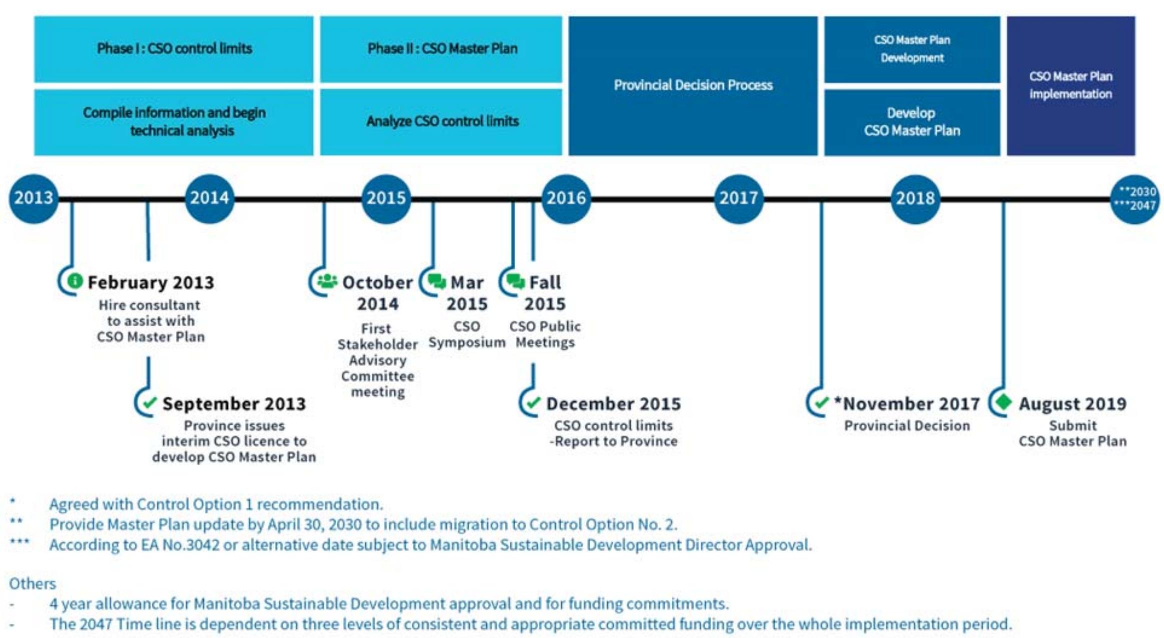

Figure 2-6. CSO Master Plan Timeline

2.7.1 Regulatory Liaison Committee

The purpose of the RLC was to facilitate a communication link between the study team and MSD. It provided an opportunity for each group to provide their perspective and understanding of the current situation and their expectations for the application of EA No. 3042. Six meetings were held during the project with five occurring during the first two phases and one during the final CSO Master Plan development phase. These meetings served to provide a summary of ongoing work and discussions with the RLC.

2.7.2 Regulatory Working Committee

The purpose of the RWC was to establish a smaller technical working group to meet on the project level items pertinent to EA No. 3042 and to discuss ongoing progress and planning. Nine meeting were held over the course of the project with five occurring in the first two phases and four during the final CSO Master Plan development phase.

2.7.3 Outcome of Regulatory Collaboration

The two groups met on several occasions to report on progress and discuss issues or clarifications necessary as part of the CSO Master Plan development. Specific requirements of EA No. 3042 were reviewed and addressed through these meetings and through supplemental submissions. Some of these additional items included a public education plan, interim monitoring plan, notification plan and annual reporting. Some of the key clarifications addressed in the first two phases include definitions for Representative Year, Overflow, and Percent Capture Calculation. EA No. 3042 and additional clarifications are included as Appendix A and B. Additional related submissions can be found on the MSD website.

The acceptance of the Preliminary Proposal in November 2017 marked the beginning of the final phase in the CSO Master Plan development. The main areas discussed during the RWC meetings held in the third phase are described below.

2.7.3.1 District Engineering Plans

EA No. 3042 required detailed engineering plans to be developed for each of the combined sewer districts. These plans, as described in Section 3.7, provide the conceptual design detail for each of the sewer districts that will be required to achieve the control target.

Due to conceptual level of detail expected in these plans as part of the CSO Master Plan submission, it was identified and agreed with MSD that these plans no longer be referred to as “detailed engineering plans” as detailed design of the solutions has not taken place. Going forward these plans were referred to as “district engineering plans” (DEPs), and this same naming convention was used through the CSO Master Plan document, where applicable. This was clarified during RWC Meeting No. 6 on June 15, 2018.

A template for the DEPs was also prepared and provided during RWC Meeting No. 6. The DEP template was accepted as appropriate by MSD and was used to develop the plan for each sewer district.

2.7.3.2 Migration Approach To Control Option No. 2

The November 27, 2017 decision letter from MSD included an additional requirement not included in EA No. 3042. It reads as follows:

> *I am hereby approving the CSO Master Plan Preliminary Proposal dated December 18, 2015 and additional information submitted on July 22, 2016 with the condition that Control Option No. 1 be implemented in such a way so that Control Option No. 2 may eventually be phased in.*

This additional requirement was included in the first RWC meeting of Phase 3, RWC Meeting No. 6 held on June 15, 2018. It was identified as a potential issue due to the different performance metric used for each of the Control Options. The City proposed a program that maintains percent capture as the performance metric in order for the program to maintain expandability and eliminate inefficiencies in the migration approach. MSD agreed in principle and requested a formal clarification from the City.

The City submitted this clarification on July 25, 2018 and MSD responded on August 26, 2018 requesting further information to demonstrate equivalence of the 98 percent capture target proposed in terms of the water quality estimated with Control Option No. 2 in the Preliminary Proposal. Supplementary information was then provided by the City to MSD as part of RWC No. 7 on September 13, 2018, providing further background on the reasoning for volume percent capture as the target metric. The City indicated that a 98 percent capture control target would not necessarily meet the same water quality performance. Nutrient loading will improve, but the number of non-compliance days for bacteria may not be the same. A response was provided by MSD in regards to this additional information on October 3, 2018. The response from MSD stated that as there are no studies or information available to demonstrate that 98 percent capture will provide equivalent water quality as Control Option No. 2, that the Department is not in a position to alter the Control Option No. 2 target.

This topic was subsequently raised at RWC Meeting No. 8 held on November 26, 2018. At this meeting MSD identified that the performance shown for Control Option No. 2 in the Preliminary Proposal is the long term goal with bacteria non-conformance as the primary driver. It was agreed that a percent capture value that has been verified to provide the same or improved reduction in the bacterial non-compliance days would be required before MSD would be in a position to alter the requirements of Control Option No. 2. This verification would need to be completed using water quality testing, and was beyond the scope of work for the CSO Master Plan submission for August 31, 2019. It was then agreed by both parties that the work necessary to demonstrate the water quality equivalence of Control Option No. 2 in terms of a percent capture approach would be completed prior to the 2030 CSO Master Plan update. At that time as part of the 2030 CSO Master Plan update future discussions on the modifications of Control Option No. 2 to maintain a percent capture approach would occur.

For further details on this approach for Migration to Control Option No. 2, please see Section 4.6 of this Part 2 Technical Report.

2.7.3.3 Opportunities

Several system wide opportunities were identified to improve the CSO Master Plan and assist in meeting the requirements of EA No. 3042. A number of the opportunities are directly linked to regulatory clauses in EA No. 3042. This includes green infrastructure (GI), real time control (RTC) and floatables management. Each of these topics was discussed with the RWC group as part of RWC Meeting No. 7 on September 13, 2018.

Green infrastructure is required for new or upgraded developments as identified in Clause 8 of EA No. 3042. GI is incorporated in the CSO Master Plan through a 10 percent capital cost allowance which is allocated to review and implement GI. The City will complete an evaluation of existing and potential GI to determine the suitability and performance in CSO control. This is further described in Section 5.2.1.

Real time control provides the City with an opportunity to reduce CSOs without added new sewer infrastructure. The City is in the beginning phases of implementing such a control program and has the potential to impact the proposed projects and reduce overall program cost. This is further described in Section 5.2.2.

The prevention of floatable materials is identified in Clause 12 of EA No. 3042. The Preliminary Proposal included an approach that would incorporate physical screens at each of the primary CSO locations. The CSO Master Plan continues with the recommendation of physical screens to ensure compliance with Clause 12. The Master Plan also includes an alternative floatables management approach where a focused floatable source control will be evaluated to prevent floatable material from entering the rivers. The ultimate goal will be to demonstrate equivalent floatable reduction performance of this alternative approach, meeting Clause 12. This would result in the physical screen facilities being recommended across the City being replaced with adopting this alterative floatable source control program. This alternative floatables management approach is described further in Section 5.2.3.

Each of these opportunities represents innovation in achieving the performance target and was well received during discussion with MSD during RWC Meeting No. 7.

2.8 City Investments Towards CSO Mitigation To Date

The CSO Master Plan development has not stopped the City from continuing with ongoing efforts to replace and upgrade infrastructure or increasing the level of understanding of the collection systems. The City's current programs are highlighted in Section 2.5.

The City has invested over $90 million since the beginning of the Master Plan project in 2013 with another $140 million committed for future investment. Prior to 2013, it is estimated that over $300 million has been spent on sewer relief work. The districts where work is currently planned, committed and underway for the near term includes the Jefferson, Ferry Road, Douglas Park, Parkside, Riverbend, Cockburn, Mission, and Armstrong sewer districts. This section provides further detail on the level of investment the City has implemented within the CS collection area since EA No. 3042 was issued in 2013.

- CSO Master Plan study and development - $5.4 million
- Interceptor Flow Monitoring - $1.0 million
- Sewer District Flow Monitoring - $2.5 million
- Sewer Instrumentation - $0.5 million
- InfoWorks ICMLive Software Purchase For Hydraulic Modeling- $0.4 million
- Sewer Relief Work - $74.0 million
    - Cockburn / Calrossie / Jessie- $53.0 million LDS separation
    - Ferry Road / Riverbend / Parkside / Douglas Park - $13.0 million LDS separation including the elimination of one CSO outfall in Douglas Park
    - Jefferson - $8.0 million LDS separation
- Latent Storage Dewatering Stations - $5.0 million
    - Bannatyne – McDermot SRS - $2.5 million
    - River – Fort Rouge SRS - $2.5 million
- Sewer Cleaning (outside of annual program)
    - Mission - $0.9 million
- Green Infrastructure
    - Bannatyne – North East Exchange Sustainable Drainage System - $0.5 million
- Decommissioning of secondary CS outfalls no longer required or in use

Additional work has been completed outside of the CS area that also benefits the long term goals of the CSO Master Plan. This work has included:

- Upgrading the Northeast Interceptor river crossing to include a redundant crossing
- Installation of a relief sewer in the separate sewer districts surrounding the Transcona neighborhood
- Elimination of 20 cross connections between the WWS and LDS systems

3. Technical Approach

This section of the report describes the technical approach used for project selection and development of cost estimates for Control Option No. 1.

It follows on from the Preliminary Proposal which reviewed five control options, and its ultimate recommendation of Control Option No. 1 as the basis for the CSO Master Plan. Much of the information presented in the Preliminary Proposal remains relevant to the technical approach for the CSO Master Plan. The emphasis is now on the further development of the potential plan described in the Preliminary Proposal into the Control Option No. 1 implementation plan and document this as part of this CSO Master Plan.

3.1 Design Basis

3.1.1 Planning Projections

The construction of combined sewers for new developments has been prohibited since the 1960s, so continued growth of the total area of the City of Winnipeg serviced by combined sewers will not occur. Although it is acknowledged that population and related sanitary flow may increase within the CS districts, the regulatory requirements of EA No. 3042 require that there be no increase in CSOs from any infill or re-developments in CS districts. In order to achieve this regulatory requirement, the City restricts any infill or re-developments in combined sewer districts to the pre-development flows.

For all existing CS districts that will be separated as part of Control Option No. 1, no additional infill has been accounted for as the wastewater generated from infills should remain at pre-redevelopment flows. There will be the ability of the existing combined sewers to receive more wastewater flows due to the removal of a significant WWF component. However, any increase in potential re-development wastewater flows will have to be assessed to ensure the static primary weir level is sufficient to fully contain this flow increase and does not contribute to an increase in CSOs. A detailed overview of the planning projections attributed to the modelling assessment has been provided in Section 3.4.1.

Significant growth outside of the mature CS areas is expected. As these areas are serviced by separate sewer districts, the growth in these areas do not have to meet the flow restrictions dictated by EA No. 3042. Development in these areas only must meet servicing capacities of the sewage conveyance and treatment systems. Several areas outside of the CS districts have been identified and prioritized as areas of growth within the Our Winnipeg planning guidelines as shown on Figure 3-1.

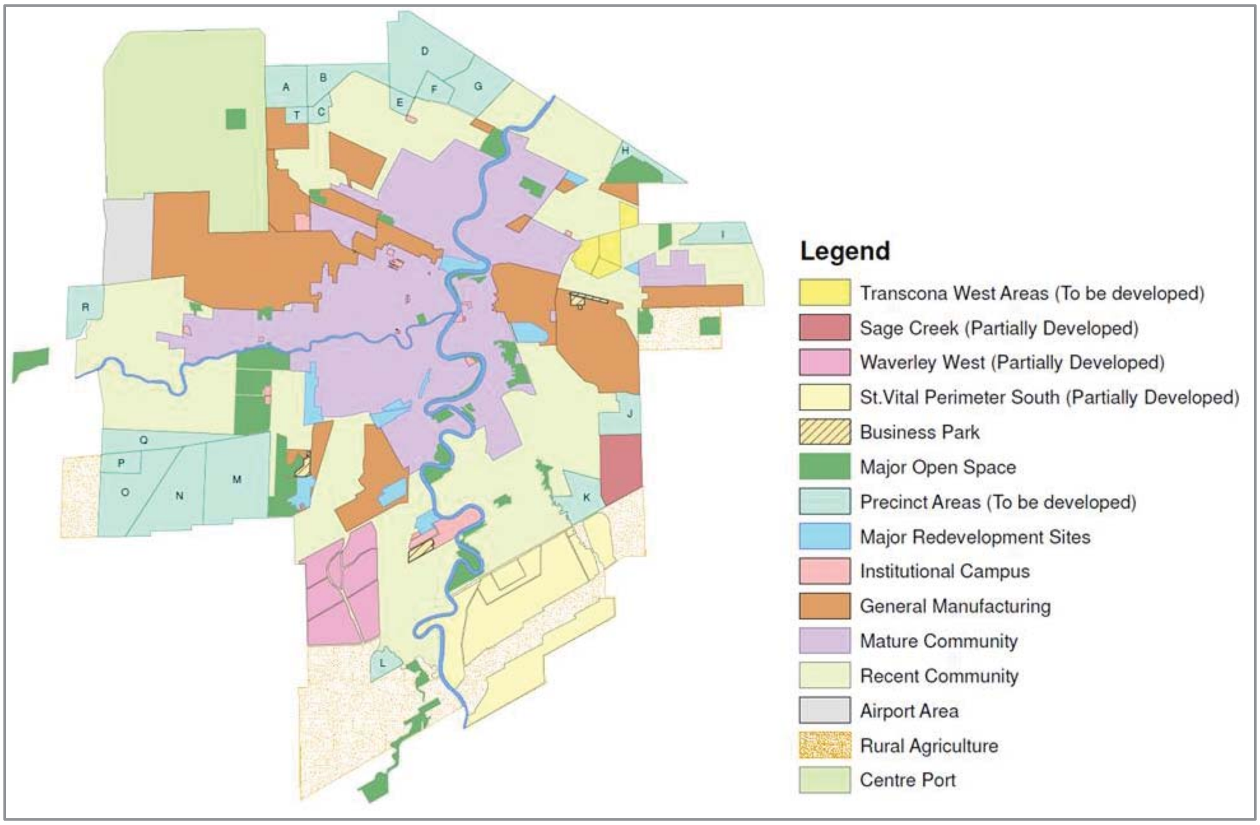

Figure 3-1. Potential Land Development or Redevelopment Areas

There is a critical link between the city-wide growth expected and CSO control options through the sewage treatment process. Combined sewage from CS districts and wastewater from separate sewer districts all flow to one of the three STPs, and essentially compete for sewage treatment capacity. This is especially important for CSO control options, where increased flow from the separate sewer areas will leave less capacity for treatment of flow from the CS districts. The growth projections are most important for the NEWPCC, since it has the largest CS area, but also applies in principle to the SEWPCC and WEWPCC.

All the combined sewage that is captured and temporarily stored must be sent to treatment facilities and treated to regulatory limits. The increased flow that reaches treatment as a result of these events is called wet weather flow (WWF) and will require treatment at an existing STP. The upgrades to the wet weather flow treatment capacity at the sewage treatment plants, to accommodate future growth and increased combined sewage capture is therefore essential to ensure this aspect of the CSO Master Plan is met.

3.1.1.1 NEWPCC Service Area Growth Projections

Future development and flow estimates for use in the CSO Master Plan were adopted from a recent study produced by the Winnipeg Sewage Treatment Program (WSTP), *North End Facility Flows and Loads* (WSTP, 2014).

The estimated 2015 population for the NEWPCC service area was 435,437, with a projected increase to 550,000 by 2037. The growth accounts for routing of Windsor Park flows to the NEWPCC and added servicing for the adjacent municipalities.

The study estimated a population of 684,000 in the year 2067, based on a continuation of the growth rate at 0.75 percent per year.

The study also included wastewater flow rate and quality projections for the NEWPCC.

CentrePort is a large development located to the northwest of Winnipeg, and was also represented in this WSTP report. This development was assigned a daily flow of 15ML/d for both the 2037 and 2067 future development scenarios, as an alternative to reporting a population figure.

3.1.1.2 SEWPCC Service Area Growth Projections

The SEWPCC Service Area is the second largest in Winnipeg. Future flow estimates for the SEWPCC Service Area were adopted from the *SEWPCC Upgrading/Expansion Preliminary Design Report* (Stantec et al., 2008). The report selected a 2031 design year and established an average annual growth rate of 0.7 percent per year. The population is expected to grow to between 229,800 and 281,000 by 2031. According to the report, DWF is expected to increase from a current flow of approximately 45 ML/day to 68.4 ML/day by 2031 (including the Windsor Park District).

3.1.1.3 WEWPCC Service Area Growth Projections

The WEWPCC Service Area is the smallest in Winnipeg. As shown in Figure 3-1, several new residential areas are expected to be developed in the near future within the WEWPCC Service Area that will increase DWF. The CS districts are at the upstream limit of the treatment area and are fully developed areas. As such, no growth within these CS districts is expected.

No future reports have been noted on development within the WEWPCC catchment area. It was therefore assumed that a growth rate similar to the SEWPCC catchment growth rate would be adopted. This results in a 2037 population estimate of 116,700.

3.1.2 Asset Information

Asset information used in the development of the hydraulic model and the CSO Master Plan was initially based on 2013 data transferred from the City. The City provided their sewer system asset data from their Land-Based Information System (LBIS) database. Additionally, all relevant reports and hydraulic models were made available.

3.1.3 Sewer System Critical Data

The technical evaluations required collection of system information and a sound understanding of the existing sewer system and its operation. A set of data was identified from the existing asset information that is critical to the selection, functioning, and design of the control option technologies under consideration.

A schematic of the critical points is shown on Figure 3-2.

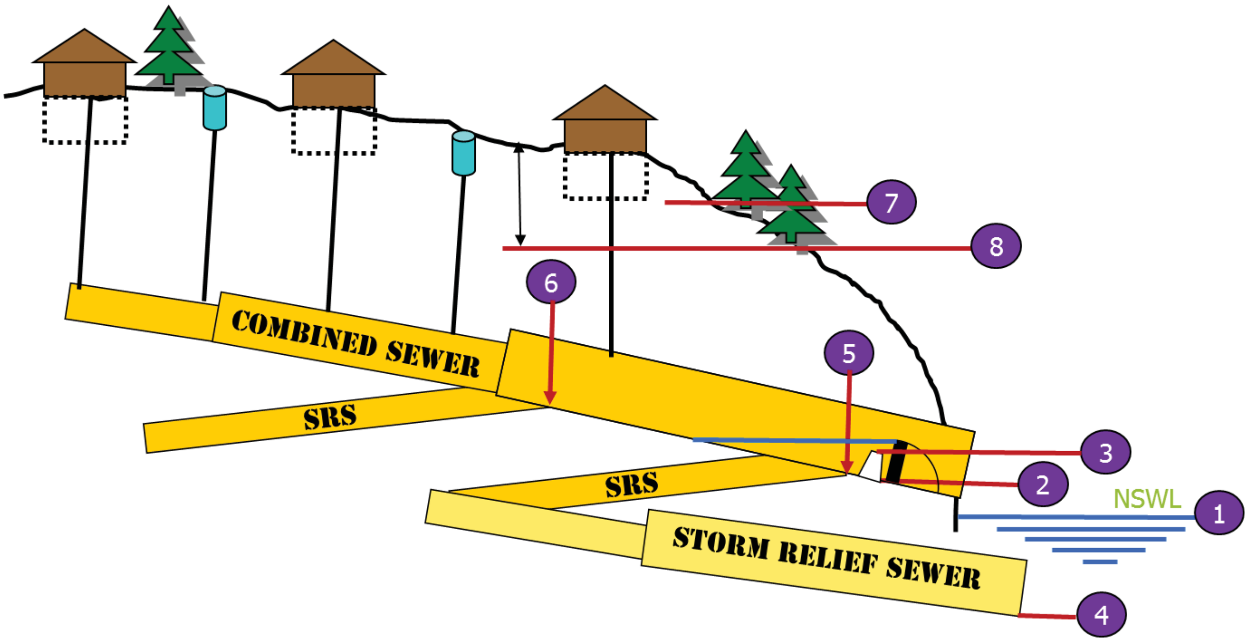

Figure 3-2. Sewer District Critical Data Points

The numbers in Figure 3-2 relate to the critical data points identified in Table 3-1.

Table 3-1. Sewer System Critical Data Points

Identification Number	Name	Description
1	NSWL Elevation	Long term average summer river levels at each CS outfall location. Considered a minimum level during the recreational season. Will vary spatially along the Red, Assiniboine and Seine Rivers.
2	Invert Elevation at Off-Take	Invert elevation of pipe diverting flow from diversion weir towards Interceptor pipe (via pump or gravity).
3	Diversion Weir Crest Elevation	Elevation of existing static weir in each district to contain up to 2.75 x ADWF prior to overflowing.
4	SRS Outfall Invert Elevation	Invert elevation immediately upstream of SRS flap gate.
5	Low SRS Interconnection Elevation	Lowest elevation level where surcharged in-line storage in the CS system would flow into the interconnected SRS system.
6	Low SRS Interconnection to alternative discharge point	Lowest elevation level where surcharged in-line storage would discharge to a secondary overflow or to an adjacent combined sewer district.
7	Low Basement Elevation	Lowest basement floor elevation in the district – considered for risk analysis to basement flooding.
8	Basement Flood Protection Elevation	Typically calculated as 3 m (10 feet) below lowest CS manhole rim elevation, but under no circumstances can be above the low basement elevation.

3.1.4 Standard Details

Standard details for each CSO control option technology selected as part of the CSO Master Plan provide a common description and basis for sizing and costing technologies used in multiple districts. Standard details apply to the control options selected in each sewer district and are discussed in each engineering plan in Part 3B. The proposed control options were initially selected because they have a proven record of operation within combined sewers. The details were updated and further refined during this phase of the CSO Master Plan. Part 3C includes a summary of the standard details used in the CSO Master Plan development. Part 3C also discusses each of control technologies in terms of design considerations and operations and maintenance (O&M).

3.1.5 Control Option No. 1 Target

As discussed in Section 2.6, potential plans were developed as part of the Preliminary Proposal to define and evaluate each of the five alternative control limits. The highest rated alternative, which best balanced the key drivers for long-term CSO control in Winnipeg, was identified as Control Option No. 1 - 85 Percent Capture in a Representative Year (CO1).

An official response from MSD was received on November 24, 2017, via a letter that states that the Preliminary Proposal met the intent of Clause 11 of EA No. 3042, and that Control Option No. 1 – 85 Percent Capture in a Representative Year, is to be implemented by December 31, 2045 or otherwise as approved by the Director, in such a way that Control Option No. 2 may also eventually be phased in.

This will require a major investment in combined sewer infrastructure. Control Option No. 1 as included in the Preliminary Proposal included a combination of the following CSO controls:

- Control gates and in-line storage
- Screens for floatables capture
- Latent storage
- Off-line storage
- Sewer separation of combined sewer districts where BFR is required
- Wet weather treatment as provided under the Winnipeg Sewage Treatment Program

Control Option No. 1 will meet the City's vision of "doing our part" to address CSOs within the City of Winnipeg. CO1 was the preferred choice from among the alternatives for the following reasons:

- It will achieve 85 percent capture, which was set by the U.S. Environmental Protection Agency for the presumption approach, thereby meeting a recognised benchmark for CSO control programs.
- The number of overflows and the amount of floatable material will be reduced in the majority of the combined sewer districts.
- It can incorporate GI and is adaptable to opportunities based on new technologies or aspects of this CSO Master Plan that require further evaluation, such as RTC.
- Although it has the lowest cost of the five alternatives it represents a significant investment from the City in CSO management, will be the most affordable for ratepayers, and have the least impact on competing programs when compared to the other alternatives.
- It will provide environmental improvements and protect river uses to a level similar to the other alternatives.
- The reduced amount of construction in comparison to the other alternatives will limit the potential disruptive impacts on neighborhoods and businesses.
- It integrates with the current CSO and BFR program implemented by the City.
- It can be expanded in the future if climate change or regulatory standards require further mitigation of CSOs.

3.1.6 Representative Year

A representative year is a single year of historic climate data for the City of Winnipeg selected from the long-term historical dataset, that best defines a typical year and was used to establish the performance of the alternative control options in the Preliminary Proposal. A defined representative year provides a reference data set on which alternative control options can be evaluated and progress can be measured. The selection included a review of annual precipitation (rain and snow) and river flow, inclusive of the recreation and non-recreation seasons. For the prior 2002 CSO study, 1992 was selected as the representative year for CSO control alternative assessment purposes. After further review using an increased dataset, 1992 was again selected as the representative year for the CSO Master Plan, as documented in the Preliminary Proposal.

The evaluation found 1992 to be a representative year for both precipitation and river flows. River flows are important for both collection system discharge calculations and river water quality evaluation purposes. The 1992 river flows were used extensively to assess the impacts of CSOs on river water quality, as reported in the Preliminary Proposal. Because the CSO Master Plan is proceeding with a percent capture regulation as per Control Option 1, the use of a representative year for river water quality evaluations was not required for this portion of the CSO Master Plan study.

3.1.7 Percent Capture Calculation

Percent capture is the main component in determining the performance of the program. The percent capture calculation is derived from the definitions in EA No. 3042, stated as follows:

> ***Environment Act Licence No. 3042 definition:*** *"percent capture" means the volume of wet weather flow treated in comparison to the volume of wet weather flow collected on a percentage basis. In other words: "percent capture' expressed as % = [(total wet weather flow collected – combined sewer overflow) / total wet weather flow collected] x 100*

A clarification was issued and confirmed with MSD in October 2015 as part of the Preliminary Proposal development, to define the measurement periods and is included in Appendix B of this Part 2 Technical Report for reference. The updated definition of percent capture is identified as follows:

> ***Approved Clarification:*** *"percent capture" means the volume of wet weather flow treated in comparison to the volume of wet weather flow collected on a percentage basis; as measured from the start of the precipitation event until the CSO controls return to dry weather conditions, determined by the completion of the dewatering process and the ending of wet weather treatment.*

As illustrated on Figure 3-3, the percentage capture calculation incorporates a combination of DWF, captured WWF, and CSO. A simplified approach for determining percent capture was used for the Preliminary Proposal and has been continued for the final submission.

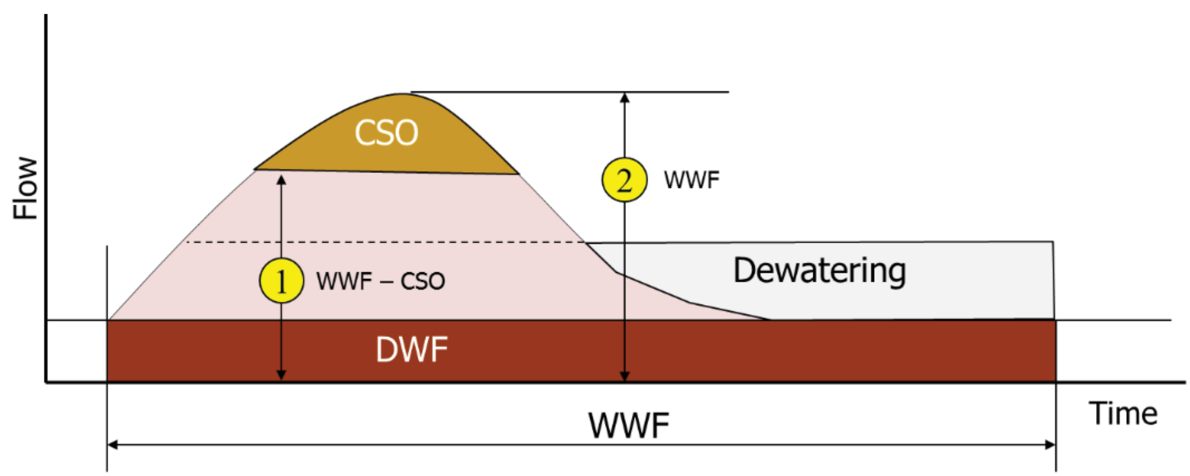

Figure 3-3. Illustration of Percent Capture Calculation

Percent capture is determined in the illustration as volume 1 divided by volume 2, including the dewatering time and is reported as a percentage estimated using the hydraulic model. Volume No 2 in the diagram was determined with volume No. 1 which is generated by the hydraulic model, plus the combined sewer overflow volume generated by the model.

3.1.8 Existing System Performance

The baseline conditions for the CSO Master Plan were established as the year 2013 as part of the original Preliminary Proposal development process. The baseline conditions are a snapshot in time and provide the basis for tracking progress for the CSO program. As the program proceeds, any changes to percent capture will be tracked and reported. The baseline conditions were established using an InfoWorks CS hydraulic model which replicated the sewer system conditions as of 2013. The 1992 representative year for precipitation and river level conditions was applied to the sewer system and utilized to report the model's performance in the Preliminary Proposal. The baseline modelled conditions were subsequently modified based on additional information and corrections in the sewer system asset data in 2018. This is considered the "updated 2013 baseline" model.

The CSO volume for the full representative year, based on the updated 2013 baseline sewer system conditions, was determined to be 5,170,000 m^3. The capture rate for the baseline conditions is 74 percent.

The CSO volumes for the updated 2013 baseline system configuration for the 1992 representative year are shown on Figure 3-4 for each of the 41 CS districts with primary outfalls. The Jefferson West and Munroe Annex districts do not have an outfall that flows directly to the Red River and are therefore not included in the reporting throughout this section.

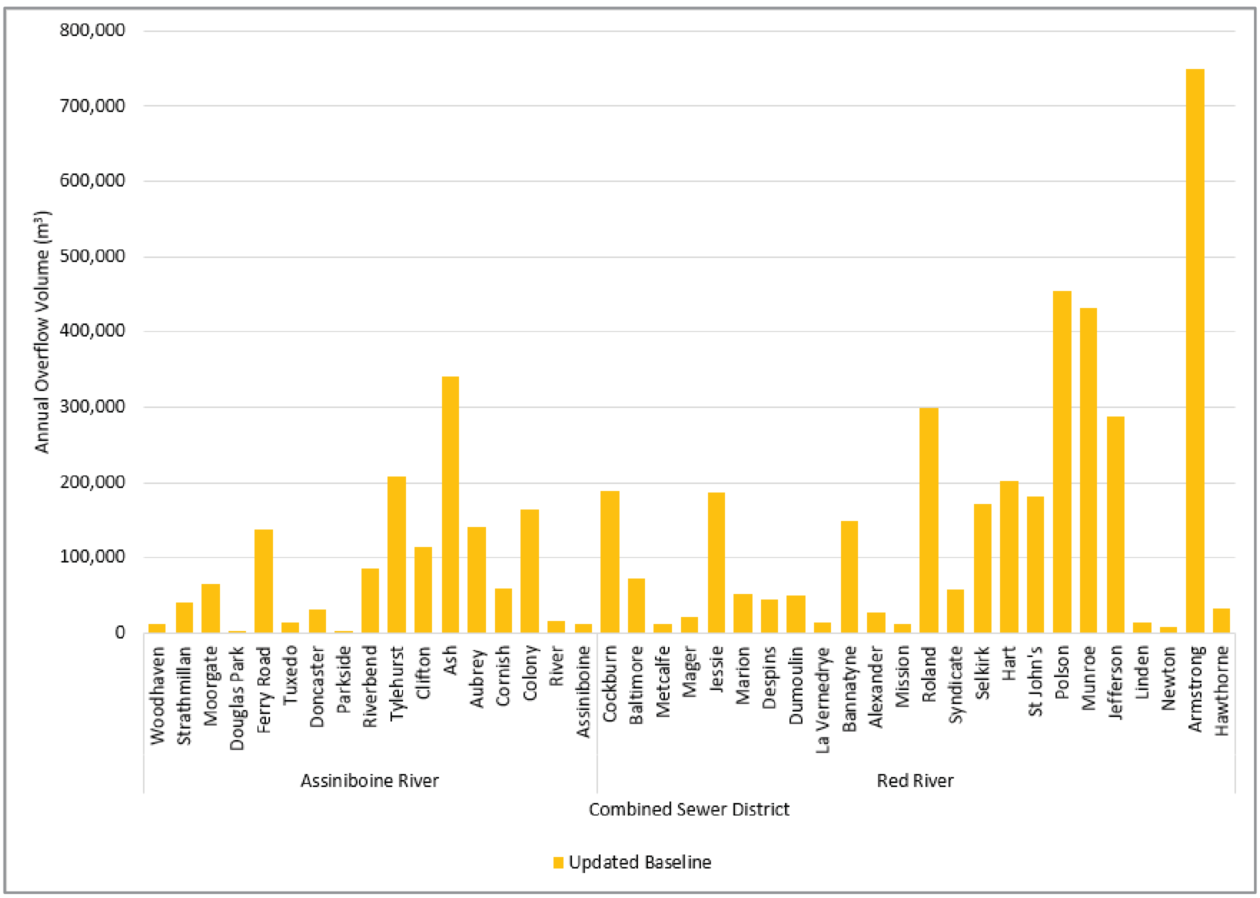

Figure 3-4. Updated Baseline Number of District CSO Volumes – 1992 Representative Year

3.2 Dewatering Strategy

The CSO Master Plan will significantly change the amount and methods by which combined sewage is captured when fully implemented. The current use of diversion weirs installed in CS trunks will predominately be replaced by control gates and temporary storage measures to capture larger runoff volumes from rainfall events. The captured combined sewage will then be gradually released back into the interceptors and treatment systems, as would occur during normal dry weather flow operation. This release process is referred to as dewatering. This will be off-set via the separation of selected districts, where the runoff collected from the streets within the district will be removed from the combined sewage reducing the captured combined sewerage in the corresponding interceptor and treatment systems.

The dewatering strategy ultimately will make better use of the existing separate and combined sewer systems to improve the sewage volume capture and treatment performance. A typical sewer district has a proposed arrangement in place to capture flow when levels within the system increase. The captured flow/volume increases incrementally as the level of in-line storage is increased through the addition of an in-line control gate. The variable flow rates received by the interceptor system following the implementation of these in-line control gates, latent storage and off-line storage arrangements result in suboptimal use of the interceptor system. The CSO Master Plan assessment was completed on a system wide rainfall event distribution. Future dewatering studies will have to evaluate the impact of spatial rainfall event distributions.

As part of an overall dewatering strategy improvements will be made that result in controlled discharge from each in-line storage/latent storage/off-line storage facility, at known and measured discharge rates. The interceptor and STPs would be able to run for longer durations at peak capacity through these controlled dewatering rates from the sewer districts. An overall dewatering strategy will maintain a more constant flow rate to the STPs and avoid uncontrolled system back-ups or CSO events.

3.2.1 Dewatering Strategy Approach

The future CSO control works, interceptor system and STPs must function as an integrated system. Discharges from CSO storage facilities must not overload the interceptors and the interceptors must not overload the STPs. If the STP are overloaded, the interceptor system will begin to surcharge, and the additional combined sewage volume captured cannot enter the interceptor system. At this point, the CSO event will simply be relocated, compromising the program performance. The planning and management of these components will be carried out through the dewatering strategy.

There is a direct trade-off between storage volumes and dewatering rates, with higher dewatering rates reducing the temporary storage requirements. The dewatering rates are limited by constraints within the existing sewer system. Interceptor, conveyance and sewage treatment have limits that are generally more difficult and costlier to change beyond a practical limit. A further limitation for increasing CSO dewatering rates is the reduction in STP effluent quality produced by wet weather treatment facilities due to the facilities being overloaded. This will further detriment the ability for the blended effluent from the STPs to meet the final plant effluent water quality limits.

The dewatering strategy approach requires that dewatering rates be developed for each CS district, and operate within the interceptor and sewage treatment plant constraints. The strategy must accommodate future growth for the entire STP service area. However as discussed in Section 3.1.1, future growth was only evaluated in the separate sewer districts. It was assumed there would be no growth in WWF in CS districts beyond that resulting from the control options recommended in the CSO Master Plan, as any further growth in WWF due to densification could result in further CSOs and would violate Clause 8 of EA No. 3042.

The dewatering strategy was established for the NEWPCC as part of the Preliminary Proposal. The NEWPCC services the largest CS area; therefore, the general approach and concepts have been applied to the smaller SEWPCC and WEWPCC interceptor and treatment systems.

3.2.2 Wet Weather Flow Treatment Capacity Considerations

Two WWF treatment scenarios were considered for the NEWPCC as part of the Preliminary Proposal. Both scenarios considered a peak WWF treatment rate of 705 ML/d, based on the design requirements for the future NEWPCC upgrade.

This sets the dewatering rate for combined and separate area inflows for the entire NEWPCC service area. The NEWPCC wet weather treatment facility will be designed for a peak rate of 325 ML/d, which is the difference between the plant peak flow rate of 705 ML/d and the biological nutrient removal plant flow capacity of 380 ML/d.

DWF and Rainfall Derived Inflow and Infiltration (RDII) from separate sewer districts will continue to be received and treated without interruption. CS dewatering will be set as a secondary treatment priority if the combination of combined sewage flow in CS districts and DWF plus RDII from separate sewer districts being conveyed to the NEWPCC exceeds 705 ML/d. CS dewatering has been set as a secondary priority, as the addition CS stored as part of the solutions recommended in this Master Plan can be held in the temporary storage facilities while peak flows generated from the separate sewer areas are conveyed and treated as soon as they are received.

3.2.3 Interceptor Capacity Considerations

The NEWPCC interceptor was assessed for dewatering rates using the InfoWorks model and found to have sufficient capacity to support the 705 ML/d WWF treatment rate. As a result, the primary limiting factor to be considered in the dewatering strategy is the NEWPCC treatment capacity, and not the interceptor system.

3.2.4 Combined Sewer District Dewatering Rates

Dewatering rates were determined for each district based on the CSO control options selected and the requirement for dewatering to be completed within 24 hours after a rainfall event has stopped, as required by EA No. 3042. The analysis indicated that the existing pumping stations will meet these dewatering requirements. Even though there will be a larger volume pumped for some rainfall events, the maximum rate of pumping required to meet the 24 hour dewatering period is less than or approximately equal to what currently exists. All that will be modified is the existing pumps will be required to run for longer durations at a constant rate. Several sewer districts do not have pumping stations and drain by gravity to the interceptors. The analysis also indicated that these gravity discharge districts meet the dewatering capacity requirements. The existing offtake pipes within these gravity discharge districts are sufficiently sized currently to accommodate dewatering of the 1992 representative year rainfall events.

An important caveat of the dewatering strategy capacity evaluation completed is that it assumes a control system will be in place, and utilized to adjust pumping rates for each district to match available conveyance and treatment capacity. This will require the installation of flow monitoring and pumping rate controls within each district. Pumping rates will range from diurnal dry weather low flows to the peak dewatering rates. For the gravity discharge districts, gravity flow controllers are to be installed to provide similar flow monitoring and control to modulate discharges to the interceptor sewer system.

This ability to monitor and control discharge rates from each combined sewage district is intimately tied with the implementation of the RTC program opportunity. Full RTC implementation would be particularly effective for dealing with variable spatial rainfall distributions, where districts receiving higher rainfall could dewater faster than those with low or no rainfalls. Flow could be retained in the districts with minimal rainfall to allow the affected districts to dewater faster. Refer to Section 5.2.2 for further details on how an RTC arrangement with the City's combined sewer system would function.

3.3 CSO Control Technology Descriptions

The CSO program requires that control options be identified, evaluated, selected, and designed for each location. A single control option or combination of options may be required to achieve the required level of performance.

This section provides a description of each control option used in the CSO Master Plan. Specific details of the control options proposed for each sewer district as part of the recommended CSO Master Plan can be found in Part 3A and 3B.

Part 3C describes the technology and/or products selected as representative for each control option. The representative control option products are then used for the performance analysis and cost estimating. The design and O&M considerations for each representative product are also included and explained in more detail in Part 3C.

3.3.1 Sewer Separation

In separate sewer systems, stormwater is conveyed in a LDS system to its own dedicated outfall for discharge directly into the receiving water, whereas sanitary sewage is collected by a WWS system and, conveyed to treatment where it is fully treated before discharge. Sewer separation projects under the CSO program modify the existing CS systems and build an adjacent WWS or LDS system to achieve the same outcome.

Sewer separation involves the installation of additional conveyance capacity to achieve independent sewers for each of the WWS and LDS flows. As such, sewer separation projects greatly reduce the volume of surface runoff entering the CS system. This reduces or eliminates the number of CSOs that occur in a sewer district when separation is completed.

The City has proceeded with sewer separation in CS districts under the previous CSO and BFR program when conditions warranted. Various levels of separation have been completed within some of the sewer districts, with large investments in sewer separation projects currently underway and projected to continue under the CSO Master Plan.

There are several methods for achieving sewer separation that may be applicable to the CSO program. The terminology used for the methods and types of sewer separation recommended throughout this Master Plan are summarized in Table 3-2.

Table 3-2. Types of Sewer Separation

Type of Separation	Features
Complete Separation*	All wet weather flow is collected by an LDS system. All wastewater flows are collected and conveyed by a WWS system.
Partial Separation "Separation Ready"	Complete separation of selected regions within a sewer district to achieve a desired level of basement flooding protection or CSO relief. The entire CS district is not separated. Small separate areas within the district may be referred to as Separation-Ready: typically, where the area can be connected to an existing LDS.
LDS Separation	A new land drainage sewer (LDS) system is constructed in which catch basins in the CS district are reconnected to the new LDS system. The existing CS system is then converted to WWS system.
WWS Separation	A new wastewater sewer (WWS) system is installed to collect domestic sewage. The existing CS system is then converted to a LDS system.

*As part of complete separation all surface runoff from roads within the CS district are removed from the CS system, by reconnecting all catch basins to the LDS system. Private foundation drains, sump pumps, and roof drain connections from older properties built prior to 1990 however may remain connected to the CS system that is being used as part of the WWS system. A wet weather flow (WWF) response is likely to remain in this WWS system as a result.

The type of separation most commonly recommended as part of this CSO Master Plan is complete separation for a district. Even after complete separation for a district has taken place, WWF in the wastewater system from foundation drainage will still require management. Flows will be monitored following separation of the district to determine if further work, such as weir height increases, are required. Where the WWF remains significant, additional consideration will be given to incorporating a sump pump and backwater valve subsidy program to divert roof and weeping tile flows from the WWS collection system.

A benefit from the remaining flows from foundation, sump pump and roof leader connections that must also be considered is that they will continue to provide a flushing flow to the CS system during wet weather to facilitate self-cleaning velocities. This must be balanced with the necessary removal of WWF to remove CSO events from the CS districts where complete separation is recommended.

An added benefit for completely separating a district is the increased level of basement flooding protection. LDS systems are not connected to building service lines and, therefore, may surcharge to street level without backing up into basements. However, all LDS systems will be designed to prevent conditions for surcharging to street level beyond extreme wet weather events, to meet the City of Winnipeg's design requirements for LDS systems.

Sewer separation is complex to implement and comes with a high cost and increased time required to implement the separation work and achieve the water quality benefits. Large pipes must be installed on every street in existing developed areas, with potential alignment conflicts with the existing combined sewers and other utility services. The level of disruption to traffic and local businesses may be significant and occur for an extended period while construction is ongoing. As identified in Table 2-2, some sewer separation projects within Winnipeg have been ongoing for many years, causing various levels of disruption to the area.

3.3.2 In-line Storage

In-line storage refers to the storage volume accessed within a CS system with the installation of a control gate. In most sewer districts, the CS pipes are large and only fill completely during very large runoff events. The use of weirs or gates to prevent discharge results in the sewers surcharging, with sewer levels rising to a known and controlled level within the pipe; this flow volume is referred to as in-line storage. In-line storage includes any point in which DWF or WWF is restricted by a weir or gate and is allowed to surcharge. The surcharged volume of CS is prevented from overflowing and is eventually dewatered to the interceptor system utilizing the existing pumping and gravity discharge infrastructure.

The existing CS districts use a diversion weir, known as the primary weir, which has a set elevation to intercept all DWF from the district but does not optimize CS capture. These primary diversion weirs are generally set at a design height capable of intercepting 2.75 times the ADWF rate, to ensure all DWF events and minor WWF events are intercepted and sent to treatment. The volume of in-line storage can be temporarily increased by installing a control gate adjacent to this primary weir. This will increase the maximum elevation under which DWF and WWF is intercepted, as illustrated on Figure 3-5. The increase in the maximum intercepted elevation ultimately results in a higher volume capture. This additional volume captured is referred to as in-line storage volume. Figure 3-5 shows a typical arrangement with the primary weir and control gate at the same location. In some cases, the control gate may be located nearby due to system constraints. There are many methods for temporarily increasing the control elevation, but the method must avoid compromising the hydraulic capacity of the CS system and not increase the risk of basement flooding caused by increasing surcharge levels within the sewer.

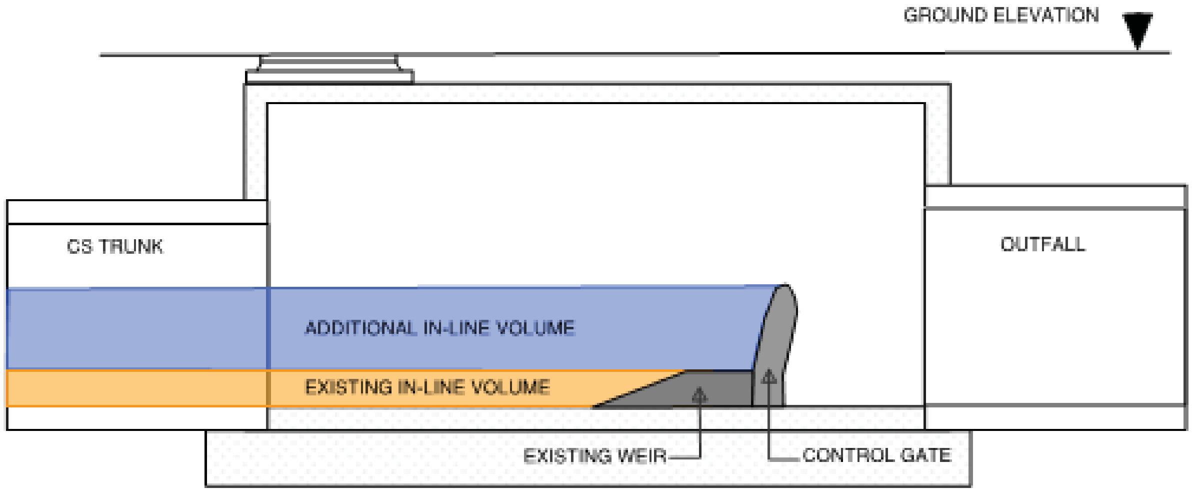

Figure 3-5. Proposed Typical In-line Storage Schematic

The CSO Master Plan proposes the use of a control gate with a height restriction for this application. This type of control gate hinges from the bottom like a drawbridge and is generally placed immediately downstream of the primary weir, as shown in Figure 3-5.

During DWF conditions, the control gate would remain in an upright raised position and all DWF would be diverted to the interceptor via the existing pumping or gravity discharge infrastructure. During WWF, the control gate in its raised position would allow the in-line storage within the CS system to increase. Flows captured behind the gate would be continually dewatered through the existing gravity discharge or lift station to the interceptor. If the in-line level continues to increase to a previously established critical height, as may occur under larger WWF events, the control gate would drop into its lowered position. This critical height will be based on ensuring the same level of basement flooding protection remains in the district. The interception height when the control gate is in the lowered position would match that of the existing primary diversion weir; therefore, having a minimal impact on head losses under these high flow conditions. At this point with such significant WWF events, a CSO from this outfall would occur, in order to protect homes in the area from basement flooding. Once levels in the combined sewers decrease, the gate would activate again and gradually rise to allow in-line storage levels within the CS system to build. This operating method is intended to maximize the volume of CSO capture by capturing all WWF from smaller events and capture the receding rainfall runoff response near the end of the medium to larger events.

The control gate would operate to fail in the lowered position in emergency situations or where the control gate is malfunctioning. Therefore, under these conditions the control gate would not provide any restriction of the CS outfall pipe during extreme WWF events. This is known as a fail open condition and is essential for the control gate product selected to ensure operational issues do not increase the risks of basement flooding. As part of the conceptual design of the in-line storage arrangements for CS districts, the control gate has been evaluated with a maximum height of approximately half the main CS incoming trunk diameter for the CS district in question. This may be modified as part of the preliminary and detailed design of the in-line storage control gate for specific CS districts.

The existing primary weir would continue to function as it currently does and continue to divert flows to the interceptor system. The difference in height between the top of the control gate and the existing weir represents an increased volume of in-line storage.

It is proposed that a rectangular concrete control gate chamber would be constructed to contain the control gate system. A typical arrangement would have the control gate chamber centered on the existing outfall pipe in the vicinity of the existing weir. The width of the proposed chamber is directly related to the width of the existing sewer trunk and the length is related to the amount of space required for hydraulics and gate operation. There will be locations where reconfiguration of the existing CS sewers, diversion structures or intercepting off-take pipe will be required to accommodate this installation. This chamber may be constructed to be stand alone or to operate with an adjacent off-line screen.

Further details of the in-line storage design considerations are provided in Part 3C.

3.3.3 Screening

Screening can be used to reduce the volume of floatables entering the receiving water course. For the CSO Master Plan, floatables screening has been proposed as a control option at each primary outfall where the system hydraulics allow. Screening operation typically requires an increase to the existing weir height or the supplemental installation of an in-line control gate to generate sufficient hydraulic head differential to allow for proper screening operation. This also provides additional in-line storage CSO volume capture. Screened flow is diverted back through the existing outfall and to the receiving stream downstream of the control gate. Screenings would be diverted back to the off-take or CS lift station for transport to the STP for removal. A schematic of a typical screening – control gate installation is provided in Figure 3-6.

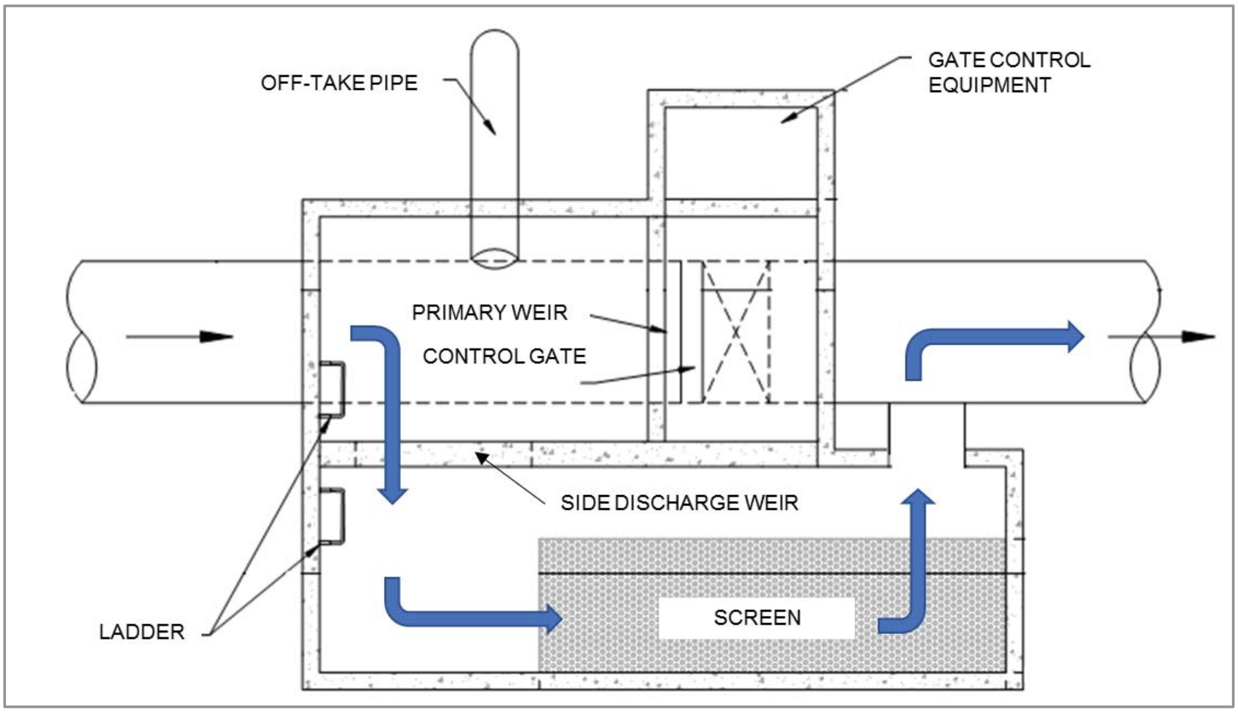

Figure 3-6. Proposed Typical Off-Line Screening Arrangement

Proposed screening facilities would typically be installed in combination with a control gate. The control gate would capture all sewage, including floatables, up to the design capacity based on the control gate height. Once the combined sewage reaches the crest of a side-discharge weir, the combined sewage would flow through the screens and capture floatables. The screening operation would continue in this manner until the combined sewage level receded below the side-discharge weir height or increased to the point where the control gate drops to its lowered position. When the control gate drops to its lowered position, there would be no further screening operation, as all combined sewage is allowed to overflow directly to the river, preserving the level of basement flooding protection. As the screening facilities are not connected to the main collection pipework in the CS system, and instead are only activated once sufficient levels in the CS system are reached, the screening facilities are considered off-line facilities.

It is proposed that a rectangular concrete structure would be constructed to contain the screening system. A typical arrangement would have the control gate chamber centered on the existing outfall pipe in the vicinity of the existing weir and the screen chamber would be located adjacent to this. The width and length of the screening chamber is related to the hydraulics at the installation location. Locations with a higher level of hydraulic head available would require a smaller screen to operate. There will be locations where reconfiguration of the existing CS sewers, diversion structures or intercepting off-take pipe will be required to accommodate this installation. This chamber would be accessed through an above grade manhole or access hatches.

The captured screening material will be pushed and retained in the storage area adjacent to the mechanical screen itself. Where there is available head and space, the screenings can be returned to the main trunk under gravity after the rainfall event has ended and the control gate has returned to its raised position. Where there are space or head constraints, a pumping system is required to remove these screenings and return them to the main CS trunk for interception and final routing to the sewage treatment plant/s. These will be assessed on an individual basis, given the unique arrangements at many of the CS outfalls.

3.3.4 Latent Storage

Latent storage refers to the existing storage available in the SRS system. Each SRS system includes dedicated outfalls and are protected from high river levels backing up into the SRS system by a flap gate. This flap gate allows one-way flow only; it allows SRS collected to be relieved from the CS system during WWF events by discharge by gravity towards the river. A sluice gate is also provided which is manually engaged for maintenance purposes.

The flap gate does not allow the river to flow backwards into the outfall pipe. Under high river level conditions, the river exerts a backpressure on the flap gate. This backpressure forces the flap gate shut and in turn does not allow the SRS system to discharge to the river under WWF events. Only until the hydraulic level in the SRS system exceeds the river level at that time does it forces the flap gate to open and allow discharge of the combined sewage within the SRS system until the SRS and river levels on each side of the flap gate equalize. This is further illustrated in Figure 3-7 below. While this is a risk which is managed now in the CS and SRS systems, it can be taken advantage of and monitored to provide additional temporary storage of WWF that can then be returned to the primary CS system during DWF conditions for conveyance and treatment.

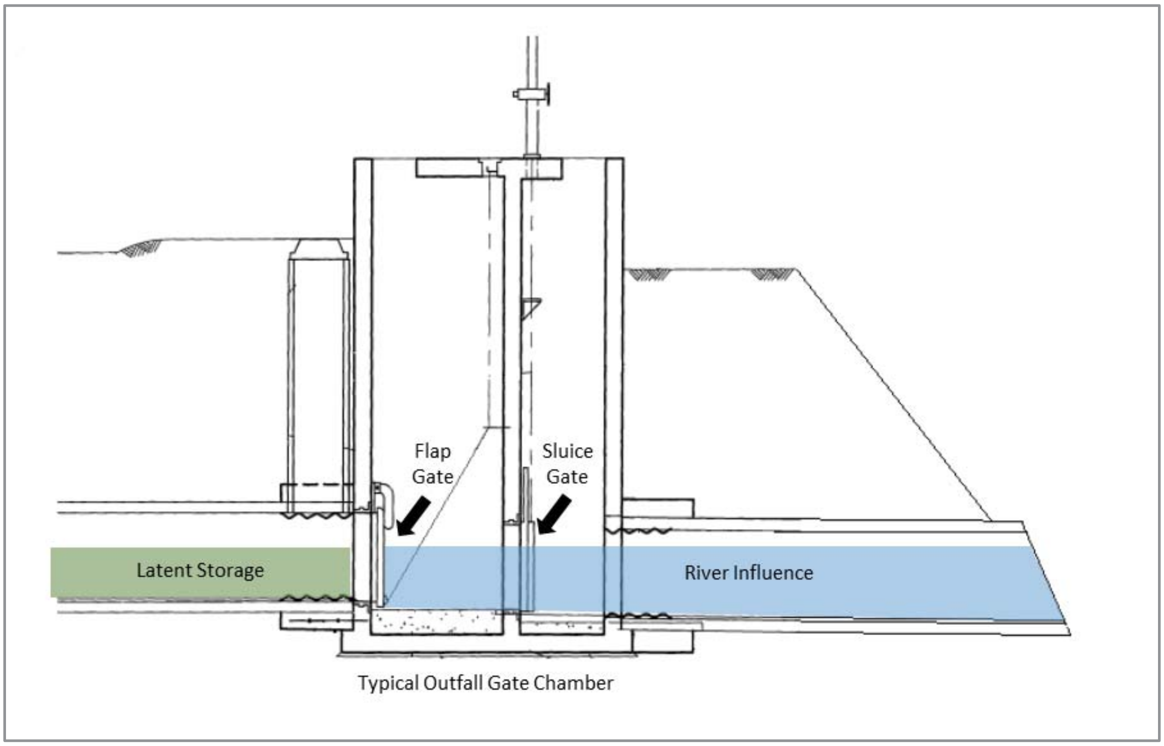

Figure 3-7. Proposed Latent Storage Schematic

This control option requires the installation of a pumping station to dewater the latent storage contained behind the flap gate following a WWF event. This option has the advantage of accessing existing storage for CSO control, off-setting the construction of more costly storage alternatives such as off-line tanks or tunnels.

The implementation of latent storage can only be completed with the installation of a pumping station and force main on the SRS outfall pipe, where the additional CS volume will be temporarily stored. The force main would provide a connection back into the existing CS system, where any combined sewage stored in the SRS system during a WWF event would be redirected to the CS, and ultimately to the STP for treatment as part of the dewatering process. Although the pumps may be installed along the SRS outfall pipe, care must be taken not to impede the discharge capacity of the SRS system. The CSO Master Plan has assumed the use of off-line latent storage pumping station (LSPS) with an off-take from the SRS immediately upstream of the flap gate.

A typical arrangement would have the off-line LSPS installed near the SRS flap gate chamber to maximize the volume that would be dewatered. An offtake pipe would connect the LSPS and the SRS trunk. A force main would then connect from the LSPS back to the CS system at the most convenient location. These installations would not require significant space for installation, or operation and maintenance needs. Typically, this would require a single manhole converted to a pump station.

The latent storage option is only applicable to sewer districts with an SRS system with a dedicated SRS outfall with a flap gate installed. The available latent storage volume has been assessed based on the NSWL at the various SRS outfalls and the amount that can be stored in the SRS at that particular elevation. In districts where the SRS system share a common outfall with the CS system, it is proposed to isolate the systems via the inclusion of a flap gate on the SRS system to control the latent storage discharge. To meet the design under the 1992 representative year requirement stated in the Preliminary Proposal, the performance of the latent storage facilities used the NSWL level for the full year and this was continued for the CSO Master Plan assessment. The 1992 representative year river level profile, including the chronological river level changes throughout 1992 should also be evaluated in the future. This will further refine the performance expectations for the latent storage control option. For further detail on the river levels used and their impact on latent storage facilities see Section 3.4.4 of this Part 2 Technical Report.

There are also situations where it has been found that the latent storage volume required to meet the Control Option No. 1 target required storage volume above the river NSWL design condition. Under these conditions a more automated control of the SRS outfall flap gate is required, which forces the flap gate closed regardless of the river level backpressure exerted. This is known as flap gate control and has been recommended as part of the latent storage design in specific districts in Part 3B. Flap gate control is also required where the level of storage volume in the primary trunk projected to be used for in-line storage is high enough to backflow through the SRS flap gate, and therefore must also be contained in the SRS system to be considered.

A key aspect of latent storage design is that the SRS system protect basements from flooding by relieving the CS system. This key function of the SRS system must not be compromised by implementing latent storage. Therefore, any flap gate control measures recommended must have a low risk of failure. A latching device that maintains the flap gate closed until a system level set-point is reached, at which point the latching mechanism disengages and allows the flap gate to naturally swing open, was selected as the preferred product for flap gate control. This is discussed further in Part 3C, Standard Details.

3.3.5 Gravity Flow Control

Gravity flow control is required for combined sewer districts that dewater by gravity to the sewer interceptor, instead of by lift station pumps. There is currently no ability to control the flow to the interceptor through these types of connections, beyond the discharge pipes reaching their maximum flow capacity and providing a restriction at this point. Gravity flow controllers will continue to allow gravity discharge but will monitor and restrict the flow rate to a predetermined dewatering flow rate, which in many cases would be below the maximum flow capacity of the gravity pipes. This is a control measure which is also intimately tied to the RTC program opportunity.

The installation of new flow monitoring and control systems would provide the control necessary to manage in-line storage to the same degree as districts which rely on pumping stations for conveying intercepted sewage. A typical gravity flow controller arrangement is shown on Figure 3-8. This is typically installed in two chambers, one located on the existing gravity pipe and a second ‘dry’ chamber that houses the controls and instrumentation and can be housed above ground where space allows.

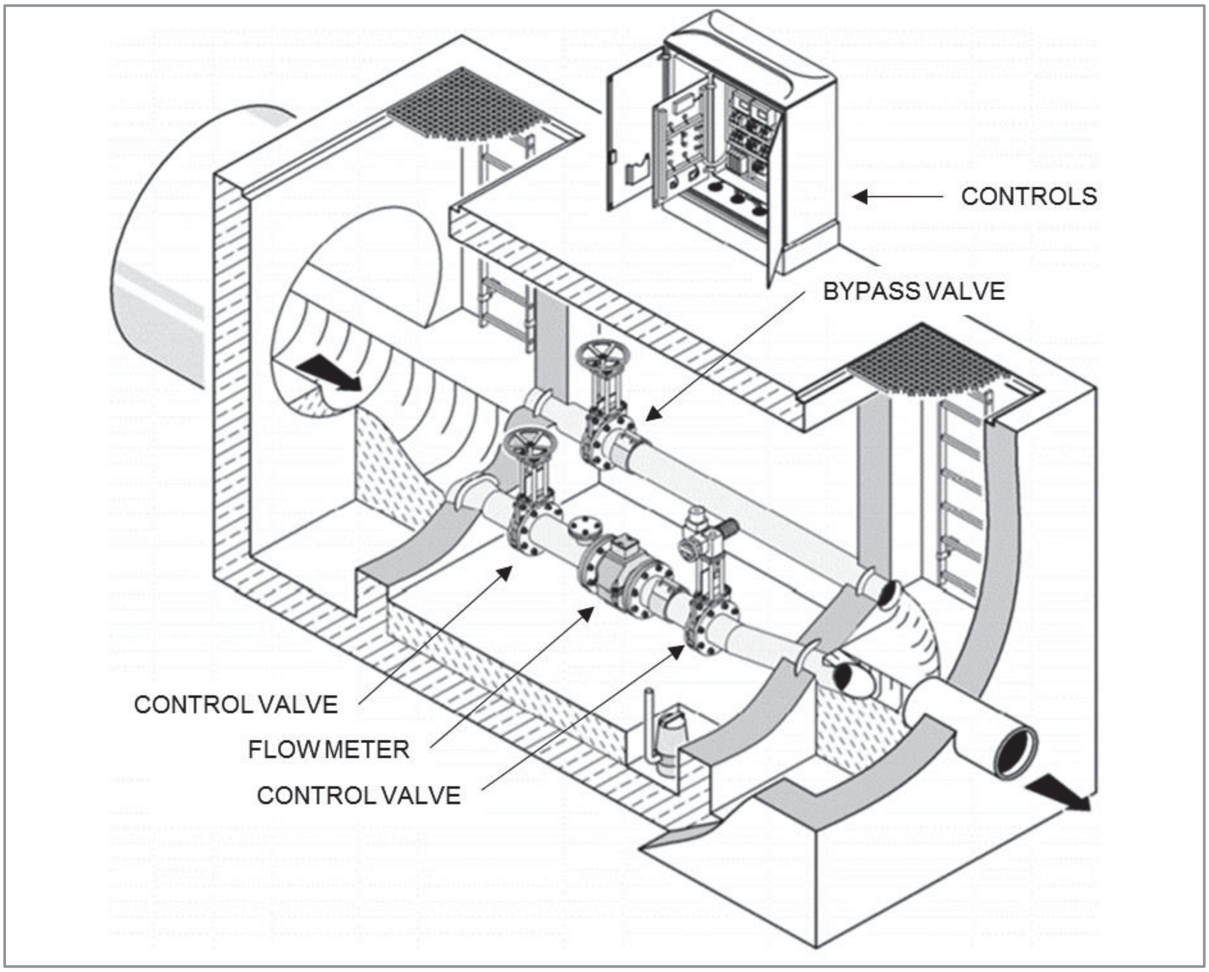

Figure 3-8. Proposed Gravity Flow Controller
(Picture credit: Veolia Water Technologies)

3.3.6 Off-Line Storage

Off-line storage refers to any storage element that does not receive flow from the existing combined sewer system under normal DWF conditions. Only excessive combined sewage flows which exceed a specific elevation are diverted to the off-line storage facilities. These elements instead rely on off-take overflow pipes or side weir arrangements, many of which are then connected to pumping systems, which will divert surcharging combined sewage during WWF events. Off-line storage is used to provide temporary storage of combined sewage where supplemental storage is required to meet the performance targets. Common types of off-line storage include underground tanks and storage tunnels.

3.3.6.1 Off-Line Storage Tanks

Storage tanks may be either near surface or deep. A near surface tank is installed with the top of tank near the ground surface and requires large transfer pumps to lift the combined sewage from the existing CS system into these tanks. Deep tanks are constructed low enough to fill by gravity from the CS sewer system after being diverted via an off-take pipe or side weir arrangement, which requires the top of tank to be below the primary sewer maximum storage level. Figure 3-9 provides a schematic for deep tanks.

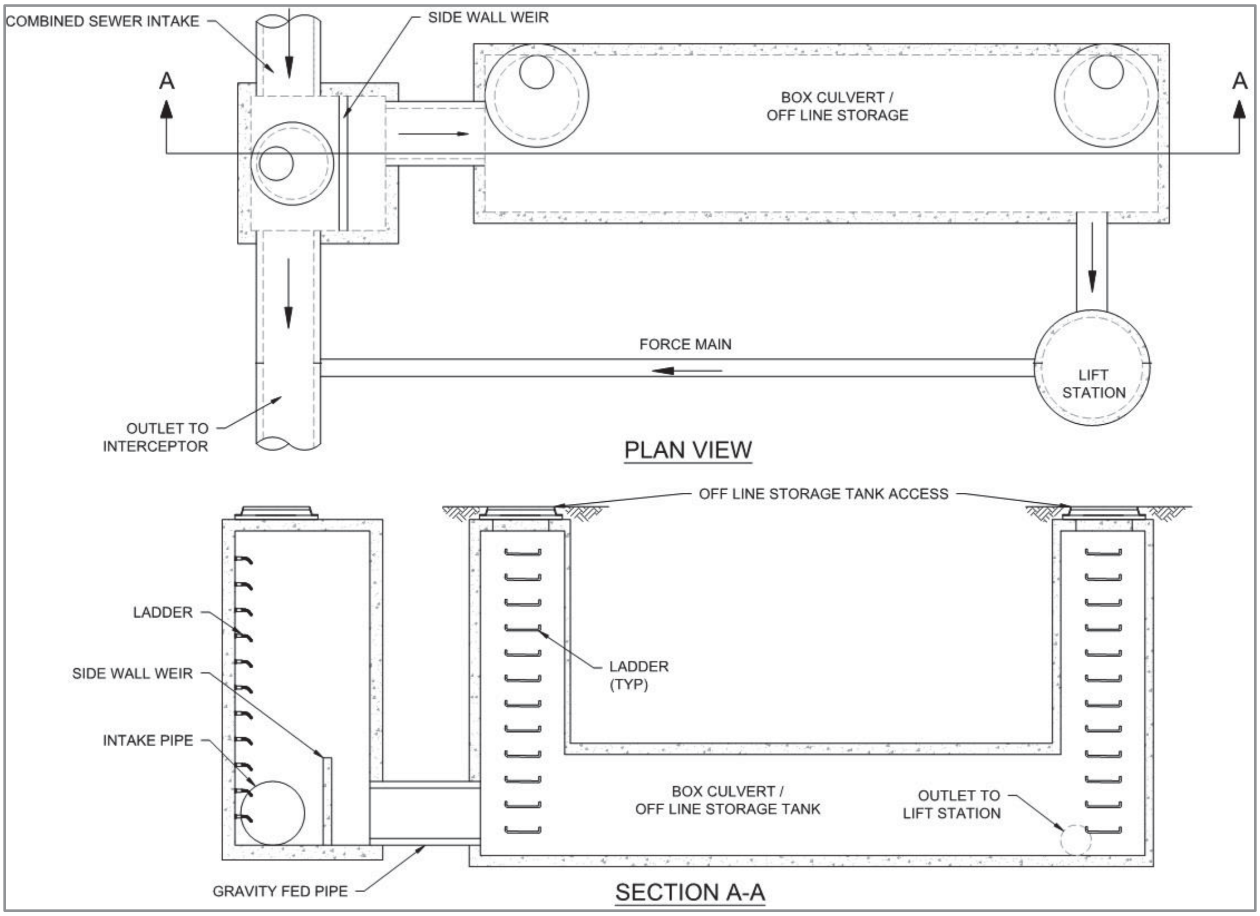

Figure 3-9. Proposed Off-line Deep Storage Tank Schematic

The deep tank would be empty and sit idle during DWF. During WWF, the levels in the sewer rise to an elevation above the side overflow weir, allowing flow to enter the tank. With enough inflow, the tank would continue to fill until it reaches maximum volume, or the downstream control gate (if applicable) opens to reduce the risk of basement flooding. The dewatering system for the tank would operate to completely dewater the tank prior to the next WWF event.

Figure 3-10 provides a schematic for near surface tanks.

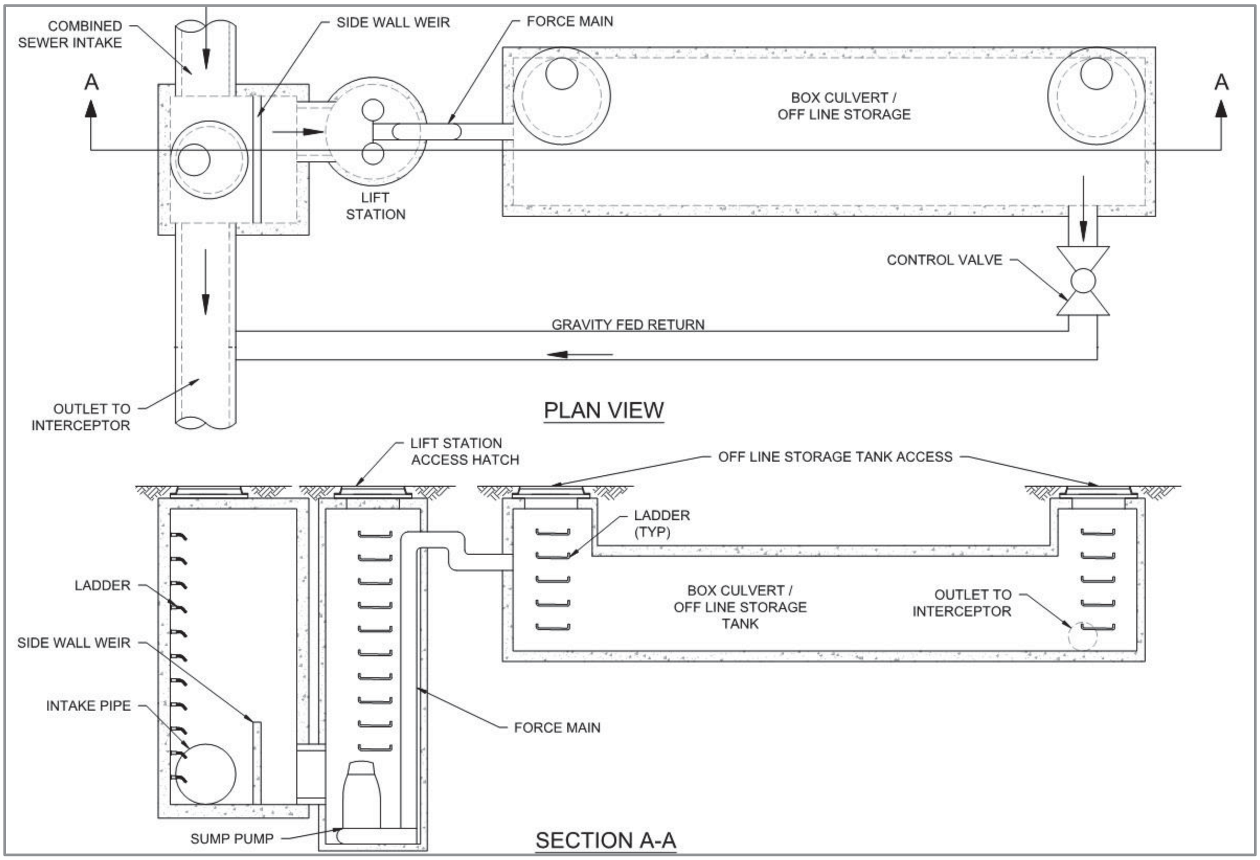

Figure 3-10. Proposed Off-line Near Surface Storage Tank Schematic

The near surface tank would be empty and sit idle during DWF. During WWF, a lift station that is connected to the CS trunk would activate and pump flow from the CS system to the off-line tank. The pumps would continue to operate until the tank is full or the level in the CS system drops below the pump operating level. Flow from the off-line tank back to the CS system would occur once levels within the CS system drop and capacity is available. The tank could be dewatered by gravity or through a pumping system. This will depend on the location and the level of control required. The dewatering system for the tank would operate to completely dewater the tank prior to the next WWF event.

There are pros and cons with each type of tank. The drawback with deep tanks is in the difficulty to construct them to such a depth, particularly when in close proximity to riverbanks due to the associated geotechnical and groundwater infiltration challenges. These challenges are significantly reduced with near surface tanks, but they introduce other challenges. Large capacity low-lift pumps would be required to fill near surface tanks, but the combined sewage may be stored high enough to drain by gravity.

The off-line storage tanks are generally large and require special considerations for selection of the final location and approvals prior to construction. The cost and implementation challenges may both be limiting factors for this control option. Consideration must be made for land availability and its acquisition, electrical and mechanical components, flushing, grit management, odour control, permitted use and riverbank by-laws, environmental and construction permits, and public acceptance.

3.3.6.2 Off-line Tunnel Storage

Tunnels are an alternative to off-line tanks for temporary storage. Unlike storage tanks, tunnels are easier to locate as they are placed under the public roadway right of way and may have multiple connections to the sewer system at strategic locations.

Off-line storage tunnels have several advantages, including the following:

- Storage tunnels can convey combined sewage over short distances as well as temporarily store combined sewage, providing increased capacity for basement flooding relief, and minor supplementation of force main or interceptor sewers for transport of wastewater to the treatment facility.
- Tunnel storage locations and sizes are much more flexible than for tanks, and engineering evaluations are likely to develop solutions that are cost competitive with storage tanks.
- Construction techniques make it possible to design tunnels at nearly any depth and alignment, making it possible to both fill and dewater the tunnel by gravity drainage rather than high-rate pumping.
- Current tunneling technology makes it possible to construct tunnels in nearly any ground condition, for long drive lengths with minimal surface disruption.

Conversely, the construction of tunnels have disadvantages, including the following:

- Storage tunnels will require flushing/cleaning after each operation, increasing the O&M requirements on the City of Winnipeg sewer system.
- Off-line tunnels may encounter odour issues and may require the construction of an extensive odour control facility.
- Storage tunnel launch and receiving shafts for large diameter tunnels can be extensive such that local streets may have to be entirely closed temporarily during construction activities, causing disruptions to the local residents.

3.4 Collection System Modelling Approach

The technical approach for the CSO Master Plan made extensive use of computer simulation modelling of the collection systems. This included creating representative InfoWorks models for the entire collection system. This section describes the main design considerations used for the model updates and refinements carried out during Phase 3 of the CSO Master Plan. Additional details regarding the initial hydraulic model development were reported in the Preliminary Proposal.

Two sewer system models covering the entire CS and separate sanitary sewage collection systems were developed using InfoWorks CS for the CSO Master Plan. These were the Global and Regional models; the Global model included all pipes, while the Regional model was a more streamlined representation. A schematic of the Regional model is shown in Figure 3-11.

Figure 3-11. Regional Hydraulic Model Schematic

The model build, calibration, and verification were primarily completed with datasets and information provided from the City in 2012 and 2013. These models are referred to as the 2013 baseline model and the regional 2013 baseline model. These 2013 baseline models were used for the creation of the five alternative plans identified in the Preliminary Proposal.

The model created for the 85 percent capture in a representative year alternative plan as identified in the Preliminary Proposal was used as the basis for further refinements during CSO Master Plan assessments. The full Regional model required several days to complete the simulation of the entire 1992 representative year event. Due to this time constraint, during Phase 3 individual district models were created based on the Regional model to evaluate the control option alternatives more efficiently. These smaller models did not represent the full interaction with adjacent sewer districts but did provide an initial indication of the performance to evaluate proposed control options. This served as the basis of Step One: Initial Control Option Selection. The specifics of this process are as described in detail in Section 3.5.3. Step Two: Control Option Refinements included recreation of the combined hydraulic model using the solutions recommended in Step One to determine the overall system performance and assisted to identify additional refinement opportunities. The specifics of this process are as described in detail in Section 3.5.4.

The following sections present the hydraulic modelling approach utilized to support the control option evaluations, project development, and program development processes.

3.4.1 Population and Growth

The future population and growth included in the hydraulic model evaluations were determined during model development in the first two phases. For future growth, the CS districts will include in-fill development/population density increase, although this is highly subjective, the exact locations are unknown and liable to change. However, any in-fill development within the CS districts must adhere to Clause 8 of the EA No. 3042 that shall not increase the frequency or volume of combined sewer overflows due to new and upgraded land development activities. This would occur with additional population added to the model for a CS district. As a result, while it is expected that further densification and population growth in these CS districts will occur over time, there should be no impact on CSOs or impact on the work planned for the CSO Master Plan. This is because there should be no change in the flow generated in these CS districts even though population growth has occurred, in order to comply with Clause 8. Therefore, for the purposes of the hydraulic modeling for the CSO Master Plan, no population change was assumed for the CS districts over time as the CS control options are installed. Within the hydraulic model the population is directly related to the sewage flow generated, and therefore it must be kept constant.

Separate sewer districts on the other hand do not have this limitation in flow rate increases as a result of densification, beyond the pipe/treatment capacity constraints typical to all development within the City of Winnipeg. These areas will be subject to similar growth to that expected to be encountered in the CS districts; however, the increase in flows from these areas must be accounted for in the hydraulic model. The level of growth expected in these separate sewer districts has been defined as part of previous land development studies, and this information was utilised to estimate the increase in flows generated by these districts. This will ultimately impact the interceptor sewer system shared by both the CS and separate sewer districts, which will impact the dewatering strategy. This is explained in further detail in Section 3.2.1 and Section 3.4.6.

The following sub-sections provide a summary of the main sources of data utilized to project the future population growth and how this was attributed to the future hydraulic model.

3.4.1.1 NEWPCC Collection Area Population Estimation

The population and growth forecasts for the NEWPCC Service Area are as defined in the *North End Facility Flows and Loads* (WSTP, 2014) report. The report identifies a 2011 population of 405,274 and a 2037 population of 550,000. An additional population of 33,500 is identified for the four outlying Rural Municipalities (RMs) of East St Paul, Rosser, West St. Paul and St Andrews. The CSO Master Plan has used the population data identified within this report for the NEWPCC Service Area as summarized in Table 3-3.

Table 3-3. NEWPCC Population used in Hydraulic Model

Contribution Area Within Hydraulic Model	2011	2037	Population Change
CS Area	255,600	255,600 [a]	0 [a]
Transcona	33,700	42,100	8,400
Rural Municipalities	0	33,500	33,500
CentrePort	0	0 [b]	0 [b]
Northeast (NE) Interceptor (excluding Transcona)	45,100 [c]	70,200 [c]	25,100
Northwest (NW) Interceptor	48,600	148,600	100,000
NEWPCC Total Population Changes	**383,000**	**550,000**	**167,000**

Notes:

[a] – No change to future 2037 CS area population as from wastewater perspective. The population generating all future wastewater flows will be the same due to Clause 8 being in effect for the CS districts.

[b] – Future CentrePort flows from development added to model as a set daily flow rate of 15ML/d and was not attributed to a specific population within the hydraulic model.

The baseline hydraulic model was updated to include the 2037 population of 550,000 to match the WSTP 2037 future population. Overall the population is projected to increase by 167,000 between 2011 and 2037.

The next step was to determine the appropriate allocation of this 167,000 population growth among the separate sewer districts. First previous assessments of the Transcona catchment related to recent sewer work was specifically evaluated based on the North Transcona Sewer f design study (AECOM, 2012) This report indicated a population increase of 8,400 was projected to occur by 2037. This Transcona catchment is upstream of the Northeast (NE) Interceptor, and so this population growth was removed from the population growth allocated overall to the NE Interceptor.

The future population growth of 33,500 peoples was included as a result of future tie-ins and subsequent growth from rural municipalities. This is a summation of the future population growth projected in the WSTP report of four separate RMs. The specific growth assigned to each of these RMs in the WSTP report is listed below:

- East St Paul (10,953);
- Rosser (1,763);
- West St Paul (14,468); and,
- St Andrews (6,369).

Each of the RMs were added to the model as single subcatchment areas draining to the closest manhole with future population as stated as above.

At this point of the 167,000 population growth expected, 8,400 and 33,500 was allocated to the Transcona catchment and RM tie in points respectively. This resulted in a remaining 125,100 population growth to be distributed to the new development areas upstream of both the Northeast and Northwest Interceptors. It was assumed for simplicity at this point to assign the remaining population growth specifically to largely undeveloped areas which would be subject to future growth. It is understood that a portion of the projected growth will occur within existing sewer districts as a result of in-fill development. For the purposes of this evaluation however, the primary impact of the allocation of this population growth is to assess impacts on the interceptor system, and how this may impact dewatering of the CS districts using the solutions recommended in this Master Plan. Therefore, the population growth remaining was conservatively assumed to be entirely allocated in these undeveloped lands, which have been identified for future development. This same approach was also utilized to assign the projected population growth within the SEWPCC and WEWPCC Service Areas (see Section 3.1.1.2 and Section 3.1.1.3).

For the identification of new development areas, further review of the WTSP report was completed. The WTSP report states that its population projection methodology is based on the Transportation Master Plan (TMP). The TMP uses the City of Winnipeg internal land-use planning model, called PLUM (Winnipeg Planning and Land Use Model). Economic and demographic forecasts, land use strategies, and OurWinnipeg are ultimately built from PLUM. The PLUM catchment model identified six areas draining to the NEWPCC (not including the four RMs) that would be suitable for allocating the additional 2037 population of 125,100. Following this an assumed average rate of density was assumed within the new sub-catchments based on City design standards for residential, commercial and industrial land uses. This density rate was applied to the area assigned to these new catchments within plum, to determine the appropriate population to be assigned to these catchments to result in the total 125,100 growth.

The CentrePort development is a large industrial/commercial/institutional (ICI) development to the northwest of Winnipeg and noted to produce a daily flow of 15ML/d for the 2037 future growth figure. A continuous inflow to match the daily flow rate was added to the model draining to the Northwest Interceptor sewer, but no associated population increase was applied.

3.4.1.2 SEWPCC Collection Area Population Estimation

According to the Technical Memorandum of Population and Flow Projections for the South End Water Pollution Control Centre Upgrading/Expansion project (Stantec, June 2006), the future population the Service Area for 2030 is projected to be 253,300. Next the population growth rate previously utilized from the WSTP report for the NEWPCC Service area was applied to the 2030 population. This further projected the future population growth, and indicated that a 2037 future population of 266,500 should be adopted. The CSO Master Plan has used the population data identified within this report for the SEWPCC collection area.

The baseline hydraulic model had a 2011 population of 185,000 for the SEWPCC, and therefore an additional 81,500 population was required achieve the 2037 future growth forecast. Here once more the PLUM catchment area evaluation was utilized to indicate the areas for development in the future. This indicated a single catchment draining to the SEWPCC was identified for future growth. Refer to Figure 3-12 below for the specific location within the SEWPCC Service Area in which this additional population growth was assigned. The typical population density figures adopted for the NEWPCC evaluation were used to determine that the area was sufficient to accommodate the entire 2037 future growth projection for the SEWPCC service area.

3.4.1.3 WEWPCC Collection Area Population Estimation

No information or previous reports have been noted on the projections for the WEWPCC. An estimate of future population using the typical rates of population growth as per the SEWPCC assessment was adopted. This resulted in a WEWPCC 2037 population estimate to be 116,700.

The hydraulic model has a 2011 population of 79,394 for the WEWPCC and an additional 37,306 population growth was included to achieve the 2037 future growth forecast. This population growth within the model was once more allocated based on the PLUM catchment areas to areas focused for future development. Ultimately four additional catchments draining to the WEWPCC were identified from the PLUM catchment areas, and the same area weighted approach was utilized to determine the portion of the 37,306 additional population to be assigned to each of these catchments. Refer to Figure 3-12 for highlighted locations within the WEWPCC service where modelled subcatchments were created and this 37,306 population growth was allocated.

3.4.1.4 Development Areas Allocated For Population Growth

All known future developments that were added to the future hydraulic model within the NEWPCC, SEWPCC, and WEWPCC Service Areas are illustrated in Figure 3-12.

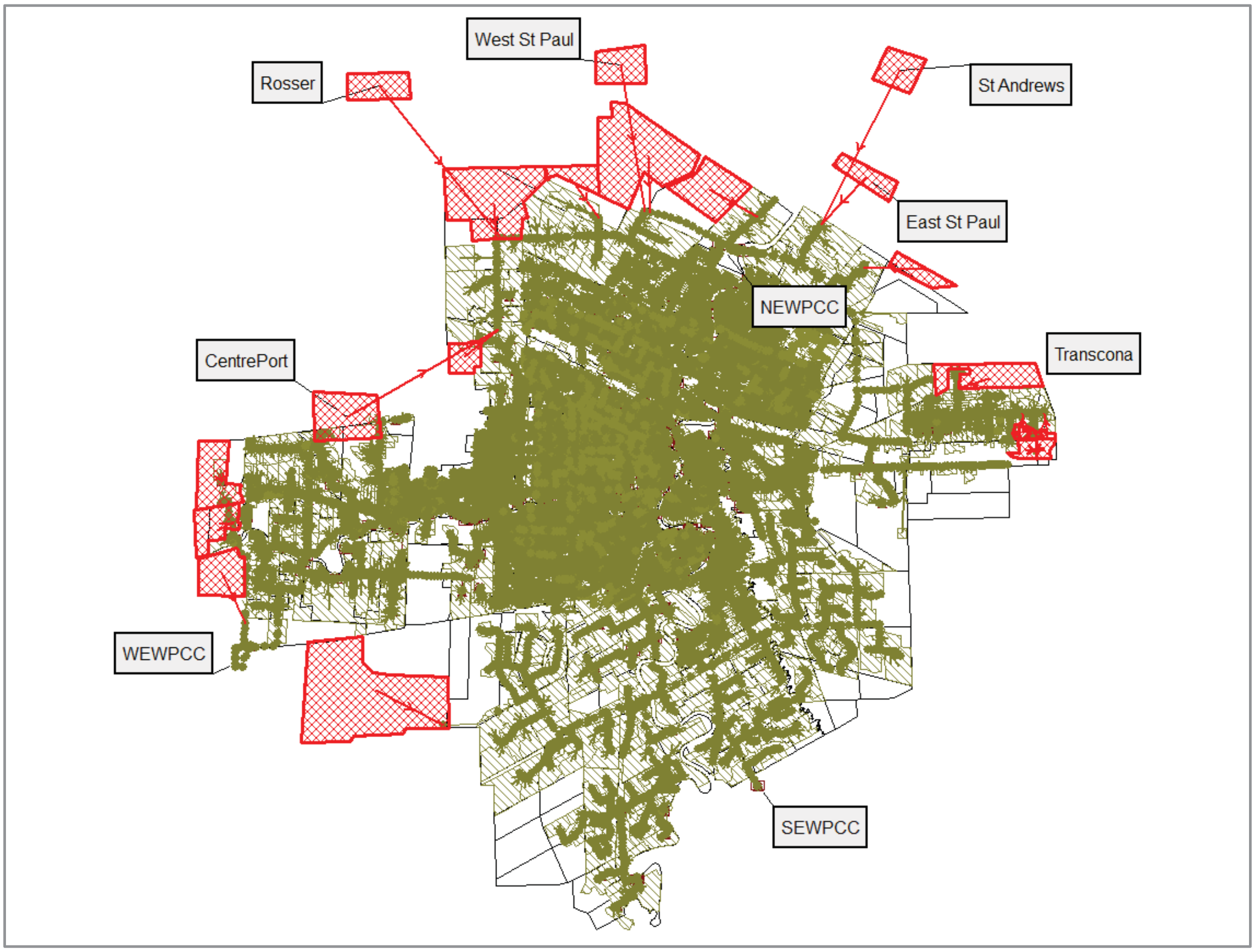

Figure 3-12 Future Development Areas (2037 Population Growth)

3.4.1.5 Wet Weather Contribution From New Sub-catchments

Each of the future growth areas have been noted in the separated districts within the outlying areas of the main Winnipeg sewerage system. As such, minimal WWF inflow should be generated by each of these new subcatchment areas. However, from monitoring and model assessment it is noted that rain derived inflow and infiltration (RDII) is generated by the separated districts. To ensure an accurate assessment for separated districts, each of the new subcatchment areas assigned for population growth were also assigned similar ground infiltration parameters as the adjacent existing separated districts. This allows realistic RDII to be included and accounted for in the interceptor system from these new sub-catchments.

3.4.2 2013 Baseline Model Findings

The Preliminary Proposal 2013 baseline model assessment concluded that the Winnipeg CS system had an overflow volume of 5,260,000 m^3 for the full 1992 representative year rainfall event. This is equivalent to a 74 percent capture rate. The overflow reduction assessment of the 2013 baseline model found that to achieve Control Option No. 1: 85 percent capture target in a representative year, required a reduction of 2,300,000 m^3 in CSO overflow volume.

3.4.3 Model Updates

The regional model was updated to include:

- Revised assumptions based on district sewer system reviews,
- Asset dataset revisions

- Updates to the sewer system based on work completed by the City of Winnipeg between 2013 and 2019.

The City provided the extent of future development and population growth expected for the City to the 2037-year planning horizon. The timeframe and estimates were not changed with the modelled growth development, and all projections remaining at the 2037 growth level. Refer to Section 3.4.1 for further details.

The City reviewed and updated the critical asset datasets within each of the sewer district engineering plans (Part 3B), and these alterations were assessed and added as appropriate to the Control Option No. 1 model. The City's updates included pumping capacities at several of the lift stations resulting from further assessment of the City's Supervisory Control And Data Acquisition (SCADA) data, and elevations of existing weirs obtained from recent survey work. The inclusion of the updated information does not remove the modelling limitations that were identified during the previous phase model build and calibration exercise. The City is committed to continuing to maintain and update the hydraulic model during the execution of the CSO Master Plan.

3.4.4 River Levels

The river levels for the 1992 representative year were not uniformly applied for drainage modelling as was done for precipitation. Instead, the NSWL at the James Avenue station on the Red River, 1.98 metres (6.5 feet) above James Avenue Datum (223.74 m geodetic elevation) was used and extrapolated along the river reaches to each outfall. River levels within Winnipeg are highly variable during spring runoff but remain relatively constant during the summer and winter seasons. The summer levels are controlled by a set of locks downstream of the City that maintains a minimum level for watercraft navigation. A comparison of the NSWL to the historic 1992 river levels, both taken at the James Avenue station, is shown on Figure 3-13.

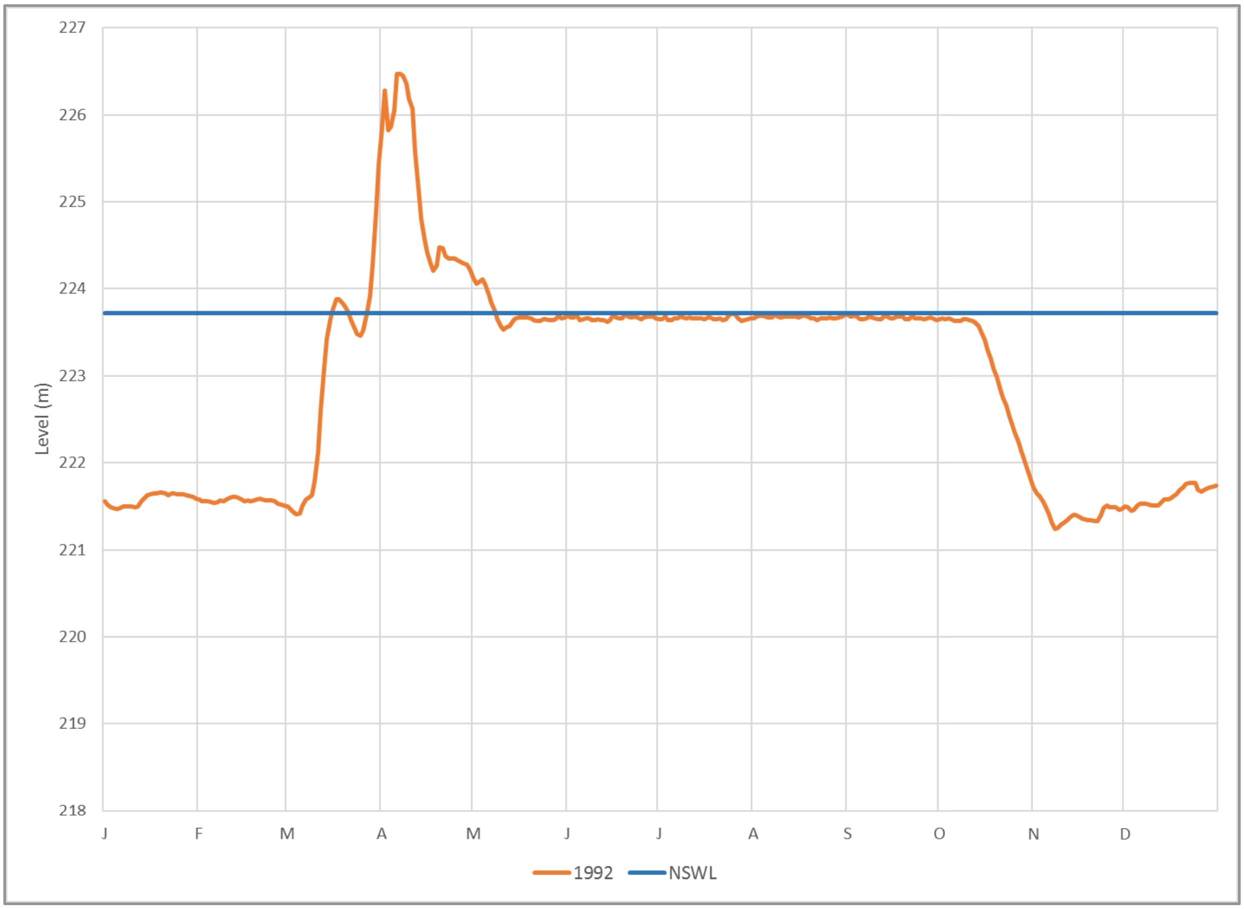

Figure 3-13. 1992 Representative Year and NSWL River Levels at James Avenue Station

Lowering of the locks that control the river elevation in the city occurs in late fall each year after the navigation season is over, with the levels remaining low until spring runoff. The lowering of the river levels coincides with reduced rainfalls and the transition to precipitation as snowfall. The lower rates of runoff during the winter season are largely captured within the combined sewers and are infrequently at rates that would overflow to the latent storage facilities, which require higher river levels to be utilized. Section 3.3.2 and Section 3.3.4 provide further details on how the use of various river level conditions impact the in-line storage and latent storage control options.

A continuous river level at this NSWL elevation was assumed at each of the outfalls for the modelling assessment. The NSWL was used in the Preliminary Proposal evaluations and maintained for the CSO Master Plan. There are notable differences in using the NSWL versus the 1992 river level. The NSWL does not fluctuate the same way as the actual 1992 river level. Using the NSWL in the model does not show improved performance during the spring snow melt period of April and May. This would be expected from the increase in available system storage volumes that occur during high river levels. The interaction between the CS and SRS system as described in Section 3.4.7 will also change the latent storage operation and requirement for flap gate control. An assessment with the 1992 recorded river level on the baseline model will need to be completed to confirm the actual variance in performance.

Use of this NSWL for CSO evaluation provides a comparative approach, since (in 1992 representative year or any other year) the river levels can only be higher during the period of the year in which CSOs are encountered. Higher river levels would benefit the performance of the in-line and latent storage solutions recommended in the CSO program. Therefore, the utilization of the NSWL provides a conservative baseline to evaluate the performance of these solutions.

3.4.5 Precipitation Events

Runoff from rainfall is the main cause of CSOs and it is therefore important to be accurately represented in the analyses. Rainfalls must be considered on a continuous rather than single event basis because of their variability, which affects runoff rates and runoff volume captured. Rainfall events are inherently variable in terms of when they occur and where they occur, within any year and from year-to-year. Long-term rainfall records were used in the evaluation to establish a representative rainfall year. It provides a common basis for control system sizing and regulatory compliance that is not affected by annual variations in precipitation. The 1992 rainfall year was identified as the representative year during the Preliminary Proposal study phase. The representative year is used by applying the annual 1992 precipitation events in the hydraulic model uniformly across the entire combined sewer area. The 1992 representative year had a total of 41 rainfalls above a minimum 1 millimetre (mm) threshold. The total depth of each of these 41 rainfall events and is shown in Figure 3-14 below, arranged in the order of depth for each event.

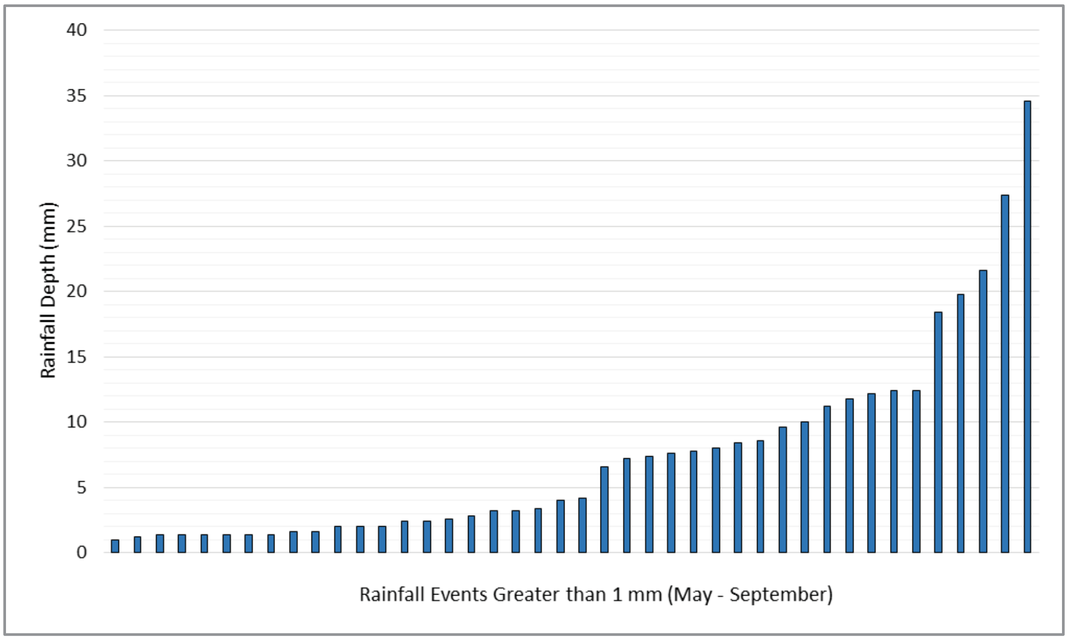

Figure 3-14. 1992 Representative Year Rainfall Depths (May – September)

The assessment of sewer system performance for the baseline and proposed control options was based on the year-round precipitation events for the 1992 representative year. To verify that the full year was accurately replicated, the snowmelt events were converted to equivalent rainfall intensities and added to the full event for the evaluations. The rainfall events were included in 60-minute increments and modelled for the entire 1992 representative year.

3.4.6 Dewatering Strategy

The purpose of the dewatering strategy is to establish target pumping rates from each of the sewer districts in balance with the interceptor and treatment capacities. The initial pumping rates from the Preliminary Proposal were established based on the requirement for the system to dewater and return levels to those experience during DWF conditions within 24 hours after the end of a rainfall event. All existing pumps and their operation conditions were simulated with InfoWorks, as well as the interceptor hydraulic capacity and WWF treatment rates at each STP. All new pumps recommended as part of the latent storage and offline storage control options were sized as part of the dewatering strategy. To verify that the stored flows within the system were not transferred to the CS and then overflowed at the main CS outfall, all latent/offline storage pumps were set to not operate when the local CS system is overflowing or when the control gate is in the lowered position.

The assessment was completed for each of the existing lift stations, interceptor, and treatment plants. The existing infrastructure was found to operate satisfactorily for Control Option No. 1, with only minor adjustments, and not needing any major changes or upgrades to lift station pump capacity.

The future dewatering strategy and potential interaction with a future RTC arrangements is beyond of the scope of this CSO Master Plan submission, and was therefore not included in the hydraulic model. RTC is included in the CSO Master Plan as part of future opportunities (see Section 5.2.2).

3.4.7 System Interconnections

There are many different types of interconnections within the modelled sewer system. Each of these are listed in detail in the individual district plans within Part 3B. Important interconnections for the CSO program are those between the CS and SRS systems. These allow overflow relief to the CS system, diverting excessive combined sewage collected to the SRS to reduce the risk of basement flooding. In cases where latent storage is to be used, these interconnections provide the source of flow into the latent storage facilities; therefore, the interconnection's hydraulic capacity and the frequency of CS-SRS interconnections will impact the performance of latent storage.

All CS-SRS interconnections within the City of Winnipeg sewer network are designed to contain all DWF in the CS system and not overflow into the SRS under DWF conditions. The models were set up with the best available data, which identified pipe invert elevations for the interconnections in numerous cases, but no weir or critical interconnection elevations. If the interconnection SRS pipe invert elevation is the same as the CS pipe, this would result in DWF entering the SRS system and ultimately discharging to the river in DWF conditions. This is known to not be the case based on how the SRS system is design, and is an issue with the way pipes are represented in the City's Geographical Information System (GIS) data. These discrepancies in the City's GIS data is continuously being investigated and improved utilizing field surveys of specific areas of the sewer network. For the purposes of the CSO Master Plan model development however, assumptions were needed to be made for these interconnections with unknown elevations. The assumption utilized in development of the model was to assume a fixed weir, stoplog, or brick wall constructed within the interconnection manhole to prevent DWF overflows. This led to numerous weir structures being added to the model and the associated weir levels being based on assumptions agreed with the City. The standard assumption used for any missing weir information for the CS-SRS interconnections was to place a weir with a height of half the pipe diameter in which the weir is placed. There are approximately 208 interconnections modified in this manner within the hydraulic model. This resulted in the hydraulic model performing as the real life sewer conditions perform now, with no overflows to the SRS system under DWF conditions. The interconnection modelling assumptions to be gradually refined and updated based on ongoing site survey work completed by the City of Winnipeg.

The controlling interconnection elevation is not a major concern to basement flooding flow simulations because of the high flow rates encountered during basement flooding conditions would necessitate full utilization of the SRS and CS systems. The interconnection heights however are critical for latent storage volume evaluation, where smaller storms provide the source of combined sewage ultimately stored in the latent storage system.

These details result in a degree of uncertainty in the performance of latent storage. Physical modifications to these interconnections are relatively easy and straight forward and can be dealt with during program implementation. This is a risk which must be considered when furthering the design and analysis of the latent storage solutions recommended for specific districts as part of the CSO Master Plan. When in-line storage and latent storage projects are to be pursued in a specific district, all CS-SRS interconnections within that district should be verified and surveyed prior to furthering any design work. Based on the actual interconnection elevations found, the potential in-line storage and latent storage volume capture performance can be re-evaluated and compared to the performance originally estimated in the DEPs based on these modelling assumptions.

3.4.8 Latent Storage

The latent storage control option does not require any pipe infrastructure to be constructed as it will utilize the existing SRS pipe system and interconnections from the CS to the SRS systems. A latent storage lift station is proposed to be installed adjacent to the existing flap gate chambers to allow the latent storage to be dewatered.

At present, some of the SRS outfalls have only a positive gate. To implement latent storage control, a flap gate is needed to separate the SRS system WWF flow from the river under sufficiently high river level conditions. The City is undertaking work to replace these single positive gates with a new flap gate and positive gate chamber. Replacement work has been completed at the McDermot SRS outfall, and work is planned or underway at the Ruby SRS and Aubrey SRS gate chambers. This work includes the installation of a submersible pumping system to allow the latent storage of the SRS system to be dewatered. No force main to accommodate the dewatering process is proposed with the replacement gate chamber work.

In the case of these recently constructed SRS flap gate chamber and dewatering pumping systems, the latest details as to the design of these facilities was represented in the hydraulic model. Specific details as to the design of these systems can be found in the specific DEPs where this has occurred.

3.4.9 Latent Storage Flap Gate Control

Flap gate control has been recommended for specific districts where latent storage is recommended, when the level of latent storage at the dedicated SRS outfall is above the design NSWL. Flap Gate Control provides a mechanism where the flap gate can be set to stay in a closed position, regardless of the river elevations. Under normal flap gate operation without flap gate control, the flap gate can only be in a closed position and store WWF when river levels are sufficently higher than the flap gate invert creating sufficiently high hydraulic back pressure on the flap gate to keep it closed.

The installation of flap gate control on the SRS system has been proposed for the following locations:

- Clifton – Strathcona SRS system
- Ash – Renfrew SRS system

The majority of SRS systems are partially below the NSWL levels and can rely on the normal hydraulic pressures exerted by the river to provide the required volume capture. For example, the Spence SRS system within the Colony district is 90 percent full when assessed against the NSWL level, while the Strathcona SRS outfall within the Clifton district is only 10 percent full. In the case of the Strathcona SRS outfall however, a 2700 mm diameter pipe is in place, and significantly more latent storage volume capture could be achieved by implementing flap gate control arrangement. Implementing flap gate control in a situation such as this would be for a minimal capital expenditure when compared to alternative method to capture an equivalent additional volume, such as by constructing an off-line storage tank of similar volume. As well in the case of the Strathcona SRS system, the relatively high elevations of the SRS system compared to the CS system result in overflow one of the CS to SRS interconnections prior to control gate operation with the in-line storage facilities also recommended for the Clifton district. In situation such as this as well flap gate control is also needed.

Where flap gate control is proposed, the flap gate control is to be set to open when the in-line control gate on the CS system is in its lowered position. This allows the SRS and CS systems to be relieved concurrently to protect homes from basement flooding.

In the hydraulic model all flap gate control arrangements, where recommended, are represented as a variable crest weir. The weir is initially set at the full height of the SRS pipe, representing the closed flap gate. The lowering of the in-line control gate at the primary outfall signals the flap gate control to open, and in the hydraulic model this causes the variable crest weir height to reduce to zero with no restriction. This represents a fully open flap gate, allowing the SRS to discharge.

3.4.10 In-line Storage Control Gates

The control gates have a dual purpose within the hydraulic model. First, they increase the depth for in-line storage capacity. Secondly, they provide sufficient head for the screens to operate successfully.

These gates were modelled as variable crest weirs, where the crest level can be adjusted by the InfoWorks software using modelling parameters that continually assess the levels in the system for the 1992 representative year rainfall/runoff conditions. The level in the upstream system determines when the gate, modelled as a weir, drops to the lowered position after the upstream levels has reached an entered set point. At this point the variable crest weir would have an elevation matching the weir crest for the existing primary weir. As the levels in the system are lowered, the variable crest weir would begin to rise until it reaches a maximum height, matching the design height for the control gate. This variable crest weir modeling approach for control gates was developed in the Control Option No. 1 Preliminary Proposal models for the representation of the gates at the required overflow locations.

The control gate is modelled in conjunction with the side overflow bypass weir for the screening chamber.

3.4.11 Floatables Screening

The screens were modelled downstream of the side overflow bypass weir and given a standard design within the model as explained in Section 3.4.11.1 below. Any blockage or partial blinding of the screen will cause the hydraulic grade line (HGL) to increase, which then will result in the control gate dropping to the lowered position, restoring the discharge capacity in the CS trunk outlet to those currently provided by the primary weir for each district.

Screens were designed as a first flush tool, where only the initial runoff from rainfall events is screened. The model evaluations indicated that for a portion of the rainfall events during the 1992 representative year all the event overflow volume is passed through the screening chamber in specific districts.

The amount of hydraulic head available for screen operation is critical to proper screening operation and was therefore reviewed for each location using the hydraulic model. This was also necessary to avoid recommending screens with excessive dimensions for construction. The typical screen width was based on the head and peak flow rate as defined in Part 3C. For a low hydraulic head available, the proposed screen width would be too large to be practical. This modelling assessment highlighted that not all districts had suitable available hydraulic head and would result in impractical screen size recommendations. The districts of Despins, Marion, and Metcalfe have negative hydraulic head due to the NSWL being above the proposed weir elevation. The districts of Jessie and Polson have limited hydraulic head available. As a result, screening is not proposed as part of the solutions recommended for these specific districts and supplementary evaluation work to determine alternative control options was required as discussed in Section 3.5.4.1.

In addition, a bypass pipe was modelled to convey all screened overflow volumes from the screening chamber back to the main outfall. This allows the full overflow volume, screened and not screened, to be assessed at each outfall location.

3.4.11.1 Side Overflow Bypass Weir

The screening arrangement recommended includes a screening chamber in parallel to the existing CS trunk. Further detail on this arrangement can be found in Section 3.3.3. A side overflow weir is included to allow flows from the CS trunk to overflow into the screening chamber. The side overflow bypass weir acts as the first overflow location within the CS district, where flow is diverted to a screening chamber.

In the model a standard weir was used to represent this bypass weir. The weir elevation is set by the constraints of the control gate height, basement flood critical level and screen performance. These controls were added as new elements in the model since the 203 basement line, and were part of the detailed individual sewer district model assessments completed as part of Master Plan development.

3.4.12 Gravity Flow Control

Gravity flow control is proposed for districts that utilize gravity discharge to convey the intercepted CS to the interceptor system. Gravity flow control is required to enable both flow control for assessment of the future RTC controls within the entire sewer network.

Gravity flow controllers however were not included in the model. This was because the controllers were specifically identified as beneficial for future RTC assessments. As part of future RTC assessments it is recommended that gravity flow controllers to align with the design criteria established in this Master Plan be added to the sewer system hydraulic model. The application of gravity flow controllers is described in more detail within each DEP. It is expected that the future RTC will allow the system to be controlled and the gravity flow controllers will provide monitoring to ensure the flows arriving at the control points during spatial rainfall events are known. This will allow RTC controls to be implemented to dewater a district experiencing rainfall event quicker than one which has DWF conditions at that same moment.

3.4.13 Foundation Drainage

A model representation of foundation drainage within a newly separated district was completed was completed in all alternative models completed for the Preliminary Proposal assessment. This modelling approach was continued and improved upon for the CSO Master Plan assessments and is described below.

A runoff area assumption with the Ground Infiltration Module (GIM) allows an RDII inflow to enter the system which allowed a replication of the potential WWF flows entering the system from foundation drains, on a district wide basis.

The sewer separation control option recommended in the Master Plan was primarily achieved by installation of a new separate LDS system in a CS area, with the existing CS being repurposed as a separate wastewater system. This is known as LDS Separation and this approach has been previously completed by the City in a number of districts. Only the catch basins are reconnected to the new LDS system, which then collects all road drainage. The sewer service lines, which carry sanitary sewage and foundation drainage from the connected buildings, remain connected to the original CS. In the past, homes were allowed to connect their foundation drainage to the CS and would often have the roof gutters connected into the CS instead of discharging at grade. Beginning in the 1990s these practices were no longer allowed, and all newly constructed homes have the foundation drainage and roof drains separate from the CS and WWS systems. Note that this foundation drainage contribution is primarily from residential homes. Industrial/commercial/institutional (ICI) areas generally do not have these same foundation drain connections to the CS system, primarily due to the lack of a basement. The amount of foundation drainage from the residential properties in the older CS districts can be quite large and needs to be considered in the CSO program.

The modelling approach for the CSO Master Plan Control Option No. 1 assessment, included specific modelling of a known representation of the district foundation drains for the complete separation control option. Foundation drains were represented in the hydraulic model as an update to the Preliminary Proposal subcatchment area, which is connected directly to the original CS system. The existing pre-separation subcatchment draining to the modelled manhole would typically include runoff area parameters (that allow the InfoWorks hydraulic modelling software to represent WWF inflows) for the road and permeable areas within the subcatchment boundary (these were defined as part of the Preliminary Proposal model build and calibration exercise). This updated subcatchment area does not affect the sanitary, industrial/commercial/institutional (ICI), or base inflow and infiltration component generated flows based on the baseline model. An update to the values within the subcatchment runoff areas was completed and the rainfall on the updated subcatchment area is still collected and routed directly to the original CS system representing the foundation drainage WWF inflow. The new areas are theoretical representations within the model, and the area values do not reflect real life conditions. The foundation drainage representation should not be mistaken as an increase to the drainage area.

The modelled representative of the foundation drainage runoff rates was based on local results developed in a study by Wardrop Engineering in 1978. The study developed typical runoff curves for a range of house lot grading types (varying from Good to Unsatisfactory) for the 10-year MacLaren design rainfall event. The Type C grading curve was used and assumed for all homes for the Master Plan, representing a poorly graded lot for all residential properties within the completely separated districts. The flow-grading curves as part of this 1978 Wardrop study are shown on Figure 3-15.

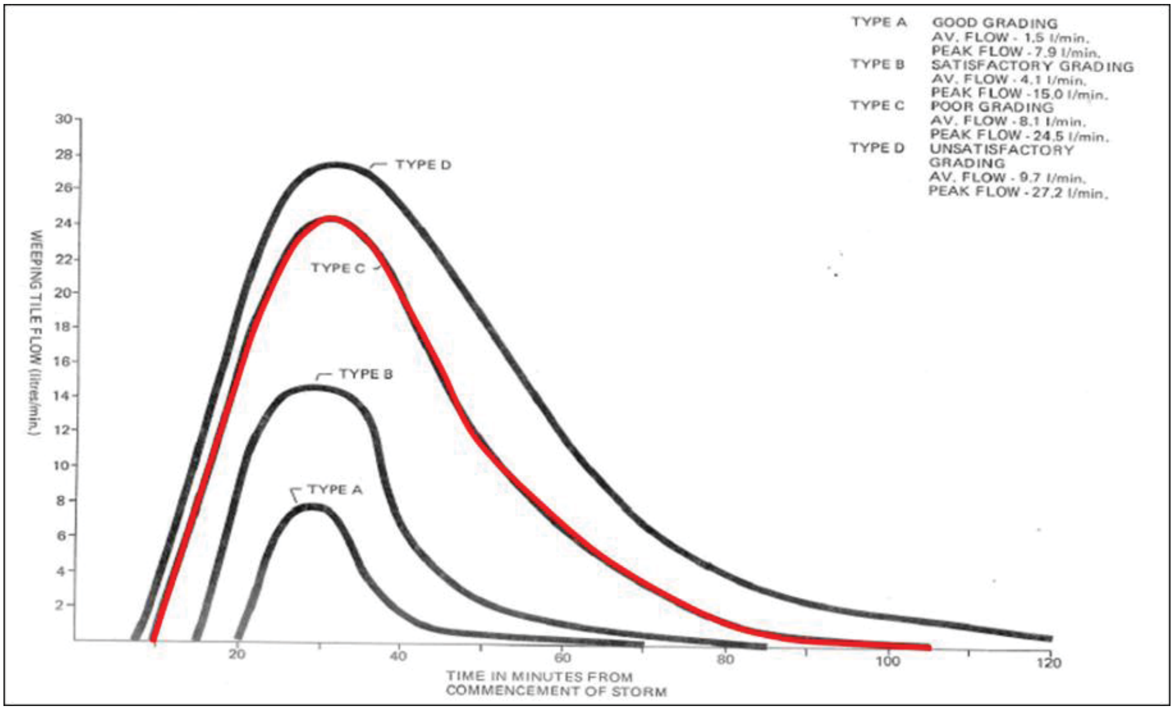

Figure 3-15. Foundation Drain Grading Curve Inflow Hydrographs (Wardrop, 1978)

Within each of the districts prioritized for partial or complete separation as per the current CSO and BFR Program (Douglas Park. Ferry Road, Riverbend, Parkside, and Cockburn), the houses identified as built prior to 1990 were provided an equivalent Type C poor grading inflow hydrograph (shown as the orange hydrograph on Figure 3-16) converted to a modelling parameter that represented this inflow as an equivalent area within the InfoWorks model runoff surfaces per house. This allowed the generation of flows within each of the separate district areas to more accurately replicate the foundation drain flows found from the real life study. This approach was extended to those districts identified as additional separation areas. 1990 was selected as this year established all new homes constructed to have weeping tiles disconnected from the sewage system. Instead weeping tiles in these newer constructed homes connect to a central sump pit, with the flow from the weeping tile system discharged overland from the property via a sump pump system.

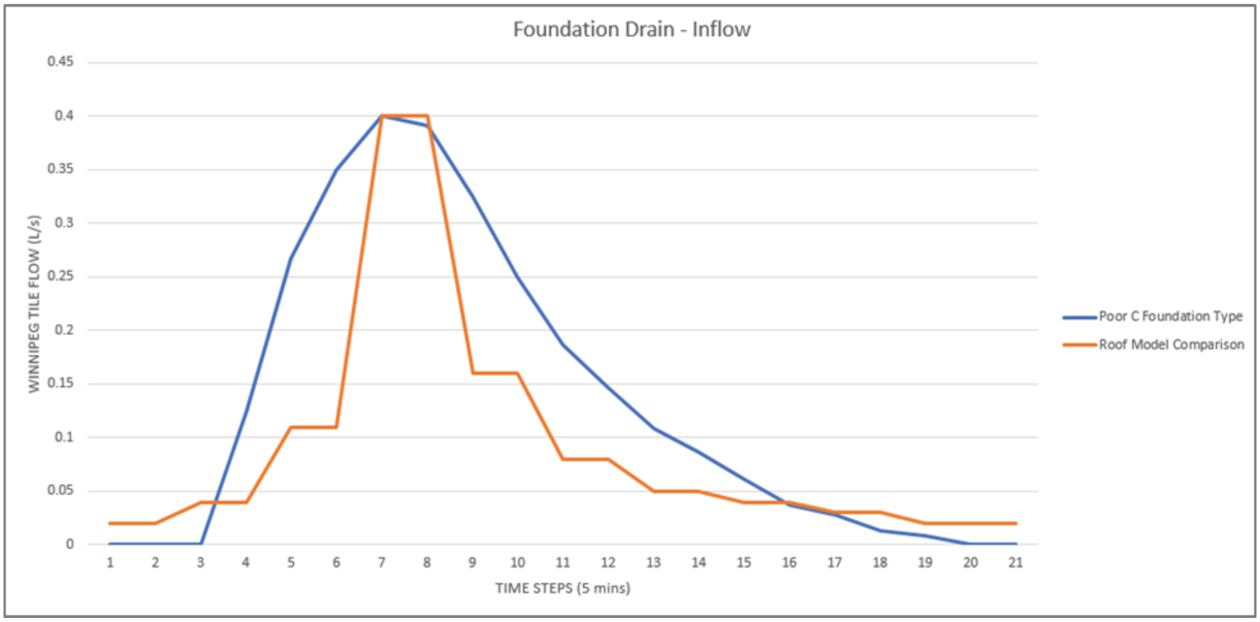

Figure 3-16. Modelled Foundation Drain Representation Inflow Hydrograph (Single property)

The infograph produced in Figure 3-16 from a single property lot, in line with the Type C grading produced in the 1978 Wardrop report, was found to occur by generating a contributing area of 0.04 ha per single family dwelling within the subcatchment. The next step based on this information was to estimate the number of such single family dwellings within the catchment. This was completed by reviewing aerial photography of the City of Winnipeg and notating all single family dwellings within the GIS dataset for the CS districts recommended to be separated. These notated single family dwellings GIS locations was then imported into InfoWorks, the sub-catchment area take-off function within InfoWorks was utilized to produce a count of such properties previously identified within each subcatchment. A dynamic formula was then established within the sub-catchment properties, such that this area-take off value, multiplied by 0.04 ha/home, would then be entered as the contributing area for that subcatchment.

This updated modelling technique provides a more accurate representation of the foundation drains within these CS districts. When considered with the district's dewatering rate, this technique can be used to provide an early indication if all existing WWF remaining from foundation drains under a 10 year MacLaren design event is captured by the primary weir of the CS district, or if the weir needs to be permanently raised. For example, this assessment was completed on the Ferry Road district following complete separation, and indicated that the existing primary weir should be raised to fully contain the separated WWF. For each CS district where complete separation occurs, the City will also conduct flow monitoring of the actual WWF response to confirm if any primary weir modifications within the district are required.

The actual WWF response from the existing foundation drain connections within a proposed separated district will determine if the system can be reclassified as a separate sewer district. The City may continue to target these areas for the sump pump and backwater valve subsidy program that has been completed in other district areas. This program removes the roof area and foundation drain WWF flows to be redirected outside the property and away from the CS system, as is done now for all homes constructed after 1990. This will provide flexibility to further improve the district's WWF performance in order to reclassify the district as a separate sewer district.

Additional notes and assumptions with the foundation drain modelling technique utilized are as follows:

- The inflow hydrograph is produced for the 10-year design rainfall event; larger or smaller runoff rates will be generated for larger or smaller events.

- Overflows for separate sewer districts are prohibited; therefore, the volume capture provided by the primary weir of the district must be able to handle a 10-year or larger foundation drainage contribution.
- Each residential housing parcel has been attributed a 'poor lot grade'. The actual grading of homes in these districts will vary, but this approach provides a conservative estimate to represent foundation drain impacts.
- This does not account for the City's previous sump pump replacement work and work to disconnect existing properties foundation drains from the CS system that has been completed throughout several districts. This also does not account for any homes built after 1990, in which the foundation drains are not allowed to be connected to the CS system are therefore assumed to have no contribution. The City of Winnipeg intends to review this work and update the model when specific locations where this foundation drain disconnection work has been completed are identified.
- Both the Tylehurst and Mission districts have been identified with large ICI areas and did not have significant residential areas. The previous Preliminary Proposal assumptions to represent foundation drains therefore remained in the hydraulic models for these areas. This assumes that there is not a significant foundation drain or roof drain component tying into the CS system in these ICI areas. The previous phase assumed a permeable runoff area (15 percent of total area) and Ground Infiltration Module (GIM) to provide a small inflow to the separated districts for foundation drain representation.

It is recommended that a flow monitoring program specific to each newly separated district be completed to confirm that these assumptions used to model the foundation drainage within both residential and primarily ICI districts.

3.4.14 Basement Flooding Evaluation

One of the requirements in selection of CSO control options was that they not be detrimental to the existing level of basement flooding protection. Therefore, the selection process included considerations for maintaining the current levels of service and carrying out additional modelling as a basement flood risk evaluation for each district.

For these evaluations, the individual district models (or combination of district models) were used to assess the impact of the proposed control options. The InfoWorks model was updated with the infrastructure proposed for each control solution, as detailed in Part 3B. The HGL produced by the model before and after the updates to the model to add the control solutions was then reviewed to determine any basement flooding protection impacts. For example, the control gate, bypass weir, and screen structures were assessed for the HGL against the baseline modelled HGL results.

Further details of this individual district basement flood protection evaluation are detailed below:

- The flood design event selected was based on no predicted surface flooding for the existing baseline model HGL results, and these were matched, within a plus 10 mm modeling tolerance, for the updated Control Option No. 1 models.
- Any predicted increases in HGL levels were noted, and the Control Option No. 1 model was altered by reducing the gate or bypass weir level or extending the bypass weir width as necessary, or both, to achieve the same HGL levels as the baseline, within a plus 10 mm modeling tolerance.
- Both design rainfall event (varying depending on surface flooding) and 5-year design river level hydrographs were simulated with the models for these HGL evaluations.

3.4.15 Percent Capture Calculation

The percent capture calculation considers the CSO volume in relation to the total of all flows collected in the system. A clarification process was undertaken with MSD during the Preliminary Proposal development, to redefine the components included in the original calculation. This clarification process is described further in Section 3.1.7. The components of flow used in this calculation were derived from the InfoWorks model assessment.

In general, the starting point for the calculation of flows collected in the system during wet weather conditions was established as:

- The beginning of a precipitation event, and
- the end point as when the system returns to DWF conditions, being either the end of dewatering or end of WWF treatment at the STP.

The approach to the calculation used for the development of the CSO Master Plan control options was based the following assumptions:

- The WWF volumes were derived from the InfoWorks model evaluations for the 1992 representative year.
- The DWF volume used in the calculation was based on the average flow calculated from recorded values at the STPs for the WWF period. The DWF duration was calculated from the beginning of the precipitation event to the end of dewatering, which was assumed to extend for an average of ten hours for all precipitation events. The dewatering time represents an average from a wide range of events, which may be from one to two hours for a small rainfall to a maximum of 24 hours.
- A City-wide DWF rate was used in the calculation and includes all combined and separate sewer district contributions.

This approach was maintained for both the Preliminary Proposal and the CSO Master Plan to allow comparisons.

3.4.16 Updated CSO Master Plan Model Findings

The WWF volume used for the CSO Master Plan calculation was updated to reflect the 2018 revised baseline model WWF volume and overflow volume. Overall the CS Master Plan refined model assessment concluded that the Winnipeg CS system had an overflow volume of 5,170,000 m^3 for the full 1992 representative year rainfall event This is equivalent to a 74 percent capture rate, and matches the percent capture rate determined with the 2013 baseline model. The overflow reduction assessment of the CSO Master Plan refined model found that to achieve Control Option No. 1: 85 percent capture target in a representative year, required a reduction of 2,270,000 m^3 in CSO overflow volume was required. Ultimately this resulted in a slight decrease in the volume required to reach the 85 percent capture target compared to the 2,300,000 m^3 value reported in the Preliminary Proposal. Ultimately by rounding this refined value the same 2,300,000 m^3 value is produced, and remains the target reduction in order to meet Control Option 1.

3.5 Project Development

Project development is the process of selecting specific control option projects for each district to meet the system-wide level of performance. At this stage, the planning projections and district-specific dewatering rates have been established and potential projects can be identified and grouped to meet the remaining constraints. The solutions under consideration for each district in the hydraulic model are then evaluated to achieve the performance requirements, which for the CSO Master Plan is Control Option No. 1 – 85 Percent Capture in a Representative Year. The term ‘project’ or ‘solution’ refers to the implementation of an individual control option as identified and discussed in Section 3.3.

The project selections proposed as part of the Preliminary Proposal form the basis of the refinements completed during this final phase of the CSO Master Plan. The basic approach to plan development for the Preliminary Proposal was as follows:

- The CSO and BFR program was leveraged to identify sewer districts that have a high cost benefit for implementing relief and corresponding higher priority for completion. Several districts with ongoing sewer relief work and recently completed planning and study work were identified for sewer separation. These districts were not evaluated any further as to alternative solutions to address the CSO Master Plan Control Option No. 1.

- Early actions were identified through the initial evaluations where large reductions could be achieved if work were to be prioritized. The Armstrong sewer district was identified for complete separation through this process.
- Maximizing the use of existing infrastructure using alternative technologies was the next consideration. In line and latent storage were considered readily accessible and evaluated first. The evaluation included consideration for the incremental benefits and increasing risks of progressively raising the levels of storage in the combined sewers. In-line and latent storage were optimized to maximize the operation storage while not allowing any increase to the risk for basement flooding to the various combined sewer districts.
- Off-line screening was considered necessary and included at each primary outfall in conjunction with the in-line storage control gate. In select districts the in-line storage control gate was a recommended project for the district specifically to accommodate off-line screening, and not for additional volume capture benefits.
- Off-line storage including both tanks and tunnel storage were considered following the optimized use of existing infrastructure through in line and latent storage. Typically, the off-line storage would be applied in districts that required a large volume reduction following the optimization of existing infrastructure with in-line or latent storage solutions.

3.5.1 Project Selection Process Limitations

The project selection process is limited to the selection and application of the control options that are used in the hydraulic model evaluations. The initial location of control options is based on the hydraulics of the sewer system and is verified with The City's GIS database. This typically means that an in-line gate or latent storage lift station in the model is located close to the diversion weir or flap gate. No consideration for land availability was made through the model development.

The DEP development included a conceptual level review of the constructability of each control option within a sewer district. The proposed locations of the selected control options are within available public lands where possible. This may be within an existing right-of-way or outfall easement. Adjustments to locations proposed in the model may have been made to account for property lines. This typically meant a control option would be moved further upstream along the trunk sewer or a lift station location would be moved away from the flap gate chamber. The locations of City owned land to potentially be utilized for construction of the selected control options is based on the City's GIS dataset. No consideration was made for other underground utilities such as water mains, communications or power. Further evaluation and consideration of constructability in relation to property lines, traffic impacts and utilities will have to be assessed at the preliminary design stage.

Other CSO Master Plan elements such as GI and RTC were not included in the project selection process. These are considered opportunities for future considerations to provide climate change resiliency or adapting to meet changing regulatory requirements. Additional details on these opportunities can be found in Sections 5.2.1 and 5.2.2.

3.5.2 Control Option Selection

A two-step process was used for control option project selection within a sewer district.

Step One: Initial Control Option Selection - The initial control option selection process identified district specific projects and estimated their performance using the individual district hydraulic models. Control options considered included in-line storage and latent storage primarily. Sewer separation was also considered if it was identified as a previously committed City project with the CSO and BFR program. This step continued until projects were defined for all specific districts, or 85 percent capture had been achieved. Section 3.5.3 describes the results of Step One.

The evaluation included in Step One can be summarized as follows:

a) Committed projects were considered first. The majority of these were sewer separation projects identified by the City to achieve BFR objectives, such as the Cockburn and Calrossie sewer districts where partial separation is currently prioritized to meet BFR objectives. The Armstrong district, although not a BFR directed project, was included as a committed project for complete sewer separation because some the results of initial evaluations show there is a large potential for CSO reduction.

b) The second stage within Step One was to identify in-line and latent storage opportunities to align with the marginal analysis. In-line storage is applicable to all but the completely separated districts. Latent storage can only be used in districts that have an SRS system with a dedicated SRS outfall. Identification of potential gravity flow control locations within sewer districts that drain to the interceptor by gravity was also included.

c) The third stage of Step One was the refinement and removal of latent storage within specific districts which have the necessary SRS infrastructure, but was not deemed cost effective based on the marginal analysis.

d) The final stage within Step One for district-specific projects was to include floatables screening for every primary outfall, where hydraulic conditions permitted. The screens are typically installed in combination with the control gates to provide the hydraulic conditions necessary for adequate screening performance.

Step Two: Control Option Refinements – This process identified additional projects required to achieve the system-wide goal of 85 percent capture, that was not achieved in Step One.

Projects evaluated with Step Two included additional latent storage, off-line tank storage, off-line tunnel storage or additional separation. Unlike the first step, these projects were not restricted to any specific districts with the requirement only to meet the system-wide performance goal. Section 3.5.4.1 describes the results of Step Two.

The evaluation included in Step Two can be summarized as follows:

a) The first stage of Step Two included refinements made to the projects selected for districts where off-line screening was determined to not be feasible due to hydraulic constraints within the CS system. This included recommendation of complete separation to remove the necessity for screening, or adoption of alternative floatables management pilot studies in these locations.

b) The second stage of Step Two included further evaluation of districts where in-line and/or latent storage arrangements previously recommended, in comparison to complete separation. Estimated capital cost differences and overall changes in O&M costs between each option considered, and resulted in additional areas of complete separation for a district recommended.

c) The third stage of Step Two included selection of partial separation of specific districts where opportunistic separation work was available. This opportunistic separation work would align with proposed major infrastructure projects in the future.

d) The fourth stage of Step Two included refinements made to latent storage arrangements in specific districts to provide the additional volume capture to meet the 85 percent target. Refinements included flap gate control upgrades, the addition of interconnections to the CS and SRS systems, and upgrades to combined CS/SRS shared outfalls.

e) The final stage of Step two included removal of off-line tunnel or off-line tank storage facilities previously recommended in the Preliminary Proposal from specific districts to meet the 85 percent volume capture target.

3.5.3 Step One: Initial Control Option Selection Process

The challenge with selecting projects when there are multiple choices is to identify those that are the most beneficial ones. This was dealt with using marginal analysis as part of Step One.

Note that this marginal analysis did not apply to the following districts in which complete separation was previously recommended to align with committed or planned projects within the existing CSO and BFR program:

- Douglas Park
- Ferry Road
- Parkside
- Riverbend
- Mission
- Armstrong

The marginal analysis completed as part of Step One compares the incremental cost of choosing one option versus another. Using this technique, a single or combination of options were selected to maximize cost-effectiveness. The marginal cost curves for the capital cost (not including O&M) of CSO mitigation for a range of options are shown in Figure 3-17.

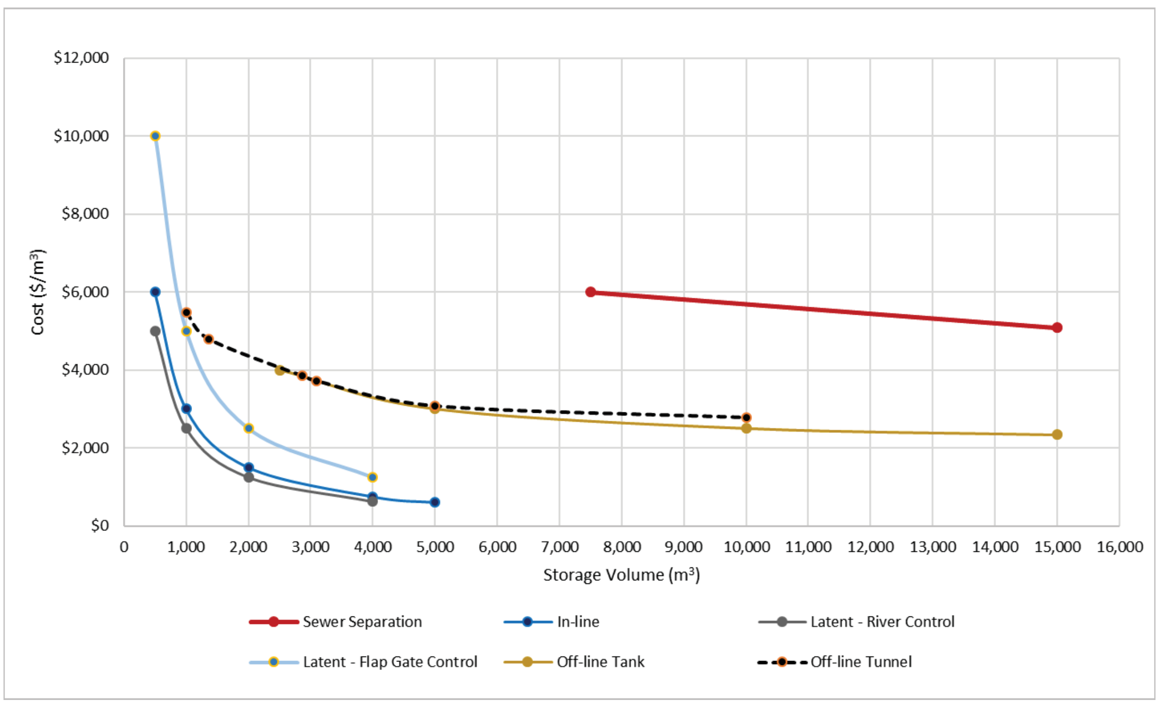

Figure 3-17. Marginal Cost of CSO Control Options (Capital Costs)

Several terms are used in the marginal cost illustration shown in Figure 3-17 which are further described below:

- Sewer Separation: represents the relative costs for separation of small area with 7,500 m^3 to a large area with up to 15,000 m^3 of CSO volume eliminated.

- In-line: represents the cost to install an in-line storage gate control.
- Latent – River Control: represents the cost to install latent storage without flap gate control.
- Latent – Flap Gate Control: represents the cost to install latent storage with flap gate control.
- Off-line Tank: represents the cost to install an off-line storage tank.
- Off-line Tunnel: represents the cost to install an off-line storage tunnel.

The marginal analysis process indicated the following:

- In-line and latent storage projects are generally cost-effective for volumes greater than 1,000 m^3 and always warrant first consideration. In cases where screens are used, in-line storage gate control may be required regardless of cost-effectiveness, in order to provide the required hydraulic conditions for screen operation. As a result of this in-line storage and latent storage was recommended for the majority of the districts, where complete separation was not recommended, and the necessary infrastructure for in-line and latent storage implementation was in place.
- If it was found that the existing weir heights within the district was sufficient to provide the equivalent of the in-line storage arrangements recommended, then no work towards in-line storage via control gate construction was recommended. This was found to be the case in the following districts:
    - Bannatyne
    - River
    - Assiniboine
- The off-line tank and off-line tunnel storage options were found to be highly variable in cost but, because they are largely interchangeable, the most cost-effective option can be picked at time of final selection. Recent bid prices from the Cockburn BFR project for mid-size tunnels, suitable for storage, varied by about a factor of two between bids from different contractors.
- Cost for separation of an entire district is always high because the unit costs are applied to the full area of separation. Sewer separation projects do not use storage, and therefore an amount of equivalent storage was substituted for the marginal analysis comparison purposes. This equivalent storage was equal to the predicted overflow volume needed to reduce the number of overflows from the district to zero. A smaller area of separation would require less sewer pipe to be installed and would equate to less equivalent storage volume.

As part of the marginal review in Step One, a more focused review of the SRS latent storage was completed. The latent storage volumes less than the 1,000 m^3 threshold were deemed to be not cost effective. This resulted in the removal of the latent storage originally recommended during Step One in the following districts:

- Baltimore District, within the Hay SRS and Osborne SRS dedicated outfalls.
- Jessie District within the Grosvenor SRS.

The marginal analysis completed in Step One provided the initial control option selections. The Step One control option selection process achieved a capture rate of 84 percent. Additional refinements as part of Step Two were required to meet the regulatory requirements and achieve the 85 percent capture target.

3.5.4 Step Two: Control Option Refinements Process

Identified as Step Two of the Control Option assessment, additional evaluations were required following Step One to assess unique circumstances and make final refinements to the proposed configuration of control options. This included a review of sewer districts on an opportunistic basis for additional complete or partial sewer separation, the addition of flap gate control or additional interconnection to the SRS latent storage arrangement recommended, and the addition of off-line storage including both tunnels and tanks. These refinements are described in the following subsections.

3.5.4.1 Floatables Screening Refinements

Floatables screening has been considered for all primary outfalls that are not completely separated. Implementation of the off-line screening facilities in these districts was found to be inoperable at some sites however because of physical constraints.

The off-line screening installations require that there be sufficient positive hydraulic head available for gravity screening operation, higher combined sewage levels than NSWL at the screening chamber. The extent of positive head was assumed to be part of the typical screen installation requirement. Refer to Part 3C Section 5.4 for further detail as to the interaction between the screen length requirements and hydraulic head applied to the screening facilities. As part of the Preliminary Proposal assessment, it was recommended and agreed with the City that the control gates would be at a maximum elevation that is equivalent to the half pipe level of the incoming trunk sewer. Increasing the control gate level above the half pipe level to provide adequate screen head in the districts where sufficient head was not available was discounted as not appropriate, given the increased risks of basement flooding associated with this. The installation of control gates artificially raises the operating levels, but at some locations this is still not sufficient to raise the level above the NSWL river level, as shown on Figure 3-18.

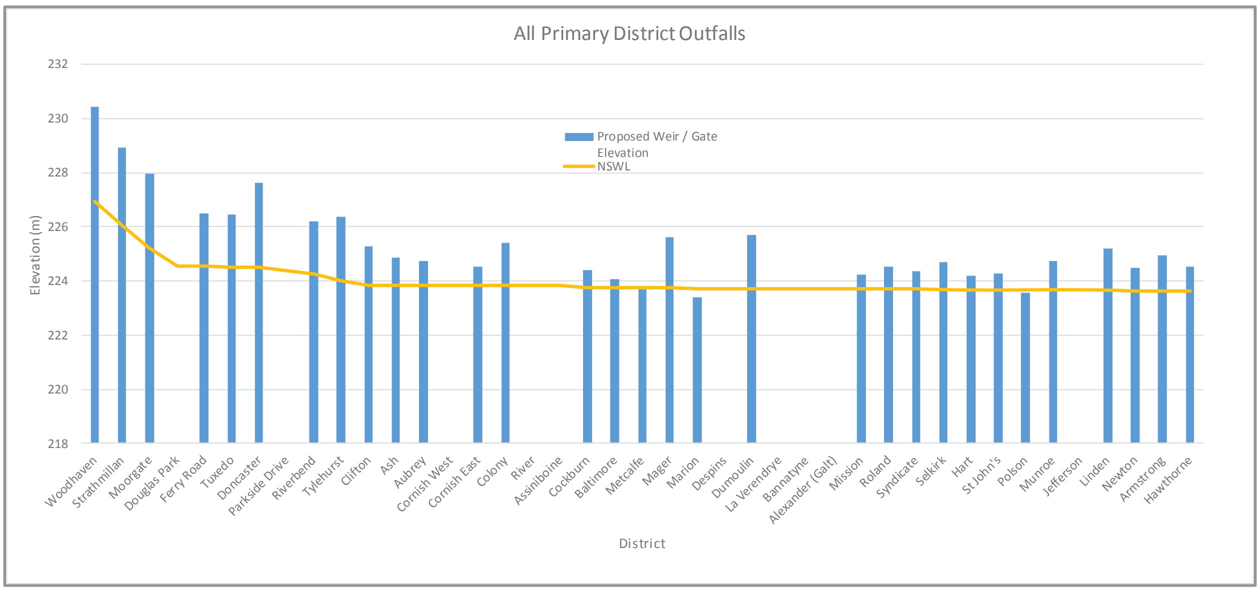

Figure 3-18. Proposed Screen Operating Height versus Normal Summer River Level (NSWL)

The selection of the standard screening chamber as described in Part 3C provides an indication of expected screening head requirements. Where negative head is noted between the screen operating height and the NSWL river level, the district was not considered for typical gravity off-line screening facilities. In addition, those districts where the slight positive head would require an excessive screen length (> 8 m) or positive head below 0.1 m were also not considered for off-line screening.

It should also be noted that the selection of the NSWL river elevation was completed as this river level is that at which the river is primarily controlled to during the majority of the months when rainfall events occur. The high spring river levels may not allow any positive head to be established between the gate/weir level and the river level and under these conditions the off-line screening facilities currently recommended would not operate.

It was concluded during the assessment that the off-line gravity screening facilities could not operate and, therefore, would not be recommended in the following districts:

- Metcalfe
- Despins
- Jessie
- Marion
- Polson

The approach to address the floatables management requirements for these districts was unique. Initially an assessment was completed to determine the feasibility of implementing control options which would remove the requirement for screening entirely. An assessment of utilizing either complete sewer separation or additional off-line storage (via off-line tank or off-line tunnel facilities) for these five districts then completed. From this assessment the recommendation for complete sewer separation based on the elimination of the screening requirement was revised for the following districts:

- Metcalfe
- Despins

It should be noted that the initial marginal analysis and lifecycle cost evaluation completed as described in Section 3.5.4.2 below both found the selection in-line storage and screening options previously recommended to be most cost effective. If the alternative floatables management approach (see Section 5.2.3.2) is utilized in the future within these districts, the recommendation of complete sewer separation in the Metcalfe and Despins districts should be reevaluated.

Additional off-line storage was then assessed in the remaining three districts where off-line screening facilities could not be accommodated, to ensure full capture of the fifth largest overflow event. By capturing the fifth largest overflow event the requirements for floatables management within the district would be met. The provision of the off-line storage to capture this volume of CSO would provide collection of the equivalent first flush flows within each of the four largest overflow events and be similar to the annual performance that would meet four overflows per representative year. The model was used to identify and optimize the infrastructure required to achieve the storage of the fifth largest event. This infrastructure would provide an increase in the capture within each of these districts and provide an improvement to floatables capture and overflow frequency although will not eliminate overflows from these districts. From this evaluation no other districts were found to be sufficiently cost effective to utilize off-line storage facilities to off-set the requirements for screening.

For the remaining three districts the approach to address the floatables management requirements involved selecting these districts for piloting of an alternative floatables management approach. This is explained in more detail in Section 5.2.3.2. If this alternative approach can be demonstrated successful by piloting in these districts, it will remove the requirement to construct an off-line screening facility to meet the floatables management requirements dictated in Environment Act Licence No. 3042.

The piloting of the alternative floatables management approach was therefore recommended for the following districts:

- Jessie
- Marion
- Polson

3.5.4.2 Sewer Separation Refinements

A lifecycle evaluation showed that several smaller sewer districts, or districts in which the majority of the area had been previously separation, could be have complete separated implemented at a comparable cost to in-line storage with screening. Sewer separation is the only control option which would eliminate the need for control gates and screens within a district. Sewer separation can also result in future decommissioning of a FPS associated with the district, potentially providing long term operations and maintenance cost savings for the district after separation is finished. Separation (either partial or complete) will also reduce the volume of flow pumped by an existing LS, reducing both operations and maintenance costs, resulting in an increase to the lifespan of existing infrastructure as well as reducing the replacement cost of existing infrastructure (e.g. smaller pumps required at lift stations for future upgrades).

The addition of the long-term O&M costs to the evaluation of in-line storage with screening increases the lifecycle costs. Conversely, the reduction of district WWF also would reduce the operation of the LS and FPS (where applicable), which would reduce the lifecycle costs. This option refinement required sewer separation to convert the district to a separate sewer district and would eliminate the need for control gates and screening.

The recommendation for complete sewer separation based on this lifecycle analysis was found to apply to the following districts:

- Linden
- Tuxedo
- Doncaster
- La Verendrye

Dumoulin may be considered as a district for complete sewer separation in the future as well. The assessment found that the life cycle costs of complete sewer separation was slightly above the life cycle costs for implementing the other control options. The control options currently recommended for this district should be revaluated prior to proceeding with preliminary design.

The potential benefit from the opportunity to reduce or eliminate FPS requirements was only reviewed at a high level as part of this analysis, and should be investigated further. This may be evaluated in more detail during the CSO Master Plan implementation and may result in other districts having revised recommendations for complete sewer separation instead of the measures currently recommended.

3.5.4.3 Partial District Sewer Separation Refinements

Partial district sewer separation can be considered on an opportunistic basis. These opportunities may arise from further technical analysis and model evaluations or as a result of unrelated redevelopments or construction activity within the district. This approach was applied to the following district:

- Ash: Redevelopment of the Kenaston – Route 90 corridor provides the opportunity for partial separation along the western edge of the district. Sewer separation has been included along parts of the roadway where Route 90 crosses into the Ash district.

3.5.4.4 Latent Storage Refinements

The initial design concept for latent storage was to fully integrate latent and in-line storage. The detailed sewer district evaluations showed that many of the interconnections between the CS and SRS systems are too high to transfer sufficient flows into the relief pipes to take full advantage of the latent storage.

In addition, many of the interconnection levels are not fully documented and further refinement of these assumed levels may not provide the level of interaction that would occur when the interconnection levels are determined as part of future data collection work. This is a potential opportunity for further refinement through model maintenance during the implementation of the CSO Master Plan.

From these evaluations the Aubrey SRS system specifically indicated that a relatively large latent storage volume is not fully utilized. Modifications to the sewer interconnections between the CS and SRS systems are required to access this storage volume. Modifications proposed for Aubrey sewer district are as follows:

- Aubrey – CS to SRS interconnections have been added for both the Aubrey SRS and Ruby SRS systems.

The feasibility and final routing of these interconnections are proposed to be investigated during future model maintenance and as part of the preliminary design for the solutions within the Aubrey district.

Of the 12 potential locations selected for latent storage, 10 are sufficiently controlled by the river NSWL to allow the latent storage to be utilized for each rainfall event. Sewer districts with high SRS outfall pipes in relation to the river NSWL require additional control measures to maximize the latent storage volume. Flap gate control has been applied at these locations to increase the active latent control storage volume.

From this evaluation the following districts were recommended to have the latent storage arrangement refined to have flap gate control as a proposed control option:

- Clifton
- Ash

For the Clifton district, the in-line storage gate allows the interaction between the CS and SRS systems to follow the original design concept. Flap gate control is required to contain the district flow above the NWSL level.

Each flap gate control would be controlled in conjunction with the in-line storage control gate at the primary outfall. Lowering of the in-line storage control gate would trigger the release of the lock controlled SRS flap gate to maintain the level of basement flooding protection.

In two sewer districts, the CS and SRS systems also share a common outfall pipe. The interaction between the two systems creates unnecessary upstream impacts. A new gate chamber including new flap gates and a lift station to dewater the SRS system are proposed to reduce the potential for interactions and separate the SRS and CS outfalls.

These modifications to the SRS outfalls as part of the latent storage refinements are proposed for the following sewer districts:

- Roland
- St John's

This will permit isolation of the SRS storage to optimize the latent storages within these districts.

3.5.4.5 Off-line Tunnel and Tank Storage Refinements

The system-wide assessment of the 85 percent target was achieved via the control options detailed above. Proposals for off-line tank and tunnel storage requirements put forward in the Preliminary Proposal were found to not be necessary to achieve the 85 percent volume capture target for the Master Plan. The increased capture via latent storage, additional sewer separation districts and the hydraulic model upgrades from more recent data sets has resulted in these control options not being required for Control Option No. 1.

However, it was noted that the complete separation of the La Verendrye district did not fully eliminate the overflows at this site. The La Verendrye district is a gravity discharge district flowing to the adjacent Dumoulin district. A combination of the under capacity pass forward pipe, high WWF flows arriving at the Dumoulin LS, and high-level gravity bypass pipe results in overflows at La Verendrye for the separated district modelling assessment. The inclusion of an off-line tunnel and flap gate to isolate the La Verendrye and Dumoulin districts eliminate overflows from the La Verendrye district and would eliminate the requirement for screening facilities. This is not ideal as any improvements to the Dumoulin district for future control options would result in flow reduction in the Dumoulin district that would allow the La Verendrye district to operate within the requirement of the off-line tunnel.

3.5.5 Final Control Option Selection

The final assessment of the control options involved the review of the overflow performance of each district based on the recommendations from Step One and Step Two. The individual district solution models were combined to form the Regional model and the 1992 representative year was simulated. The results of the combined district solutions achieved a system wide performance of 85 percent capture.

The Master Plan final assessment concluded that off-line storage, utilized in the Preliminary Proposal assessment was not required (other than for the La Verendrye district as mentioned above). The additional sewer separation districts, improvements to the modelled infrastructure and latent storage improvements replaced these off-line storage facilities and aligned better with potential future regulatory changes. . The control option selection results as identified in Step One and Step Two for the CSO Master Plan are shown in Table 3-4.

Table 3-4. Control Option Selection for the CSO Master Plan

District	Step One – Initial Control Option Selection						Step Two – Control Option Refinements					
	Complete Sewer Separation	Partial Sewer Separation	In-Line Storage (with Control Gate)	Screens	Gravity Flow Control	Latent Storage (River Control)	Latent Storage (Flap Gate Control)	Latent Storage (Interconnection Upgrades)	Additional Complete Sewer Separation	Additional Partial Sewer Separation	Off-Line Storage Tanks	Off-line Tunnel Storage
Woodhaven			Yes **	Yes								
Strathmillan			Yes **	Yes								
Moorgate			Yes	Yes								
Douglas Park *	Yes											
Ferry Road **	Yes											
Tuxedo									Yes			
Doncaster									Yes			
Parkside *	Yes											
Riverbend *	Yes											
Tylehurst									Yes			
Clifton			Yes	Yes		Yes	Yes					
Ash			Yes	Yes		Yes	Yes			Yes		
Aubrey			Yes	Yes		Yes		Yes				
Cornish			Yes **	Yes		Yes						
Colony			Yes	Yes	Yes	Yes						

Table 3-4. Control Option Selection for the CSO Master Plan

	Step One – Initial Control Option Selection						Step Two – Control Option Refinements					
District	Complete Sewer Separation	Partial Sewer Separation	In-Line Storage (with Control Gate)	Screens	Gravity Flow Control	Latent Storage (River Control)	Latent Storage (Flap Gate Control)	Latent Storage (Interconnection Upgrades)	Additional Complete Sewer Separation	Additional Partial Sewer Separation	Off-Line Storage Tanks	Off-line Tunnel Storage
River				Yes		Yes						
Assiniboine				Yes	Yes	Yes						
Cockburn *		Yes	Yes	Yes								
Baltimore			Yes	Yes		Yes						
Metcalfe									Yes			
Mager			Yes	Yes								
Jessie		Yes	Yes									
Marion						Yes						
Despins									Yes			
Dumoulin			Yes	Yes								
La Verendrye									Yes			Yes
Bannatyne				Yes	Yes	Yes						
Alexander				Yes	Yes							
Mission *	Yes											
Roland			Yes	Yes		Yes						

Table 3-4. Control Option Selection for the CSO Master Plan

	Step One – Initial Control Option Selection						Step Two – Control Option Refinements					
District	Complete Sewer Separation	Partial Sewer Separation	In-Line Storage (with Control Gate)	Screens	Gravity Flow Control	Latent Storage (River Control)	Latent Storage (Flap Gate Control)	Latent Storage (Interconnection Upgrades)	Additional Complete Sewer Separation	Additional Partial Sewer Separation	Off-Line Storage Tanks	Off-line Tunnel Storage
Syndicate			Yes	Yes								
Selkirk			Yes	Yes	Yes	Yes						
Hart			Yes	Yes								
St John's			Yes	Yes	Yes							
Polson			Yes		Yes	Yes						
Munroe			Yes	Yes	Yes							
Jefferson *		Yes	Yes	Yes	Yes							
Linden									Yes			
Newton			Yes	Yes	Yes							
Armstrong *	Yes											
Hawthorne			Yes	Yes								

* denotes a Committed Project with the CSO and BFR Program

** In-Line Storage Control Gate recommended for this district primarily to provide hydraulic head for screen operation. This solution does not provide sufficient additional volume capture to be cost-effective based on performance alone. Should screens no longer be required for this district, In-Line Storage Control Gate recommendation should be reassessed.

3.6 Cost Estimation

The following section presents the approach to estimating the costs to implement the CSO Master Plan. Sewer district level estimates are used in the subsequent programming process to develop annual estimates and the overall program budget.

For the CSO Master Plan, cost estimates were developed for each combined sewer district based on the proposed control options and totaled for the overall program. The district level estimates include the capital costs and allowances for O&M costs. The overall program is based on capital costs only, however the O&M costs and their potential impact on implementing the CSO Master Plan have also been evaluated. Estimating details are provided within the DEPs and in the Basis of Estimate Technical Memorandum included as Appendix C to this Part 2 Technical Report.

3.6.1 Capital Cost Summary

Capital costs in 2019 dollars are calculated based on the estimated construction costs and are shown, including the estimating range, in Table 3-5. The upper range of the confidence limits has been used for the budget assessment of the CSO Master Plan.

Table 3-5. CSO Master Plan Capital Cost Estimates (2019 Dollar Values)

Item	2019 Capital Cost Estimate
AACE Class 5 Estimated Capital Costs	$1,045,800,000
Green Infrastructure Allowance	$104,600,000
Subtotal – Capital Cost Estimate	**$1,150,400,000**
AACE Class 5 Estimate Range of Accuracy: -50% to +100%	$575,200,000 to +$2,300,800,000
Total Capital Cost for Budgeting Purposes	**$2,300,800,000**

The capital cost estimate breakdown is provided in further detail in the Part 3 report. The confidence limits for AACE Class 5 estimates are -50% to +100% and the expectation is that the final cost will fall within this range. The cost estimates presented in Table 3-5 do not include the future operations and maintenance (O&M) costs for CSO program upgrades. The future O&M costs have been estimated separately and further detail can be found in Section 3.6.5 and Section 4.

It is important to note that there were a number of changes incorporated since the original 2015 Preliminary Proposal was submitted. Comparison of the current capital cost estimate to the Preliminary Proposal is listed in Table 3-6. The values are adjusted to have the same cost components.

Table 3-6. Capital Cost Estimate Comparison

Estimate	Preliminary Proposal Capital Cost Estimate (2014 dollars)	Preliminary Proposal Capital Cost Inflated (2019 dollars)	2019 Capital Cost Estimate (2019 dollars)
Base Cost	$830,000,000	$962,000,000	$1,150,400,000
Base Cost + 100%	$1,659,000,000	$1,924,000,000	$2,300,800,000

Notes:

Includes 2014 to 2019 inflation of 3%
Includes full cost of current BFR projects
Includes GI allowance of 10%
Excludes O&M budgets

As agreed with the City, the upper range of the Class 5 estimate (+100%) is to be used for budgeting purposes giving a total capital cost of $2.300 Billion. In the Preliminary Proposal, a different approach was used whereby the total capital cost was reported as $1.245 Billion using +50% of the base estimate. Using the same approach of applying the full +100% estimating range to the Preliminary Proposal capital cost estimates would equate to $1.726 Billion dollars in 2014 dollars. Considering this the overall change in capital costs based on CSO Master Plan refinements is approximately 40 percent higher than that reported for the Preliminary Proposal.

This increase of CSO Master Plan total capital costs in comparison to previous estimates is attributed to the following:

- A change in City's use of the classification range of accuracy for cost estimating. For the Preliminary Proposal, plus 50 percent of capital cost was used to represent the budget estimating amount. In 2015, the City moved to the AACE classification system and the top end of the accuracy range was increased to plus 100 percent of capital cost.
- GI was applied as an allowance to the capital cost estimate of 10 percent for the CSO Master Plan but was not included in the Preliminary Proposal.
- Construction cost escalation from 2014 to 2019 equating to about 16 percent.
- An increase in the amount of sewer separation projects selected as control options for specific districts. This resulted in higher capital costs, but lower long term operation and maintenance costs for those districts.

The capital costs of each of the recommended projects for each of the districts detailed in Part 3B. Over time as the CSO Master Plan is implemented, it is intended that any modification to the CSO Master Plan be updated and reported in Part 3. Part 2 will remain as the supporting technical document to explain the estimating process.

3.6.2 Capital Cost Basis

Conceptual level AACE Class 5 estimates were developed for the proposed control solutions for each sewer district. The estimate for each control solution was based on the following:

- Cost estimation for the CSO Master Plan followed the same approach as was used for the Preliminary Proposal. This included the use of the Program Alternative Cost Calculator (PACC) parametric estimating tool for generating costs for other technologies that have not been previously applied in the City.
  - The PACC tool provided planning level costing information for commonly used CSO control technologies based on other similar completed projects, which can readily be updated to local conditions.
  - Unit costs are provided and represented by parametric curves for each of the units making up the control options. The unit costs are applied to each control option for each district and totaled for the entire CSO Master Plan. Refinements were made to the control solution cost curves and the baseline year was adjusted to 2019.
- Local costs were applied where local estimates from previously tendered work were readily available. This was typically utilized for items such as sewer and chamber installations.
- Standard unit rates from Winnipeg experience were used to estimate and quantify the sewer separation work.
- The CSO Master Plan assumes construction projects will be completed using the design-bid-build (DBB) approach, as has traditionally been used for conveyance projects in Winnipeg. With the DBB approach, the consultant designs the work, the contractor provides a bid price for the tendered project and is responsible for means and methods of construction. The bid price includes all components necessary to complete the construction work.

Further details for the estimation methodology of each control solution technology are included in the Basis of Estimate technical memorandum, included as Appendix C.

3.6.3 Class of Estimation

The CSO Master Plan is a planning level document that deals with strategic planning for a large and complex issue. Therefore, the projects are defined and estimated at a high level, which is suitable for feasibility evaluations, comparative evaluations, and planning, but which is not to be relied upon where a greater deal of accuracy is required.

The CSO Master Plan estimates are reported as a Class 5 level as defined by *Association for the Advancement of Cost Engineering (AACE) International Cost Estimate Classification System – As Applied In Engineering, Procurement, and Construction for the Process Industries* (AACE, 1997). Class 5 estimates have an accuracy range from minus 50 to plus 100 percent and are based on a project definition of between zero and two percent. The AACE Class 5 estimate accuracy range is utilized to project the potential range of total program cost estimate changes. This is based on the understanding that each of the projects included in the program will be refined and potentially modified as the Master Plan is implemented. As a result of this the upper range of an AACE Class 5 estimate (+100%) is to be used for program evaluation and budgeting purposes.

3.6.4 Capital Cost Assumptions

The total capital costs are estimated by adding markups to the expected construction costs to arrive at the total capital cost for the project. The following percentage markups are included in the capital estimates:

- Engineering – 13 percent
- Project Design Contingencies – 30 percent
- Program Management – 2 percent
- Manitoba Retail Sales Tax (MRST) – 8 percent, applies to tangible personal property and has been applied to all projects. It is expected to be applicable to some projects or parts of projects, or both, and not to others, which is subject to interpretation and may require tax department clarification at the time of construction.
- MRST was reduced to 7 percent in July 2019; however, this change was not applied to the estimates due to the timing of when the estimates were created.

In total each of the percentage markup factors above, a cumulative markup of 53 percent is applied to the base construction costs developed from the CSO unit costs.

Specific capital costs based on previous estimates or parametric cost curves are included for each capital project, except for GI. GI is considered an opportunity, with the costs and performance accounted for separately from the other control options. It has been accounted for with a separate cost allowance of 10 percent assigned to the capital costs for all the districts.

There are additional cost markups that may be applicable to portions of the CSO Master Plan but were not included. These are listed as follows:

- Federal Goods and Services Tax (GST) – normally 5 percent, but not included because of potential municipal exemptions.
- Finance and Administration – normally 3.25 percent, but not applied for the CSO Master Plan

3.6.5 Operations and Maintenance Cost Assumptions

Each of the projects will require some level of O&M throughout their life. The CSO Master Plan addresses the need for reporting the O&M costs by two means, the lifecycle 35 year O&M costs, and the program

O&M costs. The lifecycle O&M costs are identifying them as separate line items within each DEP, while combining them together for scenario evaluations. The cumulative O&M program costs and impacts based on the project sequencing and timelines can be found in Section 4 of this Part 2 Technical Report.

O&M costs accrue after capital projects are completed and continue while the project is in service. O&M costs include routine labour and expenses for servicing (such as energy, materials, and chemicals) and labour and expenses for periodic refurbishment or replacement. The O&M estimates were developed based on the PACC tool approach, as described in Appendix C: Basis of Estimate Technical Memorandum. The O&M costs consider the annual maintenance and operation based on the expected number of times operated and a periodic replacement cost.

O&M evaluations were first completed for the lifecycle cost analysis as part of the initial project selection and for the program scenario evaluations. The lifecycle costs were based on the hypothetical assumption each project would be implemented in 2019, and were based on 35 years of O&M costs. The 35 years timeframe was used in alignment with the City's business case process used for planning and project comparisons. This information will be utilized further as part of comparing solutions selected amongst different districts as the solutions recommended in the districts are taken forward to preliminary design.

Next the O&M evaluations were completed to determine the program additional O&M costs. O&M costs were assumed to initiate following the completion of a control option based on the project sequencing and funding scenario, and continue for the life of the infrastructure. In the evaluation of the various budget scenarios, the O&M costs were evaluated based on a projection to the year 2100. It includes routine costs at a constant annual rate in 2019 dollar values, inflated to the year of expenditure, as well as the periodic costs:

- Routine O&M costs were initially estimated in 2019 dollar values and are extended to the year 2100.
- Periodic maintenance costs were applied as a factor of the capital cost at 10, 20 and 30 years.
- The cost estimate for each sewer district includes the net present value (NPV) of the combined routine and periodic O&M costs, which are used in the Master Plan programming and budget estimates.

3.6.6 Estimating Allowances

An estimating allowance was included for the CSO Master Plan. The estimating allowance is calculated as 100 percent of the base capital cost estimate. Note that this estimating allowance is a separate consideration from the AACE Class 5 estimate accuracy range. This allowance is applied to the final cost figures to account for unknowns and provide the necessary contingency allowance for budget projections.

The estimating allowance accounts for program unknowns and uncertainty beyond the risks normally encountered on a project basis. Examples of potential cost increases are as follows:

- **Proof of Concept:** The CSO Master Plan includes a ten year period for technology evaluations and pilot studies, intended to validate and gain comfort in the control option selections. This implies that there is a possibility of rejection, which may lead to the need for more costly substitutes.
- **Consequential Upgrades:** The project development process for the CSO Master Plan assumed the works would be carried out independent of existing or other asset condition or upgrading needs. In practice, there may be needs or pressures to integrate indirect upgrades, such as LS upgrades, water mains, integration of other BFR works, street repairs, or rehabilitation of existing sewers to support the CSO program upgrades.
- **Market Demand Price Changes:** The rapid growth in work and the long-term implementation period increase the risk of construction cost increases. The engineering and contracting resources are currently not in place to deal with the volume of work projected in the Master Plan. The usual market response to increased demand results in increased costs, which may be exacerbated because of the need for specialized skills and limited resources for much of the work.

- **Program Support Services:** The capital cost estimates include a line item for project support services. The budget is intended for field services by internal resources, consulting services, and contracts for carrying out or supporting the engineering evaluations, pilot testing, and RTC works in support of program management.
- **Constructability Issues:** Several issues in relation to the process to construct some of the solutions recommended as part of the CSO Master Plan could result in escalating costs. This could include logistical issues related to existing underground infrastructure, high water table and groundwater infiltration concerns impacting unground construction, or items relating to unforeseen ground conditions during construction.

3.6.7 Cost Estimate Exclusions

Section 3.6.6 identifies items outside of what is included in the cost estimates, but which are assumed to be covered as part of the estimating contingency and allowances. There are other items that may impact the overall cost of the CSO Master Plan but are not included within the cost estimates provided. These items are described as follows:

- **FPS Usage Reduction:** FPSs are present in number of sewer districts that have been identified for work as part of the CSO Master Plan. There is the potential that the requirements for the FPS could be reduced or eliminated if the basement flooding issues are mitigated by other means. There would be long term operational savings attributed to this reduced service.
- **BFR Projects:** Current projects initiated under the BFR projects are underway and include works associated with CSO mitigation. The value of the constructed works directly related to CSO and BFR is approximately $440,000,000 to date. All future work of this nature is included in the CSO program. This will need to be reviewed and will result in minor reductions to the total capital cost estimate provided at this time.
- **Sewage Treatment Plant Upgrades:** Combined sewage captured under the CSO program will be routed to STPs for WWF treatment. Allowances have been committed for WWF treatment at the SEWPCC and WEWPCC. The future NEWPCC project is to include upgrading an independent treatment facility for WWF, which will be used by the CSO program. The capital and operating costs of all WWF treatment is included with the STP upgrade budgets as part of the Winnipeg Sewage Treatment Program (WSTP) and has not been allocated to the CSO program estimates.
- **Land Acquisition:** The base estimates do not include land acquisition costs, if required.

3.7 District Engineering Plans

EA No. 3042 required the development of district engineering plans (DEPs) as part of the CSO Master Plan. As such, DEPs were developed for each of the combined sewer districts. Each DEP documents the existing relevant sewer data and the solutions proposed to meet regulatory requirements. This process incorporates the use of a standard template to streamline the creation of the plans. This template will be maintained and used for future sewer planning efforts in the City.

The DEPs have been developed to a conceptual level of design that will require further analysis prior to implementation. It is expected that the proposed solutions will be further refined through the preliminary and detailed design phases. The CSO Master Plan will be updated to reflect any changes required from the additional analysis. The DEPs are included with Part 3B.

3.8 Project Data Collection Documentation

The development of the CSO Master Plan required a detailed review of the City's sewer system and the creation and updates to the sewer system hydraulic models. The review and analysis undertaken to complete these tasks required the use and creation of a large set of data. The CSO Master Plan study began in 2013 and the Preliminary Proposal was based on the data set collected during the initial stages of the project at that time. The CSO Master Plan included a more detailed review of the City's data, model updates identified as a result of the review of the district engineering plans, and the creation of an updated baseline and preferred solution for the Master Plan.

A data tracking and review plan was put in place to record the changes that have taken place between the submission of the Preliminary Proposal to the submission of the CSO Master Plan. The main components of the data tracking and review plan are described in the following subsections.

3.8.1 Data Sheets

Data sheets were created during the detailed plan development and implementation to track changes to the asset data, hydraulic model, control options, and costs. Data are tracked in a spreadsheet for each sewer district to identify the changes between the baseline and the CSO Master Plan versions of the model. This includes the identification of critical elevations used in selection of the CSO controls for the CSO Master Plan. The content of these datasheets is ultimately included within each of the DEPs.

3.8.2 Hydraulic Models

Hydraulic models were created in InfoWorks CS for the City's sewer collection system during the study phases of the CSO Master Plan project. A baseline model representing the year 2013 was created based on available data at the start of the project. This included a global, all-pipes model and a skeletonized CS system model. Preliminary Master Plan alternative models were created for each of the control limits requested by MSD and others added by the study team. A hydraulic river model was created with the Water Quality Analysis Simulation Program and used in the study phase to estimate the loading and dynamic water quality impacts. These planning models were finalized and included in the submission of the 2015 Preliminary Proposal.

A new baseline and CSO Master Plan model were created based on new information available at the beginning of the implementation phase in 2018. Additional updates were included resulting from a detailed review and development of the DEPs. The Master Plan model and associated modelling files are included with the CSO Master Plan submission to the City of Winnipeg.

4. Program Development

Program development is the process of defining the CSO Master Plan program details. It begins after project development, with projects meeting the performance requirements having been identified and evaluated, and capital and operational cost estimates prepared for each project.

Program development considers the project sequencing for the long-term implementation. The program will include multiple projects, resulting in many variations to the potential programs. The wide range of variations warrants a methodical approach for program development.

Program development is ultimately used to produce the CSO Master Plan submission. The Master Plan will include a project listing, project descriptions, the year of implementation, and capital and operating costs for each project. Both of these costs are directly impacted by the sequencing of the projects during program development, due to the impacts from inflation. The project sequencing alternatives presented below form the CSO Master Plan and will be reviewed by MSD for compliance with EA No. 3042. It will then be used in the City's capital budgeting process and followed for program implementation and performance tracking.

The following section describes the program development process. It includes review of scenarios, with the recommended implementation plan presented in Part 3A. As the program evolves, it is intended that the program updates will be documented through changes to Part 3A, without the need for updates to the technical sections of this Part 2 report.

The project development process is summarized on Figure 4-1 and its application is described in the following sections.

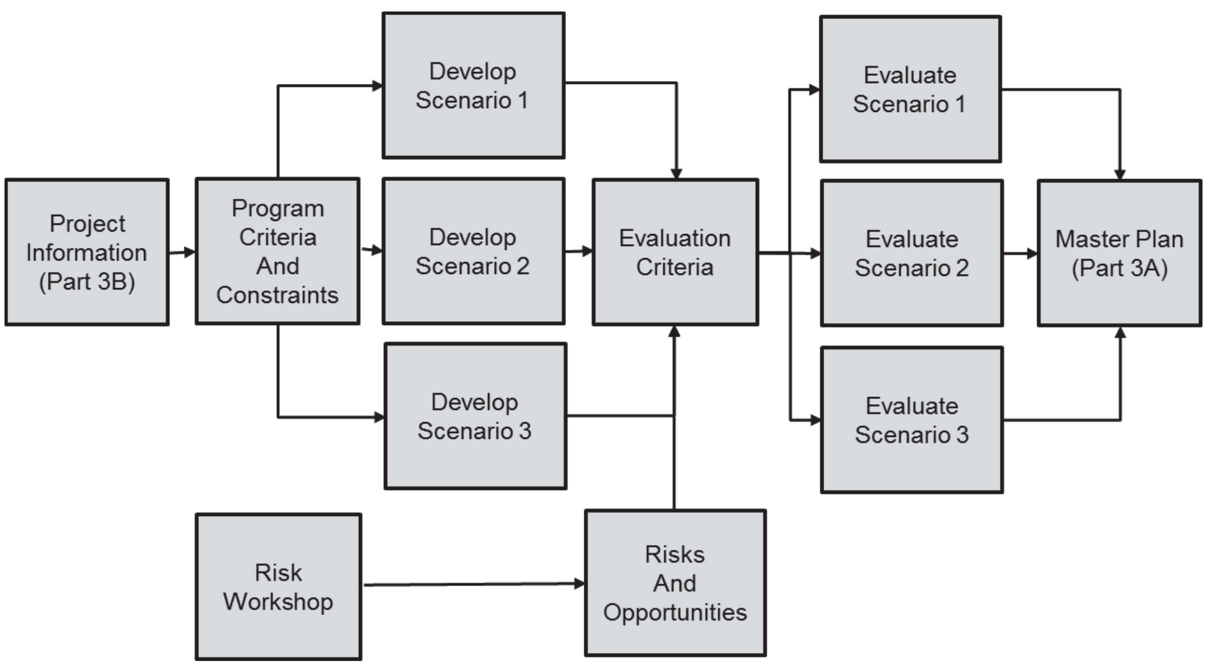

Figure 4-1. Program Development Process

4.1 Program Criteria and Constraints

Several criteria and constraints have been identified through the CSO master planning process as having a direct impact on the scenario definitions, their evaluation, and how they impact the program. Each of these criteria are defined below as follows:

- **Regulatory Requirements:** The primary objective of the CSO Master Plan is to achieve compliance with the regulatory requirements, with the two key requirements being CSO capture and implementation schedule.

  Ideally all scenarios would meet the regulatory requirements, but in fact the high costs may be too onerous on the ratepayers, with an extension to the time frame for implementation being required. An extension may be approved by the Director of MSD, as stated in EA No. 3042.

- **Water Quality:** Since all the scenarios will achieve the same water quality improvements, there is little differentiation between the scenarios. The main consideration is that the extended implementation schedule due to lower funding levels means there will be a delay in achieving the projected water quality improvements.
- **Affordability:** The City's Water and Waste Department finances its capital and operating budgets for the sewer utility on a user-pay basis through water and sewer rates. The City takes a longer-term view of rates to provide stability for its rate-payers. The rates have steadily been rising for several years and are expected to continue to rise because of major obligations for wastewater treatment plant upgrading and replacement and refurbishment of aging infrastructure. However, continuous increases in water and sewer rates to fund these obligations are not sustainable. The City has determined that the upper threshold for the CSO program funding specifically should be no more than $30 million per year and has set this as a funding constraint. There are additional resources available to guide municipalities such as the EPA's *Guidance for Financial Capability Assessment and Schedule Development* (EPA, 1997). The approach assesses the average cost of the program per household in comparison to the median household income. This produces a numerical factor called the Residential Indicator (RI). In general, an RI of 2 percent or greater is considered a "large economic impact" on residents. In Winnipeg, most of the CS areas are within lower income neighbourhoods and this factor is already above the indicator which means any additional costs from the CSO Master Plan will impact this further.
- **2003 CEC Recommendation:** Timeframes to achieve the completion of the program are directly related to the level of funding committed. The CEC hearings (CEC, 2003) recommended shared costs for upgrading the City's wastewater collection and treatment systems in order to complete the work in a reasonable amount of time. The program development phase has therefore been evaluated based on shared funding from municipal, provincial and federal levels of government.
- **Committed Projects:** Several sewer separation projects have been initiated and are underway. These projects were part of a previously approved program and align with the objectives of the CSO Master Plan. There will be no changes made to the project sequencing of these specific projects within the program development.
- **Technology Validation:** The CSO program has identified several cost-effective control technologies which have not yet been applied in the City. The City plans to carry out investigations and testing of these new technologies under local conditions prior to full scale commitment.
- **Operations and Maintenance:** The new CSO control technologies include mechanical equipment that is more labour-intensive, and with a potentially shorter service-life than what the current infrastructure would have. The O&M assessment includes the estimated annual O&M costs and an allowance for the periodic equipment replacement costs as they occur.
- **Startup:** The City is currently working on projects previously approved as part of the CSO and BFR program. These projects are similar to the CSO projects as they are based on sewer separation and will be well positioned for initiation of other separation work, but the City still recognizes the time required for approvals and provincial and federal funding commitments. Accordingly, the schedule has assumed two years for Provincial Approval and a further two year delay for the commitment of

long-term provincial and federal funding before initial implementation of the projects developed in the CSO Master Plan using the project sequencing provided.

- **Beneficial Uses:** The rivers running through Winnipeg are not recommended for recreational use in which sustained contact with the water occurs. It is not expected that the improvements in percent capture with implementation of the CSO program will improve the river water quality to change these recommendations.
- **Stakeholder Expectations:** The public has been engaged during the Preliminary Proposal phase at the public events held between 2013 and 2015. Further public communications work will continue as elements of the CSO Master Plan are initiated. Throughout this process it will be important to restate the improvements and existing issues surrounding CSOs as they occur, to educate the public of the improvements the CSO Master Plan will provide. It has been stated to the public in the past as part of these events that the complete removal of CSOs will not provide the level of bacteria removal necessary to recommend swimming in the river system. The complete removal of CSOs will also not impact the lack of clarity in the waters of rivers in Winnipeg. Large amounts of suspended soils inherit in the river system give the rivers their natural murky brown appearance. The removal of CSOs will also not significantly impact the nutrient loadings to the Lake Winnipeg watershed to prevent algae blooms. The primary contributors to nutrient loadings to Lake Winnipeg are from the Red River excluding the City Of Winnipeg, the Winnipeg River, and the Saskatchewan River systems.
- **Risks and Opportunities:** Longer implementation periods would tend to reduce many of the risks inherit to a capital program of this scale. The longer implementation period however would result in an escalation in market pricing due to inflation.

4.2 Program Scenarios

The purpose of multiple program scenarios is to provide a structure for evaluation of a broad range of program alternatives. In practice, however, the final range of scenarios was quite limited, because the projects were pre-selected and the application of the criteria and constraints limited the number of variables to be considered. The different program scenarios were therefore selected to specifically address different sources and levels of funding. This was found to be the primary criteria subject to large variations.

The program scenarios are as follows:

- **Scenario 1 – Shared Tri-Level Funding:** Tri-level funding agreement between the Government of Canada, Government of Manitoba and the City of Winnipeg, based on previous recommendations from the CEC Hearings (CEC, 2003). Under this scenario the City has an expectation that the entire program will be equally funded through a cost-sharing arrangement with the provincial and federal governments, at one-third equal funding contributions from each level of government. This scenario places a cap of $30 million per year on funding from each of the three levels of government ($90 million per year total), based on the City's $30 million affordability limit to support the CSO program.
- **Scenario 2 – Shared Bi-level Funding:** Bi-level funding agreement between the City of Winnipeg and either the Government of Manitoba or the Government of Canada. As a compromise to three-way sharing, the second scenario assumes that either one of the two senior levels of government will not participate in the funding arrangement. This has the effect of maintaining the same $30 million per year level of funding per year from two of the three levels of government ($60 million per year total) and extending the program until its completion.
- **Scenario 3 – City-only Funding:** This scenario assumes the two senior levels of government will not participate in shared funding, with the program being fully funded by the City at a limit of $30 million per year. The schedule would be extended as necessary at the fixed rate of funding to complete the program.

It should be noted that there are other multiple possible variances of scenarios such as delays in committed funding from other sources or they are partial and or inconsistent, which will impact schedules. There are risks associated with changes of government and associated policies and available funding. There are also risks associated with City committed funding as it is based on annual capital budget approval by council. The scenarios above however are considered to cover a broad range of possible scenarios.

A workbook tool was developed to assist in the development of the scenarios. A descriptive overview of this workbook is provided in Appendix D. Detailed figures from each of the scenario workbooks is provided in Appendix E. The scenarios are created to include four main components; the project details, O&M cost summary, capital cost summary, and a budget schedule. Further details on each of these components is described as follows:

Project Details

The project details include the following:

- Three control option categories are listed for each district (i.e., separation, in-line storage/latent storage/screening, and off-line storage). The percentage of separation and use of a control gate for in-line storage, latent storage, and screening is identified.
- Individual capital costs for the three types of control options are listed in 2019 dollar values.
- Performance estimates are individually listed for each control option in terms of annual capture volumes for the 1992 representative year.

Operations and Maintenance

The O&M summary includes the following:

- Annual O&M cost estimates are provided for each control option for each district where they apply.
- The annual O&M cost is based on the 2019 O&M estimate inflated to the year in which the control option is completed and operational.
- NPVs for O&M are provided for the projects, beginning after the project is complete and sequenced to continue over the implementation period.
- A budget summary of the O&M values is provided for the year in which the work takes place.

Capital Cost Summary

The capital cost and budget summary include the following:

- Capital cost totals in 2019 values for each control option for each district are provided, which includes the 53 percent markup on construction cost for engineering, burdens, and contingency.
- The CSO Master Plan includes a minus 50 percent to plus 100 percent range on the total capital cost, based on a Class 5 level of estimate.
- NPV for the projects, as sequenced over the implementation period.
- A budget summary of project values in their year of construction is provided.

Budget Schedule

The budget schedule is specific to each worksheet and includes the following:

- A timeline for project implementation and the respective project budgets for capital projects is included.
- A timeline for the annual additional O&M expenditure in the year in which each recommended solution is to be completed is included.
- A summary of annual project and O&M costs is included for all projects to illustrate the annual expenditures.

4.3 Implementation Considerations

The main objective of programming is to sequence and schedule the projects into an implementation plan that meets the program criteria and constraints. It also provides the opportunity to maximize or optimize the program for other considerations, such as cost-effectiveness or CSO capture performance.

The high-level scheduling considerations are as follows:

- The projects as part of the CSO and BFR program are a high priority. The City has committed projects at various stages of delivery based on previous benefit-cost analyses and these were approved and underway prior to issuance of EA No. 3042. The projects as part of this program provide demonstrated tangible benefits to residents, and a change to the sequence of these projects to accommodate CSO projects is not warranted.
- Opportunities such as GI and RTC also offer potentially low costs for CSO reduction, but these technologies also require research and validation prior to a commitment for full scale implementation. For this reason, the exact sequencing of these works as part of the program development was not considered.
- The use of NPV for project evaluation favours deferral of large expenditures and extended program durations. While this is true for the CSO program, there is little opportunity for adjustments because of the constant annual budgeting approach and duration being dictated by the rate of funding and funding scenario ultimately implemented.

Projects were selected to maintain a relatively uniform level of expenditure within the approximate implementation period based on the three funding scenarios identified in Section 4.2. Capital project sequencing was identified for the scenarios based on the following:

9) **Start-up**:

   Funding for the first four years of the program was limited to the City's contribution limit of $30 million. The delay accounts for a two year period to allow alterations to EA No. 3042 and a further two year period for the senior levels of government to arrange for their funding commitments necessary for the program.

10) **Committed Projects**:

   According to the criteria and constraints, the first priority is to complete the committed projects from the CSO and BFR program.

   Several CS districts have been identified for relief as part of this program, with the preferred method of relief being sewer separation, which provides the dual benefit of flooding reduction and CSO mitigation. Specific details for each of these committed projects are listed below:

   - Cockburn and Calrossie: Conceptual engineering has been completed and detailed design and construction is underway. Cockburn West is in the process of being completely separated, and completion of the project is required to leverage its full benefits.

     The Cockburn project is unique in that the project consultants have identified the use of in-line storage for Cockburn East. This will achieve the CSO program objectives without the need for its complete separation. The need for separation of Cockburn East to achieve BFR benefits was not part of the CSO project scope. In-line storage proposed for Cockburn East was evaluated to ensure it would not be detrimental to the existing level of basement flooding protection.

   - Ferry Road, Riverbend, Douglas Park and Parkside: These districts are bundled together for the CSO and BFR program, with works well underway. The design approach is for complete separation, which will continue for this scenario.

   - Jefferson East: This project is well underway. The design approach is for partial separation, which will continue under all scenarios for the CSO Master Plan.

- Armstrong: This district has also been considered a committed project with the CSO and BFR program because of its high cost-effectiveness in meeting CSO reduction. Some preliminary evaluations have taken place within the district.
- Mission: As a sewer district with a high level of industrial land use, there is an expectation that the water quality impacts would be significant relative to a residential or commercial area. An extensive sewer cleaning project and flow monitoring has been completed in this district. No sewer separation work under the CSO and BFR program is currently underway in this district, but has been prioritized to occur following the completion of other projects in the program.

The CSO study has not dealt with specific details for sequencing of the committed projects. Each of these has or will have a conceptual study to assess the exiting conditions and detailed upgrading requirements for establishing an implementation plan. It is common for the detailed plans to change as work progresses, and this degree of flexibility should be retained in the CSO program.

The sequencing and phasing assumptions for these separation projects was to prioritize based on the CSO volume which would be removed a result of the separation work. The large volume of work can most readily be achieved by assigning manageable size projects to multiple locations.

11) Additional Separation Projects:

Additional evaluations made to the initial project selections concluded that sewer separation should also be selected for several districts. These projects however are not committed to the CSO and BFR program.

These projects will be sequenced following the committed projects, as it has been identified that all sewer separation projects be sequenced before all new technologies being recommended. This will allow for sufficient time for these new technologies to be piloted and their performance evaluated. The additional sewer separation projects to be sequenced after the committed projects are listed below:

- Tuxedo: As a small distrct with partial separation, the cost of extending separation to the full district and avoiding use of in-line storage and sceening is cost-effective.
- Doncaster: Widening of the Route 90 - Kenaston Boulevard transportation corridor and the redevelopment of the Kapyong Barracks within the Doncaster district provides opportunites for complete separation. The CSO study has not investigated this redevelopment work in detail. This district should be further reviewed during the CSO Master Plan implementation to determine the feasibility to align with the expected future development schedule.
- Metcalfe, La Verendrye and Despins: These districts are each small in area in which partial separation has already occurred. As well in the case of the Metcalfe and Despins districts the primary outfalls cannot be screened due to hydraulic constraints, providing further incentive to complete the separation of these districts. Therefore, the cost of extending separation to the full district and avoiding use of in-line storage and sceening only has a small cost premium for these districts.
- Linden: The existing level of separation in the Linden district is approximately 87 percent by area . This results in separation being a cost-effective option, as compared to in-line storage previously recommended for the district.
- Tylehurst: This district was identified as a potential sewer separation candidate in the Preliminary Proposal. It was listed in the top ten priority districts to be relieved in the 1986 BFR report, but sewer relief has yet to be implemented. No sewer separation work under the BFR program is currently proposed in this district. As such this sewer separation will be programmed as the last of all separation projects to be completed.

The sequencing and phasing assumptions for these additional separation projects was to prioritize based on the CSO volume which would be removed a result of the separation work. These sequencing and phasing assumptions will be refined by staff within the City of Winnipeg as the CSO Master Plan is implemented and is subject to change.

12) **Partial Separation Projects:**

The partial separation projects are recommended for a variety of reasons, generally because of their connection to another project:

- Ash: To be completed on the Route 90 – Kenaston corridor upgrading schedule
- Jessie: Southeast Jessie is to be separated as part of the Cockburn BFR project.

The sequencing and phasing assumptions for these partial separation projects was to prioritize based on the CSO volume which would be removed a result of the separation work. These sequencing and phasing assumptions will be refined by staff within the City of Winnipeg as the CSO Master Plan is implemented and is subject to change.

13) **In-Line Storage, Gravity Flow Control and Latent Storage Projects:**

In-line storage, gravity flow control and latent storage generally provide the highest cost-effectiveness but concerns with operations and the reliability of the technologies must be resolved prior to their use. Because of their high cost-effectiveness, these projects are sequenced to be implemented after the committed projects, additional separation projects, and partial separation project are completed. At this point the evaluation and acceptance of the technologies will also have been completed.

Control gates are also an integral part of floatables screening and RTC.

The sequencing and phasing assumptions for these projects was to prioritize based on the CSO volume which would be removed a result of the separation work. These sequencing and phasing assumptions will be refined by staff within the City of Winnipeg as the CSO Master Plan is implemented and is subject to change.

14) **Tunnel and Off-Line Storage Projects:**

Tunnel and off-line storage are considered similar to each other from a project sequencing perspective, with neither taking a priority over the other.

Neither tunnel nor off-line storage are being applied for basement flooding improvements, and control gates are integrated into both to maximize their performance. The implementation of these solutions will follow with the implementation of the high cost effective in-line storage, latent storage and gravity flow control projects.

15) **Program Support Services:**

The CSO program will require a wide range of engineering and administrative services throughout its completion to support overall program management as described in the Section 4.5. They are expected to include the following:

- Technology Evaluation and Pilot Studies:
  - Control Gates
  - Screens
  - Flap Gate Control
  - Green Infrastructure
  - Real Time Control
- Alternative Floatables Management Demonstration Project and Pilot Study
- In-Situ Flow Monitoring Of Districts Before and After Control Options Implemented
- RTC Instrumentation Upgrades (as required) and SCADA Integration
- 2030 CSO Master Plan Update

Project support services will include one-off investigations as well as continual annual activities. The details will be established once the program is initiated. Cost allowances for these works have been included in the CSO Master Plan.

It is recommended that the analysis of the main technology evaluations and pilot studies are completed within the first ten years. This will provide confirmation that these proposed options are appropriate and suitable for the Winnipeg sewerage system. After this time the level of effort for support services is expected to reduce, and recommendations from the work will be incorporated into the already budgeted capital projects. Some level of support services will continue but has not been accounted for in the CSO Master Plan estimates.

16) **Green Infrastructure/Climate Change Resiliency Projects:**

GI has been addressed separately from the other control options. It has not been included in the base solutions because of unknowns and uncertainty with its application. The GI projects will provide the necessary additional performance improvements to mitigate any detrimental impacts from Climate Change on future precipitation trends. Further details on the approach to GI implementation can be found in Section 5.2.1 of this Part 2 Technical Report.

Review and evaluation of GI is included in the ten year technology investigations phase and is anticipated to be implemented from that point forward. An allowance of ten percent of the Master Plan capital costs has been included for its implementation.

17) **Unbudgeted Projects:**

The implementation strategy does not include capital or O&M allowances for wet weather flow treatment. This is assumed to be included as part of the WSTP.

The implementation strategy also does not consider any work required for the future migration to Control Option 2. The costs for this work will be considered in further detail as part of the 2030 CSO Master Plan update. This is detailed in further in Section 4.6 of this Part 2 Technical Report.

18) **Budgeting Allowance:**

A 100 percent budgeting allowance has been applied the estimated capital cost, and is included in the CSO Master Plan estimates for budgeting purposes.

4.4 Program Scenario Evaluation

The three scenarios were compared in the overall program format to determine the timeline and costs to complete. The comparisons took place after the proposed solutions were identified, and in adherence with the criteria and constraints listed in Section 4.2 and defined below. Each scenario incorporates the same projects, with the only material difference being the rate of funding and resulting project sequencing, and ultimately the length of implementation period. This process simplifies the comparative evaluation to assess the differences.

4.4.1 Scenario Budget Summary

All three scenarios will meet the intention of EA No. 3042 to capture 85 percent of CSOs for the 1992 representative year. The program is dependent on the level of funding received to complete this work. It can be completed under any of the funding scenarios identified, but the timeframe is extended as the level of funding decreases. $2.3 Billion was used as the total capital budget for assessment of each of the scenarios, and is explained in further detail in Section 3.6.1. A comparison of the implementation timeline and budget expenditures is shown in Table 4-1.

Table 4-1. Program Scenario Implementation Time Comparison

Program Scenario	Description	Funding by	Annual Budget	Total Capital Expenditure	Timeline
Scenario 1	3 Levels of Funding 3 x $30 Million	Tri-level Government of Canada, Manitoba Government and the City of Winnipeg	$90 Million	$3,667,000,000	27 years (2047)

Table 4-1. Program Scenario Implementation Time Comparison

Program Scenario	Description	Funding by	Annual Budget	Total Capital Expenditure	Timeline
Scenario 2	2 Levels of Funding 2 x $30 Million	Bi-Level City of Winnipeg and either the Manitoba Government or the Government of Canada	$60 Million	$4,482,000,000	39 years (2059)
Scenario 3	1 Level of Funding 1 x $30 Million	One Level City of Winnipeg Only	$30 Million	$8,285,000,000	75 years (2095)

The total capital expenditure demonstrates how the same $2.3 Billion capital budget, if projected over a longer period of time, results in a much larger cumulative dollar total. This is due to the impacts of construction inflation from delaying planned work further into the future. The effect of time extensions is to increase the annual budgets in the year of expenditure but reduce the NPV overall. All values are inflated to the year they are planned to take place. This is further illustrated in Table 4-2.

Table 4-2. Program Scenario NPV Capital and O&M Cost Comparison

Scenario	Capital Expenditure	NPV of Capital Expenditures	Total of Additional O&M Costs (Extended Until 2100)	NPV of Total Additional O&M Costs (Extended Until 2100)	Total NPV Of Capital Expenditures + O&M Extended to 2100
Scenario 1	$3,667,000,000	$1,534,000,000	$1,367,000,000	$61,000,000	$1,595,000,000
Scenario 2	$4,482,000,000	$1,336,000,000	$1,246,000,000	$42,000,000	$1,378,000,000
Scenario 3	$8,285,000,000	$936,000,000	$543,000,000	$11,000,000	$947,000,000

Each of the scenarios has a specific net present value (NPV), which accounts for capital costs, operation and maintenance costs and their year of expenditure. Each scenario has a specific timeline including the year all control solutions are in operation, with Scenario 1 being the earliest due to the increased level of funding.

The total and NPV for the additional O&M costs anticipated are shown for each scenario, and also reflects the implementation timeline. The O&M costs associated with each project are extended to the year 2100 in order to compare the scenarios with all projects complete. All additional O&M cost estimates extend from the year after project completion to the year 2100. In reality, these O&M costs will continue for the life of the infrastructure.

Table 4-3 illustrates the average additional annual O&M costs for each scenario in the year following the completion of all projects. Any changes to the project sequencing will change the projections shown for Capital and O&M costs. This provides an estimate of overall impact on year to year operations as a result of implementation of the solutions recommended to meet Control Option No. 1.

Table 4-3. Additional Annual O&M Costs For Each Program Scenario

Scenario	Year all Control Options are in Operation (CO Completion Year)	Additional Annual O&M Costs After CO Completion Year	Additional Annual O&M Costs after CO Completion Year in 2019 Dollars
Scenario 1	2048	$10,600,000	$4,500,000
Scenario 2	2060	$15,100,000	$4,500,000
Scenario 3	2096	$44,000,000	$4,500,000

All O&M costs shown in the above evaluation are specific to the CSO Master Plan projects and do not include additional O&M costs for existing infrastructure.

4.4.1.1 Definition of Scenario Cost Terms

Each of the scenarios will have a specific NPV, which accounts for capital costs, operation and maintenance costs and their year of expenditure. NPV is commonly used to compare engineering projects, with the lowest NPV being one of the key evaluation criteria. The effect of time extensions is to increase the annual budgets due to inflation to the year of expenditure but reduce the NPV overall.

1) **Inflation:** Annual inflation has a major impact on annual budgets. The evaluation adds the fixed percentage of inflation to the capital and O&M costs and determines the costs in terms of the actual year the project is sequenced to occur.

   The average annual inflation rate fluctuates over time, with recent inflation rates for consumer goods being less than two percent. For the CSO program construction inflation is more relevant and has historically exceeded the consumer rate of inflation. An average annual inflation rate of three percent has been selected for the evaluation of capital costs and O&M budgets.

2) **Discount Rate:** A simple definition of the discount rate is; the rate of return required on a project when inflation is removed. For public projects, this is referred to as the social discount rate, and a fixed value of three to four percent is commonly used. In theory, if the rate of return associated with a project is lower than this amount, other competing projects will have more benefits and be of higher priority for approval. An average annual discount rate of three percent has been selected for the evaluation of capital costs and O&M budgets.

3) **Net Present Value:** Present value converts the future capital and O&M costs to a single equivalent amount. The term NPV is used instead of PV only to maintain consistency with the naming convention within the workbook tool. NPV is established as rate of annual inflation plus the discount rate (for example, three percent inflation plus three percent discount rate produces a six percent NPV rate). For the CSO program, the year 2019 is used as the base year for present value comparisons. An average annual NPV rate of six percent has been selected for the evaluation of capital costs and O&M budgets, based on the previously selection inflation and discount rates.

4.4.2 Scenario 1 – Tri-Level Funding

The shared funding scenario assumes three-way sharing of funding between the three levels of government, with the upper limit being an annual funding level of $30 million per year from each level of government, totaling $90 million per year capital funding.

4.4.2.1 Scenario 1 Capital Budgets

Scenario 1 is based on equally shared cost by the three levels of government for a total of $90 million per year. The programming goal was to develop relatively uniform annual budgets in 2019-dollar values after accounting for the initial funding gap for the startup period.

The 2019-dollar value annual budgets are shown in Figure 4-2. As can be seen in the figure a near constant funding of $90 million dollars is maintained.

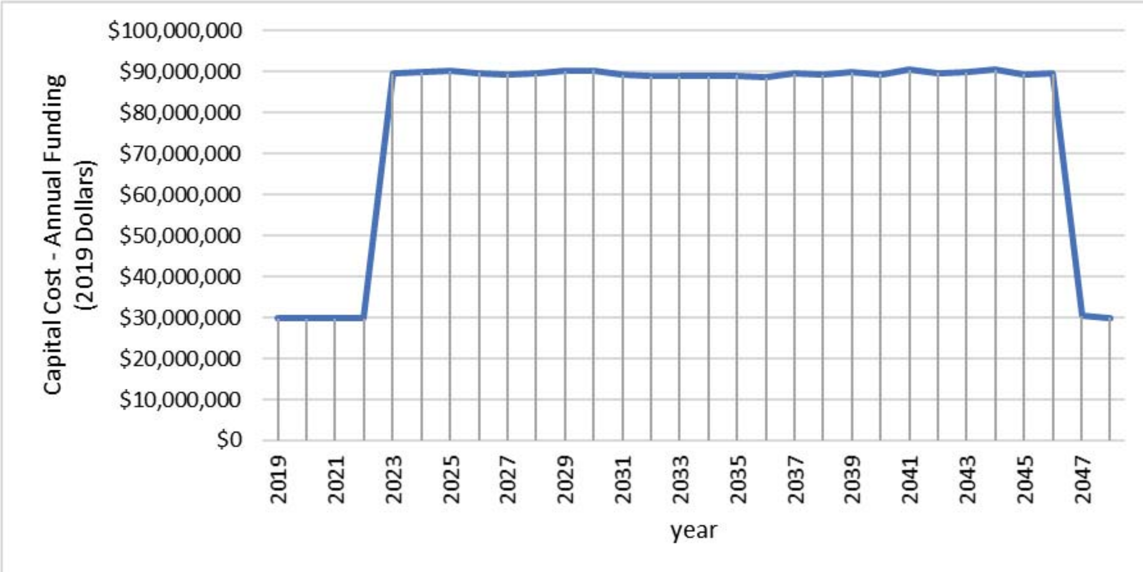

Figure 4-2. Scenario 1 Annual Capital Budget (2019-dollar value)

Figure 4-2 shows the annual budget varying slightly from year to year which is a result of discrete project costs that cannot readily be smoothed out to accommodate uniform budgeting. The overall budget is approximately $90 million in 2019 dollars. The implementation costs are not allowed to exceed the budget for each year of the program.

The annual capital budget values inflated at three percent per year are shown in Figure 4-3. The inflated values show the increase to the annual budget over the implementation time period. The maximum annual capital budget shared by the three levels of government in the second last year in 2046 is $199,000,000.

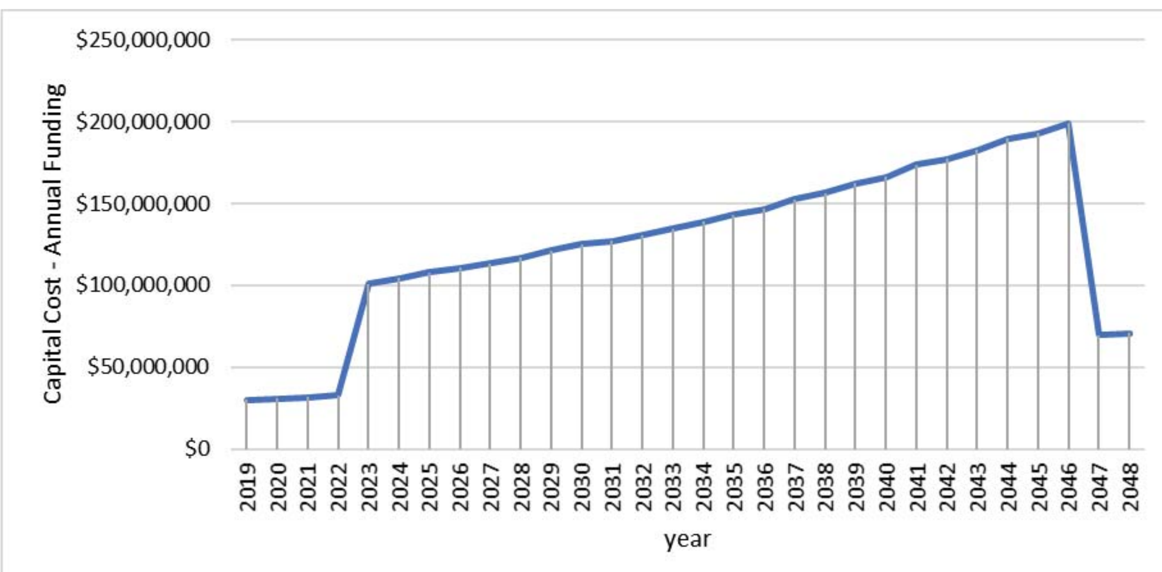

Figure 4-3. Scenario 1 Capital Budget Inflated at Three Percent Annually

The Scenario 1 budget in 2019-dollar values plotted on a cumulative basis is shown in Figure 4-4. The projects are sequenced by year in the budget schedule, per the project sequence determined during the program development, and they show the budget value for the year of construction. Based on an escalation of three percent per year, the total for the future budget amounts is $3,667,000,000.

The NPV for Scenario 1 is $1,534,000,000 based on a six percent discount rate.

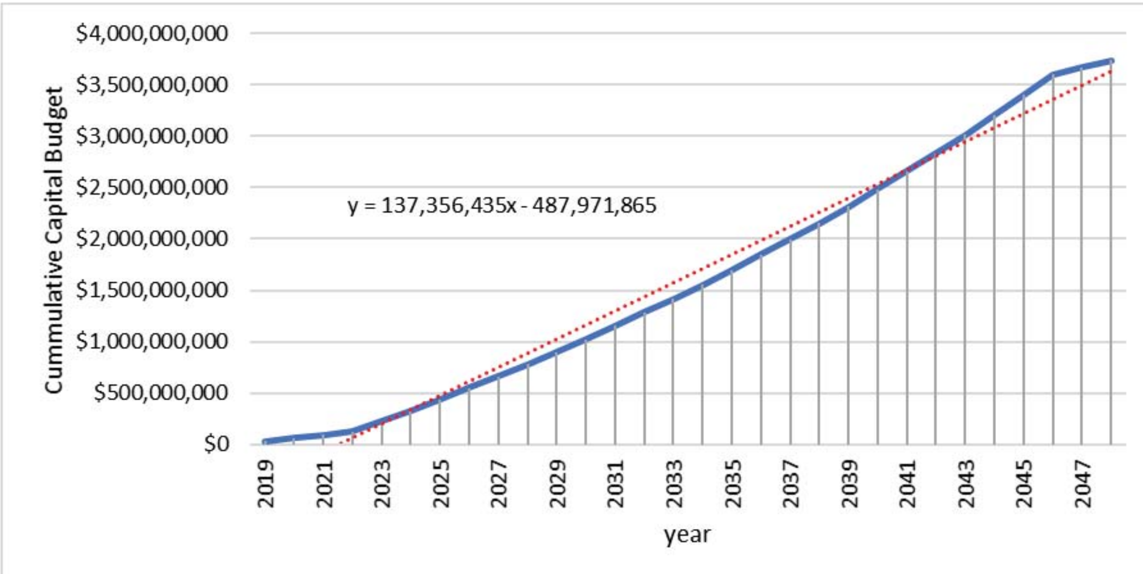

Figure 4-4. Scenario 1 Cumulative Capital Budget with Three Percent Inflation

Figure 4-2 shows that the implementation of Scenario 1 can be completed within 27 years with an annual budget of approximately $90,000,000, with provision for delayed full commencement due to license approval and funding confirmation periods. The annual costs under the assumption of three-way capital cost sharing between the three levels of government will be within the $30,000,000 affordability limit identified by the City.

4.4.2.2 Scenario 1 Operations and Maintenance Budget

The operating and maintenance costs are considered separate from the capital cost budget. There is no target budget value for O&M similar to the $30 million capital budget, as operation and maintenance costs are a function of the control technologies selected. The annual budgets in terms of 2019 dollar values are shown in Figure 4-5.

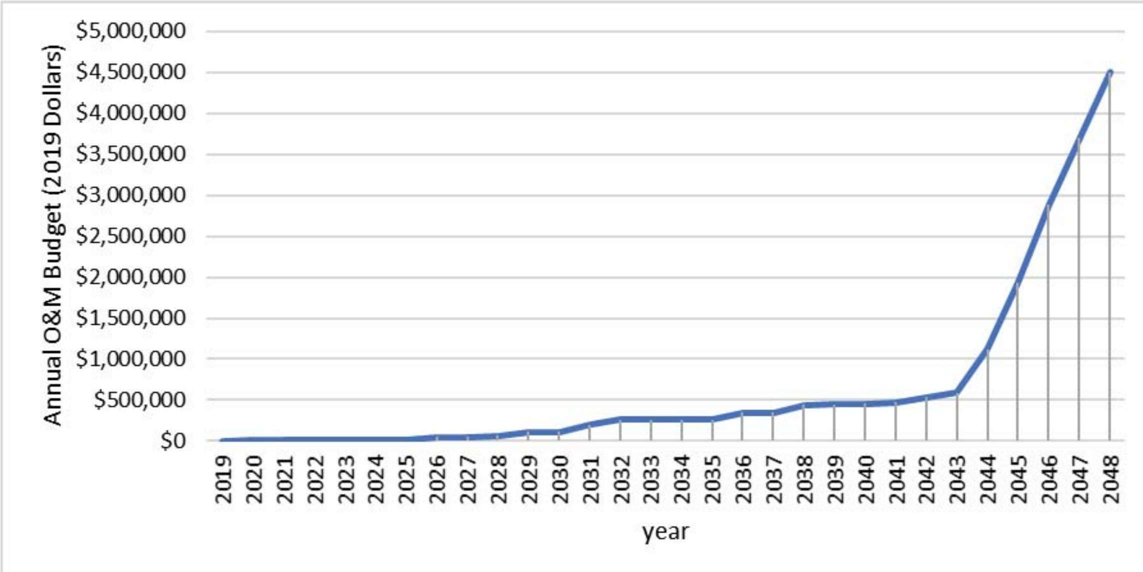

Figure 4-5. Scenario 1 Annual O&M Budget (2019-dollar value)

Projects with higher O&M requirements have been scheduled to take place later in the program, which is reflected in the figure. The steep rise in the operating budget results from the cumulative effect of having to operate and maintain new infrastructure with the more O&M intensive projects scheduled later in the program. The completion of the program will result in an additional annual O&M cost of $4,500,000 per year in 2019 dollars by the year 2048 in which all projects are complete and operational.

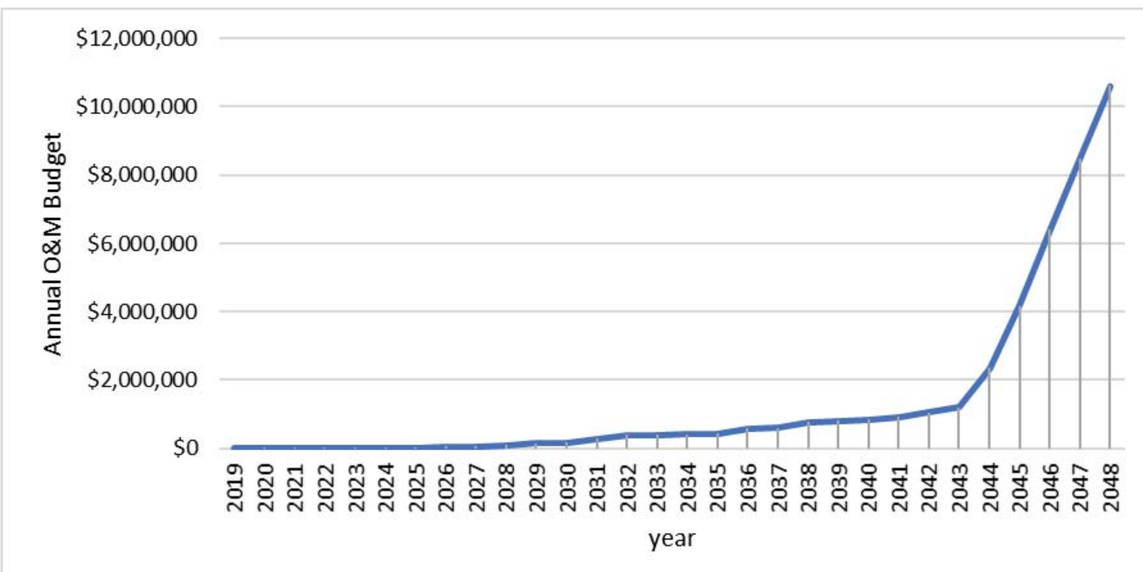

Figure 4-6. Scenario 1 O&M Budget Inflated at Three Percent Annually

The estimated O&M costs shown in Figure 4-6 have been inflated to the year of expenditure at three percent annual escalation. The inflated annual cost of O&M, at the end of the implementation period, with all the works in place and operational is estimated to be approximately $10,600,000 per year in 2048 dollar values.

4.4.2.3 Scenario 1 Performance

The reduction in CSOs is relatable to the implementation period for Scenario 1 and the reductions are assumed to occur as the projects are completed. This reduction in the annual CSO volume is shown in Figure 4-7. This shows that the 85 percent capture target will be met in the year 2047.

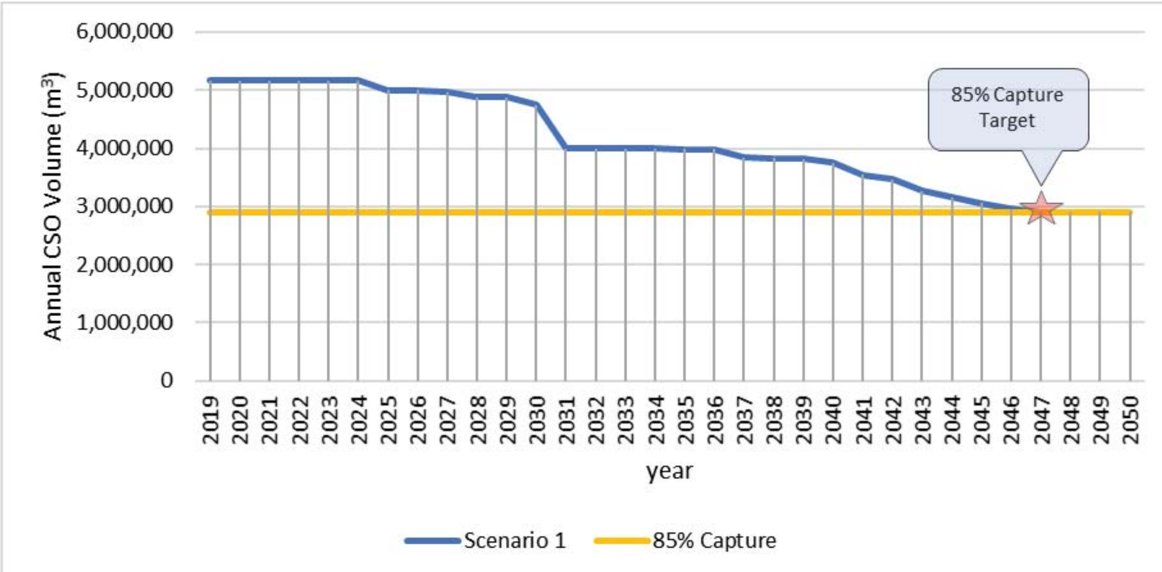

Figure 4-7. Scenario 1 Annual CSO Discharges

4.4.3 Scenario 2 – Bi-level Funding

Funding for this scenario will be by the City and one of either the provincial or federal governments at $30 million per year each. The net effect is to extend the implementation period beyond the December 31, 2045, date listed in EA No. 3042.

4.4.3.1 Scenario 2 Capital Budgets

The Scenario 2 program is based on equally shared cost by the two levels of government for a total of $60 million / year. The programming goal was to develop relatively uniform annual budgets in 2019-dollar values after accounting for the initial funding gap for the startup period.

The 2019-dollar value annual budgets are shown in Figure 4-8. As can be seen in the figure a near constant funding of $60 million dollars is maintained.

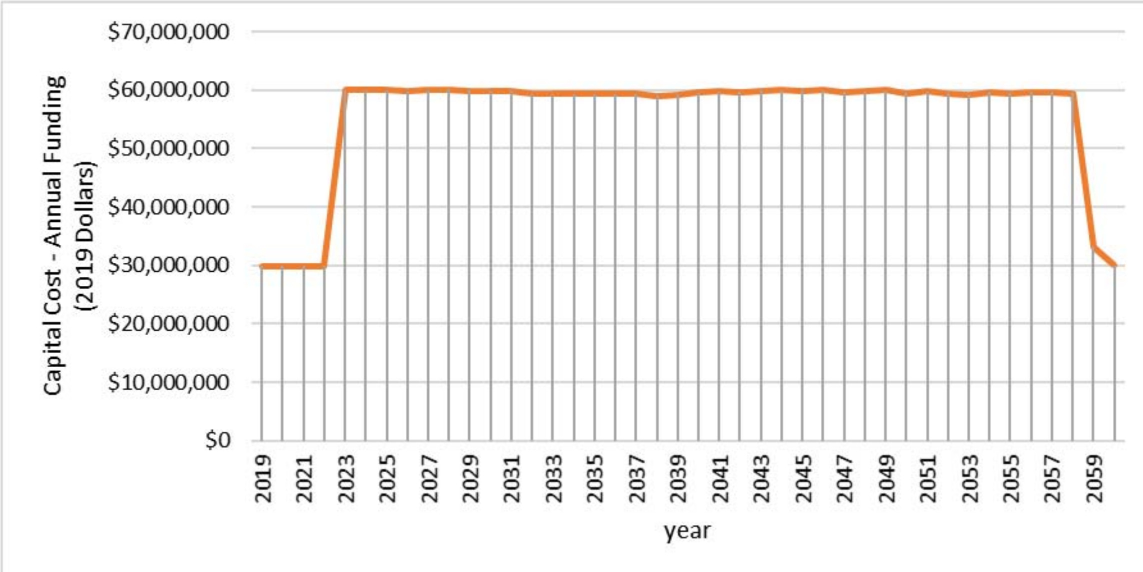

Figure 4-8. Scenario 2 Annual Capital Budget (2019-dollar value)

Figure 4-8 shows the annual budget varying slightly from year to year which is a result of discrete project costs that cannot readily be smoothed out to accommodate uniform budgeting. The overall budget is approximately $60 million in 2019 dollars. The implementation costs are not allowed to exceed the budget for each year of the program.

The annual capital budget values inflated at three percent per year are shown in Figure 4-9. The inflated values show the increase to the annual budget over the implementation time period. The maximum annual capital budget shared by the two levels of government in 2058 is estimated at $188,500,000.

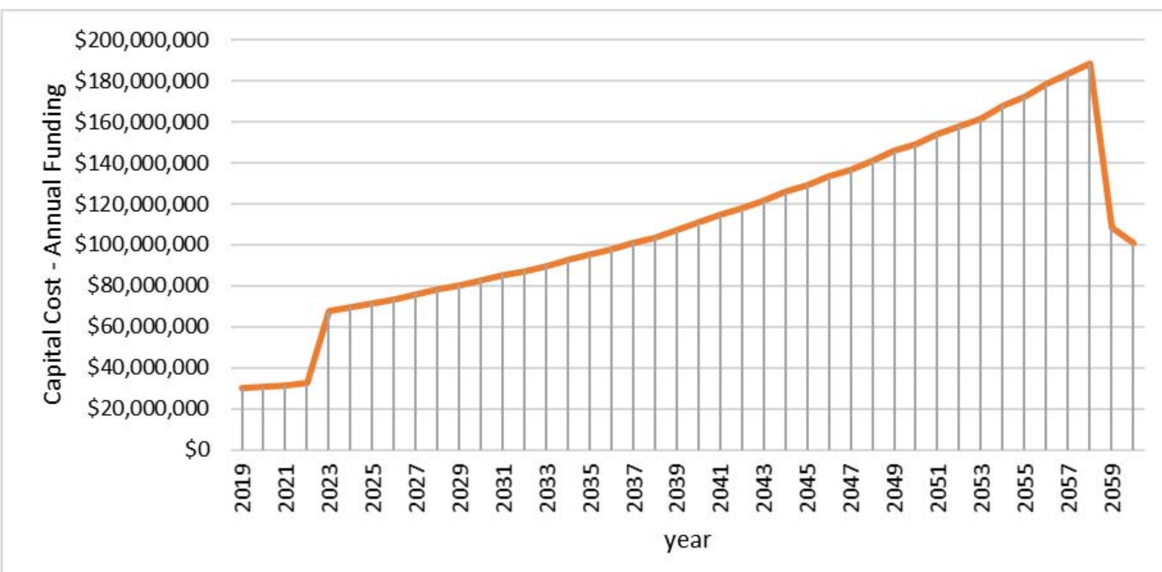

Figure 4-9. Scenario 2 Capital Budget Inflated at Three Percent Annually

The Scenario 2 budget in 2019-dollar values is plotted on a cumulative basis shown in Figure 4-10. The projects are sequenced by year in the budget schedule, per the project sequence determined during the program development, and they show the budget value for the year of construction. Based on an escalation of three percent per year, the total for the future budget amounts is $4,482,000,000 in the year 2059.

The NPV for Scenario 2 is $1,336,000,000 based on a six percent discount rate.

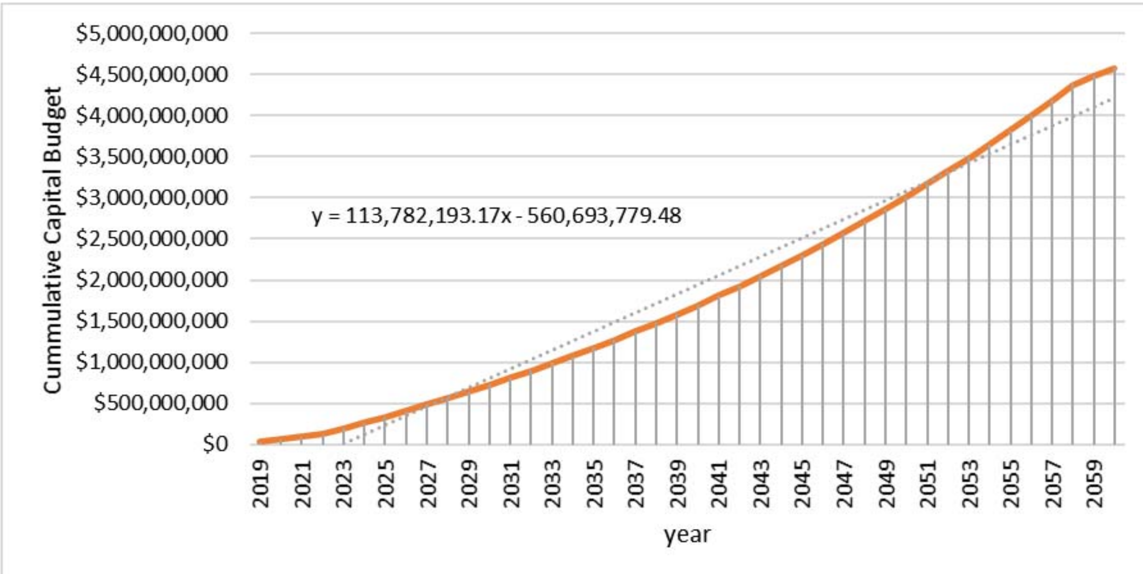

Figure 4-10. Scenario 2 Cumulative Capital Budget with Three Percent Inflation

Figure 4-8 shows that the implementation of the CSO Master Plan can be completed within 38 years with an annual budget of approximately $60,000,000, with provision for delayed full funding commencement due to license approval and funding confirmation periods. The annual costs under the assumption of two-way capital cost sharing between two levels of government will be within the $30,000,000 affordability limit identified by the City.

4.4.3.2 Scenario 2 Operations and Maintenance Budget

The operating and maintenance costs are considered separate from the capital cost budget. There is no target budget value for O&M similar to the $30 million capital budget, as operation and maintenance costs are a function of the control technologies selected. The annual budgets in terms of 2019 dollar values are shown in Figure 4-11.

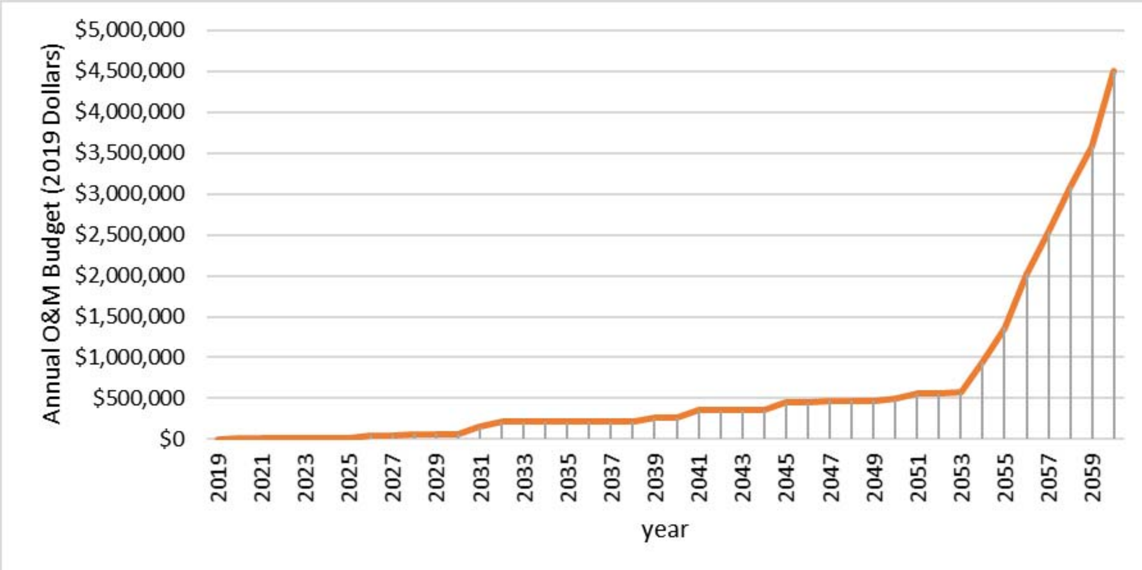

Figure 4-11. Scenario 2 Annual O&M Budget (2019-dollar value)

Projects with higher O&M requirements have been scheduled to take place later in the program, which is reflected in the figure. The steep rise in the operating budget results from the cumulative effect of having to operate and maintain new infrastructure with the more O&M intensive projects scheduled later in the program. The completion of the program will result in an additional annual O&M cost of $4,500,000 per year in 2019 dollars by the year 2060 in which all projects are complete and operational.

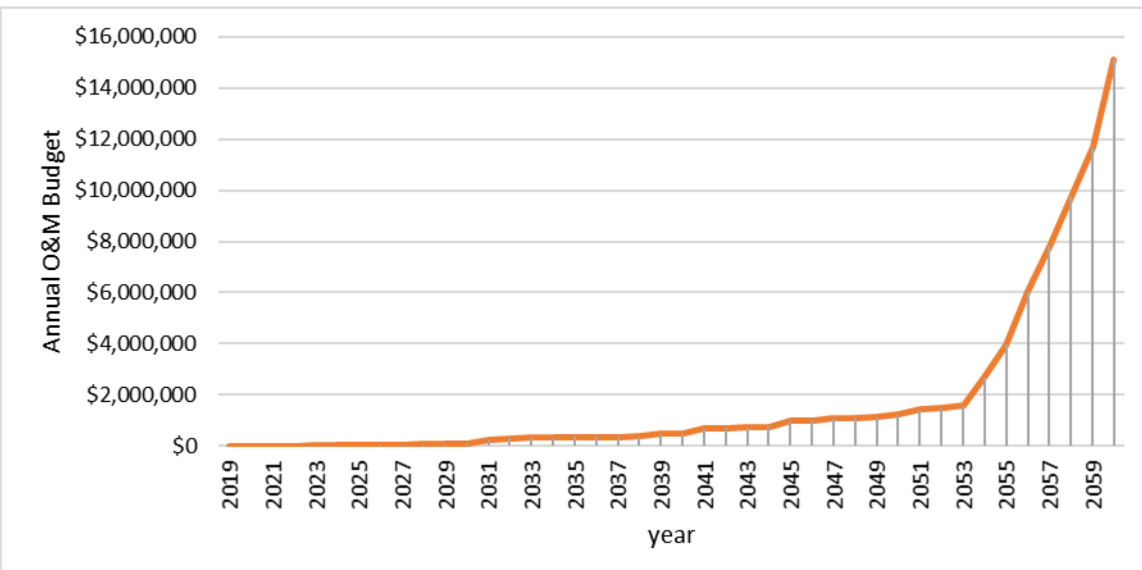

Figure 4-12. Scenario 2 O&M Budget Inflated at Three Percent Annually

The estimated O&M costs shown in Figure 4-12 have been inflated to the year of expenditure at three percent annual escalation. The inflated annual cost of O&M, at the end of the implementation period, with all the works in place is estimated to be approximately $15,100,000 per year in 2060 dollar values.

4.4.3.3 Scenario 2 Performance

The reduction in CSOs is relatable to the implementation period for Scenario 2 and the reductions assumed to occur as the projects are completed. This reduction in the annual CSO volume is shown in Figure 4-13. This shows that the 85 percent capture target will be met in the year 2059.

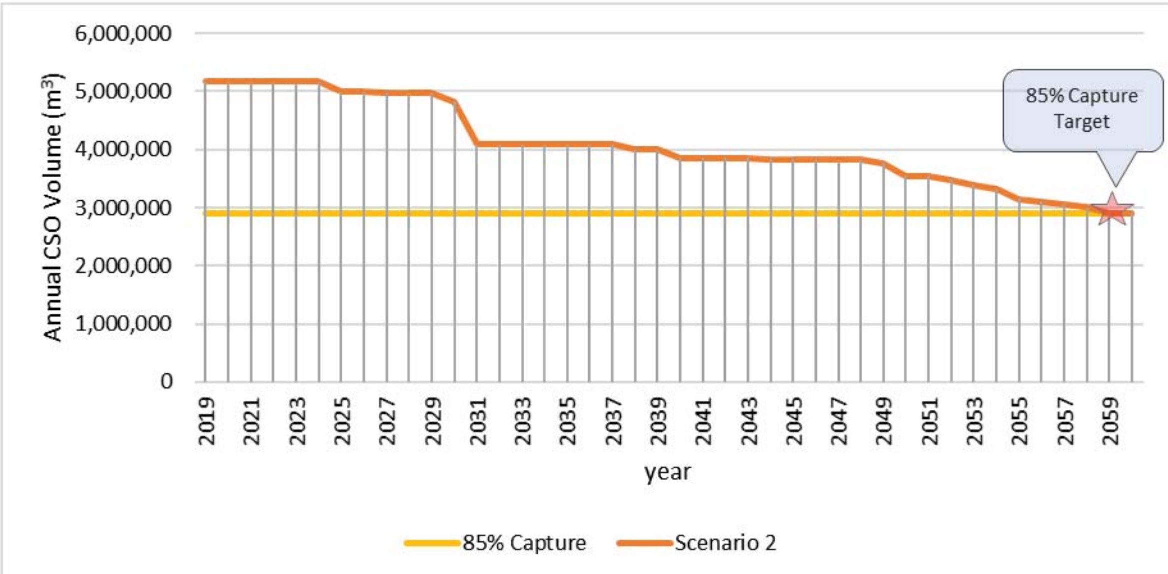

Figure 4-13. Scenario 2 Annual CSO Discharges

4.4.4 Scenario 3 – City-only Funding

The City would be the sole source of funding for this scenario at $30 million per year. The net effect is to further extend the implementation period beyond December 31, 2045, as listed in EA No. 3042.

4.4.4.1 Scenario 3 Capital Budgets

The Scenario 3 program is based on City funding only for a total of $30 million / year. The programming goal was to develop relatively uniform annual budgets in 2019-dollar values after accounting for the initial funding gap for the startup period.

The 2019-dollar value annual budgets are shown in Figure 4-14. As can be seen in the figure a near constant funding of $30 million dollars is maintained.

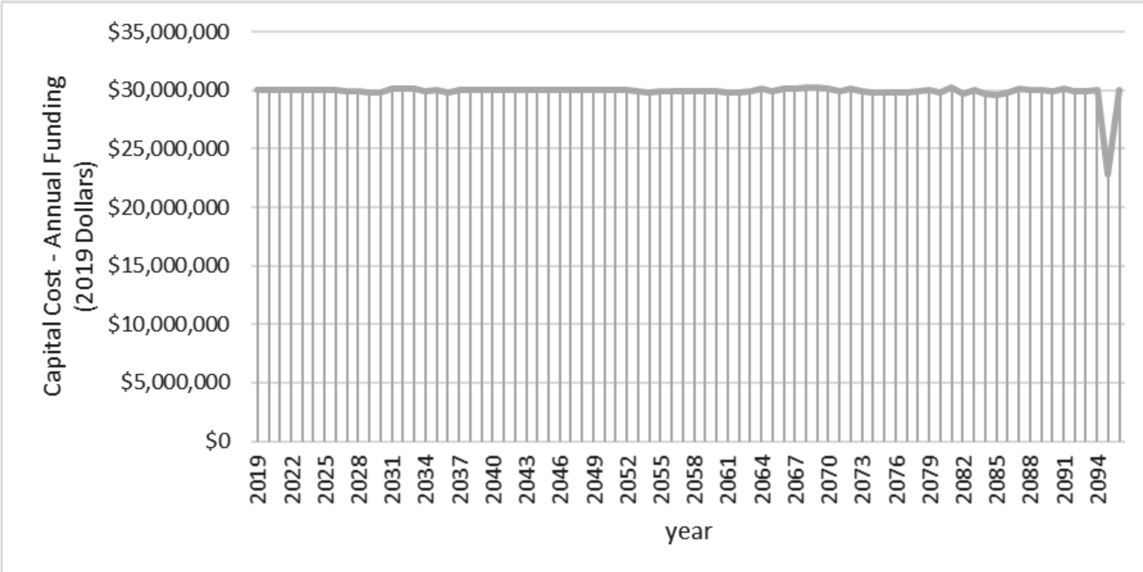

Figure 4-14. Scenario 3 Annual Capital Budget (2019-dollar value)

Figure 4-14 shows the annual budget varying slightly from year to year which is a result of discrete project costs that cannot readily be smoothed out to accommodate uniform budgeting. The overall budget is approximately $30 million in 2019 dollars. The implementation costs are not allowed to exceed the budget for each year of the program.

The annual capital budget values inflated at 3 percent per year are shown in Figure 4-15. The inflated values show the increase to the annual budget over the implementation time period. The annual capital budget in 2094 is $275,800,000.

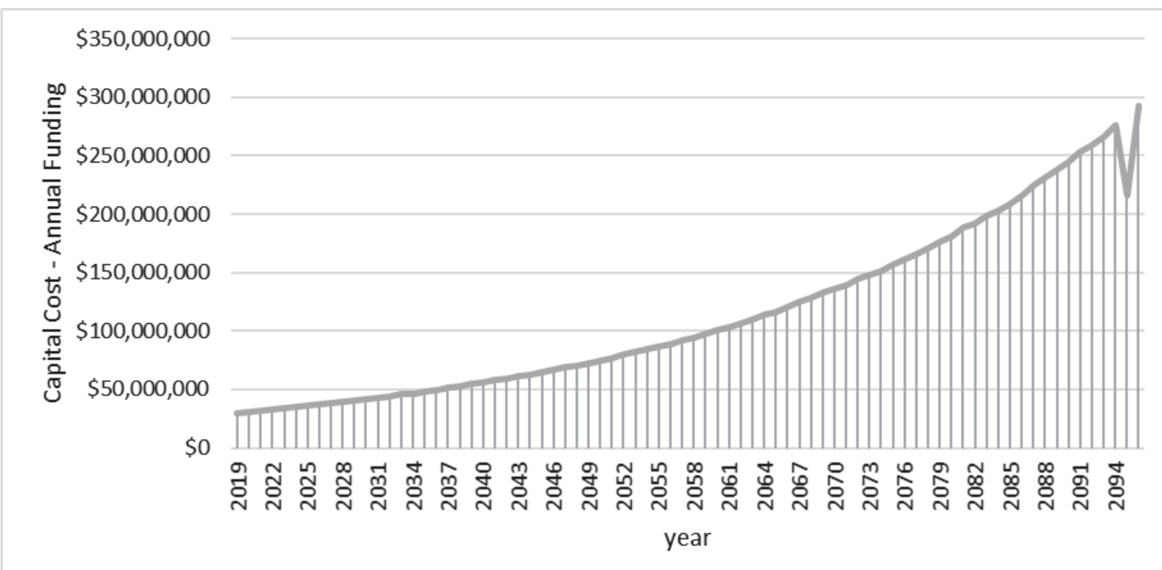

Figure 4-15. Scenario 3 Capital Budget Inflated at Three Percent Annually

The Scenario 3 budget in 2019-dollar values plotted on a cumulative basis is shown in Figure 4-16. The projects are sequenced by year in the budget schedule, per the project sequence determined during the program development, and they show the budget value for the year of construction. Based on an escalation of three percent per year, the total for the future budget amounts is $8,285,000,000.

The NPV for Scenario 3 is $936,000,000 based on a six percent discount rate.

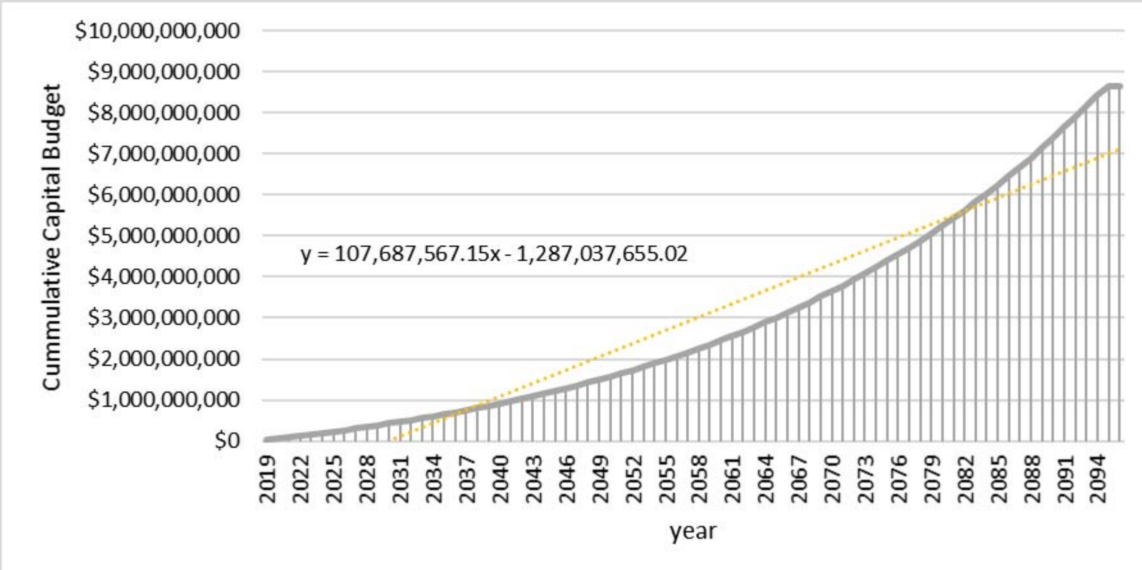

Figure 4-16. Scenario 3 Cumulative Capital Budget with Three Percent Inflation

Figure 4-14 shows that the implementation of Scenario 3 can be completed within 73 years with an annual budget of approximately $30,000,000. The City of Winnipeg funding remains at $30,000,000 per year with no cost sharing.

4.4.4.2 Scenario 3 Operations and Maintenance Budget

The operating and maintenance costs are considered separate from the capital cost budget. There is no target budget value for O&M similar to the $30 million capital budget, as operation and maintenance costs are a function of the control technologies selected. The annual budgets in terms of 2019 dollar values are shown in Figure 4-17.

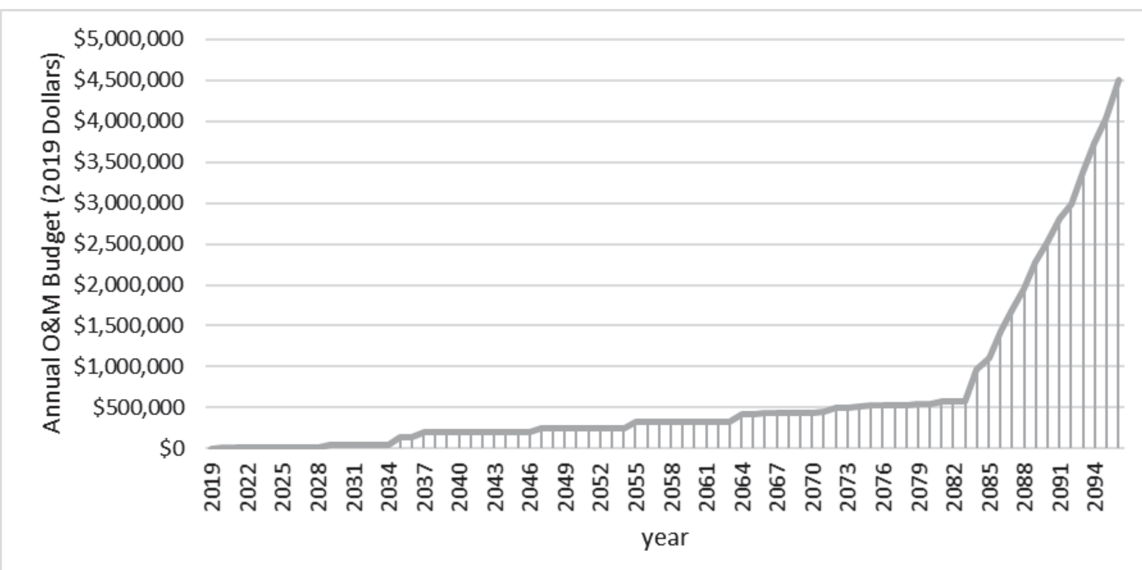

Figure 4-17. Scenario 3 Annual O&M Budget (2019-dollar value)

Projects with higher O&M requirements have been scheduled to take place later in the program, which is reflected in the figure. The steep rise in the operating budget results from the cumulative effect of having to operate and maintain new infrastructure with the more O&M intensive projects scheduled later in the program. The completion of the program will result in an additional annual O&M cost of $4,500,000 per year in 2019 dollars by the year 2096 in which all projects are complete and operational.

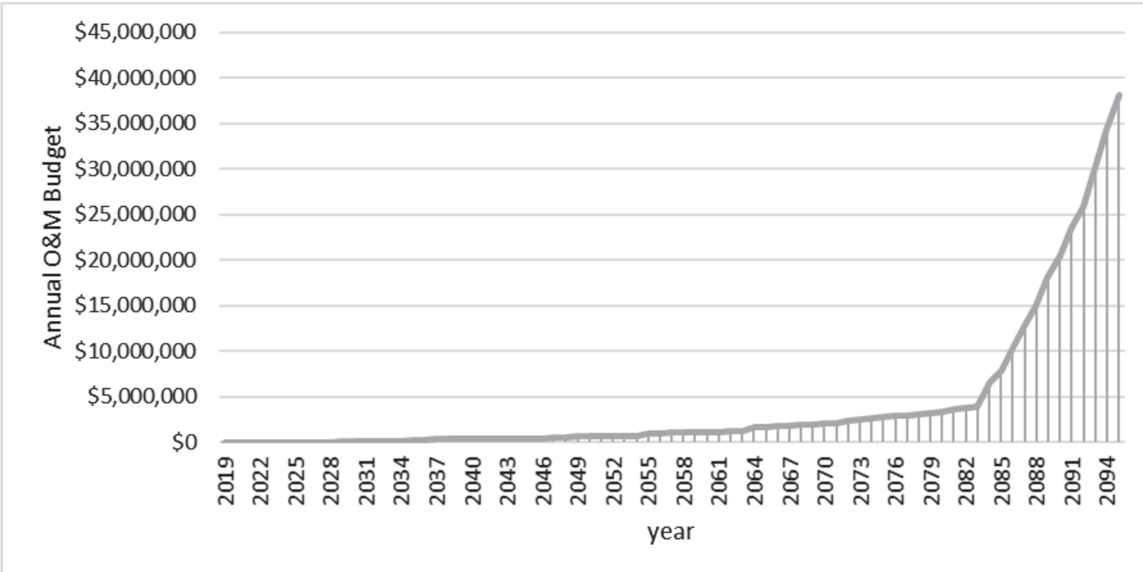

Figure 4-18. Scenario 3 O&M Budget Inflated at Three Percent Annually

The estimated O&M costs shown in Figure 4-18 have been inflated to the year of expenditure at three percent annual escalation. The inflated annual cost of O&M, at the end of the implementation period, with all the works in place and operational is estimated to be approximately $43,700,000 per year in 2096 dollar values.

4.4.4.3 Scenario 3 Performance

The reduction in CSO is relatable to the implementation period for Scenario 3 and the reductions assumed to occur as the projects are completed. This reduction in the annual CSO volume is shown in Figure 4-19. This shows that the 85 percent capture target will be met in the year 2095.

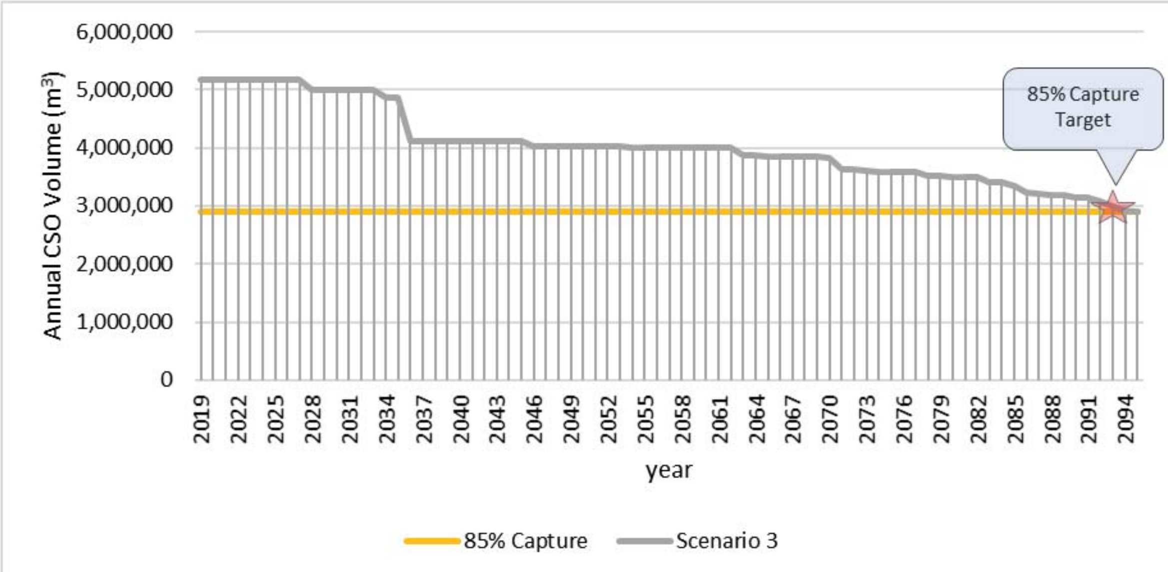

Figure 4-19. Scenario 3 Annual CSO Discharges

4.5 Program Management

Once the CSO Master Plan is initiated, the City will take on responsibility for the implementation of a large-scale, long-term program. Programs of this size and complexity typically require dedicated resources, either with internal staff or by engaging external program management support.

Since program management is a required component of implementation it should be accounted for in the CSO Master Plan. This has been done by allocating a two percent allowance of the estimated construction costs within the capital projects estimates. The City will be responsible for defining the scope and assigning responsibilities prior to the services being required.

A general review of the program management tasks and responsibilities is provided below to support this future activity, with many of these tasks being dependent on future decisions:

- **Administration:** The CSO program will require a high level of administration for budgeting, accounting and reporting of routine activities.
- **Engineering Investigations:** The CSO Master Plan project implementation schedule includes assumptions that the review and acceptance of new technologies associated with some of the control solutions be completed within the implementation phase prior to some projects commencing. These include review of control gates, flap gate control, screens, floatables management approach, RTC and GI. Each of these will be smaller side-stream projects within the program and may require pilot testing or demonstration projects for each new technology.
- **Planning:** A continual process will be required to identify and account for changes to service areas, technologies, standards and expectations, and prepare for project implementation. Land acquisition and preliminary studies may need to take place several years before actual construction can begin. Additionally, public information has to be rolled out to ensure all stakeholders involved are properly informed. The planning projections used as part of this study will need to be continually re-evaluated to ensure they are consistent with actual growth.
- **Coordination:** The CSO Master Plan program will impact and be impacted by other programs and services ongoing within the City of Winnipeg Water and Waste Department. By integration of the projects within the CSO and BFR program, the parameters for project prioritization and selection are affected. Additionally, large scale developments can impact option selection and implementation scheduling. Coordination of the CSO Master Plan works must also occur with the upgrades to the STPs to confirm that customer billing rates are consistent and remain affordable. Projects related to the CSO

Master Plan should be coordinated with street works to realize synergies and cost savings where possible.

- **Project Delivery:** Alternative methods of project delivery may need to be considered for the large capital project investments projected in this CSO Master Plan program. This includes how supplemental studies related to specific projects in this CSO Master Plan are carried out and by whom. The DEPs, as part of this CSO Master Plan, will be heavily relied upon to educate Consultants and Contractors of the overall vision for CSO mitigation in a particular district. These plans will be further updated as conceptual and preliminary design of these solutions is pursued.
- **Risk Management:** As with any large program there are multiple risks and opportunities to be considered and dealt with. These will require careful management of risk responses and contingency budgets.
- **Regulatory Liaison:** The City has a responsibility for reporting and responding to MSD on all matters related to EA No. 3042. Documentation of the benefits each project contributes in terms of percent capture will be essential to keep MSD informed on progress over time.
- **Public Engagement:** It will be important to provide public notifications for large scale construction works related to the CSO Master Plan projects, which affect infrastructure the public readily uses, such as major transportation routes.
- **Master Plan Maintenance:** The CSO Master Plan is intended to be a living document. Information will be updated as projects are completed, and new developments or redevelopments within districts occur. Periodic reprioritization of projects may be necessary to address new developments or redevelopments.
- **Master Plan Update:** A formal update of the CSO Master Plan to demonstrate the process to migrate to Control Option No. 2 is required under EA No. 3042 by April 30, 2030. The scope and level of effort has yet to be established and will be a future phase of the CSO Master Plan.

4.6 Control Option No. 2 Migration

MSD completed its review of the City's CSO Master Plan Preliminary Proposal submitted in December 2015, with a letter response dated November 24, 2017. The response indicated that the document and additional information prepared subsequent to its submission met the intent of Clause 11 of EA No. 3042. The letter provided the Director's approval for the Preliminary Proposal recommendations, with the condition that "Control Option No. 1 be implemented in such a way so that Control Option No. 2 may be eventually phase in." The letter required that the final CSO Master Plan for Control Option No.1 - 85 Percent Capture In A Representative Year be submitted by August 31, 2019, and by April 30, 2030 for Control Option No. 2: Four Overflows In A Representative Year.

- **Control Option No. 1 – 85 Percent Capture in a Representative Year:** This system-wide performance measure aligns with the City's current plans to continue with sewer separation in CS districts. It also accommodates selection of the most cost-effective projects in other districts. The plan proposes that every one of the 41 combined sewer districts will have at least some level of CSO control, but it will result in a wide range of performance. If it were most cost effective to have all CSO control within only a portion of the districts, this would be allowed with the percent capture performance measure.
- **Control Option No. 2 – Four Overflows in a Representative Year:** This option requires a maximum of four overflows in a representative year for each district. Projects completed in districts to achieve the Control Option No. 1 performance may have to be further upgraded to meet the increased performance target. Projects in districts that are shown to have a low cost benefit may have to be completed.

Migration from Control Option No. 1 to Control Option No. 2 is now a requirement of the CSO Master Plan program. The City has reviewed this additional requirement and has discussed and documented the potential impacts with MSD. The CSO program will have to adapt to meet the additional requirements associated with the water quality performance of this option as identified in the Preliminary Proposal.

The City raised concerns that the migration approach is not cost-effective, and not in keeping with the aspiration goal of eliminating all CSOs in the long term. Potential impacts associated with upgrading to Control Option No. 2 are as follows:

- The performance metric changes from a system-wide to a district-based limit, meaning that each district would be required to meet a four overflow limit for the representative year. To achieve this, the configuration of projects changes for Control Option No. 2. This reconfiguration to meet the Control Option No. 2 performance target is not directly aligned with the project configuration for Control Option No. 1 and projects completed as part of meeting 85 percent capture would not necessarily be useful in meeting the long term water quality objective.
- It would require a higher level of control, increasing to an equivalent level of capture of approximately 98 percent as compared to 85 percent for Control Option No. 1. The exact percentage needs to be confirmed and agreed with MSD prior to the 2030 submission and needs to meet the equivalent water quality bacterial performance reduction as Control Option No. 2 presented in the Preliminary Proposal

A compromise approach of migrating to a 98 percent capture value, and maintaining a percent capture target approach was proposed. This has been reviewed based on the data available from the Preliminary Proposal and is expected to provide similar overall CSO performance to Control Option No. 2. This would then avoid throw-away costs by allowing for contiguous projects following the same performance metric and establish a path for complete separation.

MSD requires equivalent river water quality performance with regards to bacteria for any control alternative in order to demonstrate compliance. It is possible that a percent capture target above 98 percent capture could be required for compliance. The City understands that the future expandability of the program is important to meet future regulatory requirements; therefore, the City has chosen to move ahead with a plan that will maintain percent capture as the performance measure.

4.6.1 Master Plan Approach to Migration

Changing to a higher level of control during the implementation of the CSO Master Plan creates additional risk for the master planning process. Risks are mainly associated with the types of control option projects completed and the ability of those projects to adapt and continue to contribute effectively to the overall percent capture targets. The approach taken in the CSO Master Plan is to maintain an expandable percent capture program. In order to most effectively apply this approach, the initial projects identified for completion during the CSO Master Plan implementation are sewer separation which is considered lower risk when considering an increasing percent capture target. The contributing benefit from sewer separation does not change if the level of control increases. Sewer separation projects are aligned with the City's percent capture approach to achieving the higher control limit required for Control Option No. 2 – Four Overflows in a Representative Year.

In order to maintain an expandable percent capture program, the City of Winnipeg is required to demonstrate compliance with the increased water quality performance of Control Option No. 2. This process will align with the 2030 Master Plan Update.

Specific details of the next steps to address migration to a future performance target are summarized as follows:

1) Submit the CSO Master Plan by August 31, 2019, in accordance with EA No. 3042 with the performance target based on Control Option No. 1 – 85 Percent Capture in a Representative Year.
2) Complete the sewer separation projects identified in the CSO Master Plan through the initial period of implementation while the water quality performance evaluations and pilot studies are being completed. Determine the percent capture required to meet the water quality performance identified for Control Option No. 2 in the Preliminary Proposal.
3) Collaborate with MSD regarding any changes necessary to the CSO Master Plan or EA No. 3042 in order to meet the required performance.

4) Submit the updated CSO Master Plan before April 30, 2030, in accordance with EA No. 3042. The update will incorporate any agreed changes required to achieve Control Option No. 2 water quality performance equivalence.
5) Continued implementation of the updated CSO Master Plan following acceptance by MSD.

4.7 Monitoring and Reporting

Monitoring and reporting on a regular basis is a requirement of Clause 13 of EA No. 3042 and is required during the implementation of the CSO Master Plan. Section 2.2.6 identifies the specific requirements of this clause. As part of the reporting process, progress will also be communicated to the public at large, as explained in the Public Education Plan previously submitted to MSD.

This section provides an indication of the existing and planned approach to meet these requirements.

4.7.1 Public Notification System

The City initiated a public notification system in 2004, which identifies the likelihood that an overflow is occurring based on levels recorded by instruments in the CS System. This notification is manually updated and provided on the City's website.

The City is updating this system and developing a tool which will link in with the hydraulic model for the City of Winnipeg CS system, and the permanent instrumentation at each of the 39 primary outfalls, to provide a real-time indication of an overflow occurring and forecasted overflows. This notification system will indicate to the public that based on the hydraulic model and permanent instruction conditions at that time, a CSO is occurring or is predicted to occur.

4.7.2 Interim Monitoring

The City has continued water quality sampling and testing through their bi-weekly water quality program as described in Section 2.5.4. This water quality sampling will continue during the implementation of the CSO Master Plan.

The City plans to undertake further water quality analysis and review the prioritization of districts to include the consideration of reducing the number of river water quality failings as a result of bacteria exceedances.

4.7.3 Current CSO Reporting

The City currently completes quarterly and annual CSO reporting to track variations and trends in system performance. This reporting is based on actual rainfall received as measured by permanent rain gauges installed across the city and includes recorded and calculated CSOs and volume capture. Outfall monitoring instrumentation in combination with the hydraulic model is used to calculate the volume and frequency of CSOs at each primary and secondary outfall within the city.

Reports of these CSO volume and frequency trends are submitted to MSD for compliance and are provided to the Federal Government as required by the Wastewater System Effluent Regulation (WSER) with the total pollutant loading required to comply with the National Pollutant Release Inventory (NPRI) requirements. The City also reports to MSD upon the occurrence of significant events. A significant event is defined by the occurrence of a 10 year rainfall event within the City limits.

4.7.4 CSO Master Plan Implementation Reporting

Progress reporting for implementation of Control Option No. 1 will be based on project completion in comparison to the CSO Master Plan. Annual reporting will identify construction progress in comparison to the current version of the CSO Master Plan and the work plan for the subsequent year.

The reporting approach is dictated by selection of the percent capture performance metric. Each project of the Master Plan will contribute to the percent capture which is directly related to its implementation with no improvement shown until a project is complete. Each project's performance in terms of improvement in percent capture will be recorded and tracked as part of a benefits register. This will be included as part of the annual progress reports. The City will also conduct flow monitoring within CS districts where projects have been completed to verify the benefits provided.

5. Risks and Opportunities

The program planning process identified a number of potential risks with significant consequences. Consideration of risks and opportunities was part of the CSO Master Plan development. Individual risk responses and contingency allowances were not directly identified, but recognition and general allowance for risk is included in the upper end of the range of cost estimates (i.e. +100 percent AACE estimating contingency).

The following risks and opportunities are being highlighted as having potential impacts on the CSO program.

5.1 Risks

The CSO Master Plan assignment included a broad risk management approach to address project delivery and program risks, with a risk workshop conducted with key stakeholders within the City Of Winnipeg and Jacobs Engineering, focused primarily on program risks. The project delivery risks have been dealt and closed on an ongoing basis, while the program risks are to be transferred to the program implementation phase. Risk management will continue through the implementation of the Master Plan and is a component of every project.

Risks to the successful completion of the CSO Master Plan were identified throughout the planning process. Where possible, mitigation measures have been identified and are described in the following subsections.

5.1.1 Program Feasibility and Sustainability

Aside from the funding requirements and affordability risks, there is a number of other factors to be considered regarding the feasibility of completing this work in the implementation period of 27 years. The 27 year implementation period is the minimum timeframe necessary to meet the deadline as set out in Environment Act Licence No. 3042. These considerations are described as follows:

- Proof of Concept: A period of time for technology evaluations and pilot studies, intended to validate and gain comfort in the control option selections. This implies that there is a possibility of rejection, which may lead to the need for more costly substitutes.

- Project Overlap: There are multiple competing infrastructure needs within the City to consider (e.g. STP upgrades) as well as the possibility of additional requirements in the future that cannot be forecast.

- Construction Capacity: The local construction industry is committed to assisting the City with its objectives. While it is assumed that the industry will add resources to meet the City's needs, it is expected that there would be a delay in the ability of the industry to adjust to the additional number and types of projects.
- City Capacity: To meet the 2047 implementation timeline the City would have to triple the size of its current capital delivery program from $30 million to $90 million with increased work associated with implementing key aspects of the CSO Master Plan. To achieve this would require additional resources and time to expand.
- Operations and Maintenance: New infrastructure will be added that will require additional O&M staff and resources. Some of this infrastructure will be new to the City and will require additional training and supplier support.
- Public Impact: Sewer separation projects are planned throughout the combined sewer system and will encompass large sections of the sewer districts. Each of these will include large programs that will each take several years to complete, resulting in extended periods of impact on residents and businesses.

- City Impact: Coordination with other City services will be needed to minimize impacts and identify planning overlap. Services that will be impacted include Transit, Public Works, Fire Paramedic and Police Services. Aligning with street renewals will be difficult but necessary, new streets have an expected lifespan that may be reduced if sewer work is required in the same right of way.
- Affordability: The City's Water and Waste Department finances its capital and operating budgets for the sewer utility on a user-pay basis through sewer rates. The City takes a longer-term view of rates to provide stability for its rate payers. The rates have steadily been rising for several years and are expected to continue to rise because of wastewater treatment plant upgrade works and replacement and refurbishment of aging infrastructure. However, continuous rate increases are not sustainable.

5.1.2 Program Implementation

A number of significant factors associated with funding and scheduling during implementation must be considered as follows:

- Funding Risks: The expectation is that funding assistance will be provided by senior levels of government. There is a risk that the shared funding will not be available over the life of the program. To mitigate this risk, the City will continue to request funding from both the Federal and Provincial Governments, with the fallback position of extending the program completion date in accordance with the actual sustainable funding levels.

- Cost Risks: There are many sources of cost risks. For example, many of the technologies are new, with little local market information on which to base cost estimates, and vulnerability to cost increases because of the increased work load. To mitigate this risk, the City will take advantage of experience and resources from other locations. This could include reaching out to the design and construction industries beyond the local markets to inform them of the opportunities planned for Winnipeg. By notifying those with experience in design or construction in the proposed technologies, more realistic costs of the work involved can potentially be received. Unavoidable changes in costs may have to be accepted and managed through a risk contingency allowance.

- Schedule Risks: There are many sources of schedule risks. Major delays may result from funding shortages or high bid costs. Shortages of engineering and construction capacity or project approvals may cause delays to implementation plans. Risk mitigation includes providing early notice to the design and construction industry for the work to be implemented as part of the CSO Master Plan, and stream-lining bidding techniques.

5.1.3 Migration to Control Option No. 2

The regulatory requirement to migrate from Control Option No. 1 to Control Option No. 2 represents a significant change to the program. Section 4.6 addresses this topic in detail. In general, this risk can be reduced though further technical analysis and continued liaison with MSD.

Changing to a higher level of control during the implementation of the CSO Master Plan creates additional risks for the master planning process. Risks are mainly associated with the types of control option projects completed and the ability of those projects to adapt and continue to contribute effectively to the overall percent capture. The approach taken in the CSO Master Plan is to maintain an expandable percent capture program. In order to most effectively apply this approach, the initial projects identified for completion during the CSO Master Plan implementation are sewer separation which is considered lower risk when considering future performance targets. The contributing benefit from sewer separation does not change if the level of control increases.

5.1.4 Climate Change

Precipitation trends across the globe are expected to change over time because of the effects of greenhouse gases on our climate. Climate change is linked to less frequent, but larger rainfall events which could have a negative effect on the CSO program. Larger rainfall events will increase the rate and volume of runoff that must be managed by the CSO controls. This increase in extreme weather events is a potential risk to the performance of the CSO program. The program is based on a 1992 Representative Year, which would become less representative of the City of Winnipeg precipitation trends, if the average rainfall event intensities increase over time. Increased rainfall totals would not change the 1992 performance estimates, but the frequency of actual overflows could gradually increase and not meet desired outcomes.

The historic climate information for the City of Winnipeg gathered and reported in the Preliminary Proposal showed an increase in the frequency of small rainfalls, but a consistent trend for the larger ones. Because the CSO control system will capture the smaller events, this trend would not be detrimental to the program performance. However, there is a high degree of uncertainty in the long-term trends, and the opposite effect would occur if the frequency of large events increases over time.

The long-term precipitation records were reviewed to identify any climate change trends that may already be in progress. The rainfall categories used for the recreational season (May to September) assessment are useful for this evaluation since it compares not only the total annual and event rainfalls, but the number of rainfalls of varying sizes.

The review for long-term trends indicated the following:

- There was no increasing trend observed for annual rainfall accumulations.
- There was no increasing trend observed for any of the larger increments of rainfall.
- The 0 to 5 mm increments of rainfall showed an increased frequency in the more recent years, but this would not be significant in terms of the CSO program.

Examples of the long-term historical trends for the number of events for the 0 to 5 mm, 10 to 15 mm, 15 to 20 mm, and greater than 25 mm incremental ranges are shown on Figure 5-1.

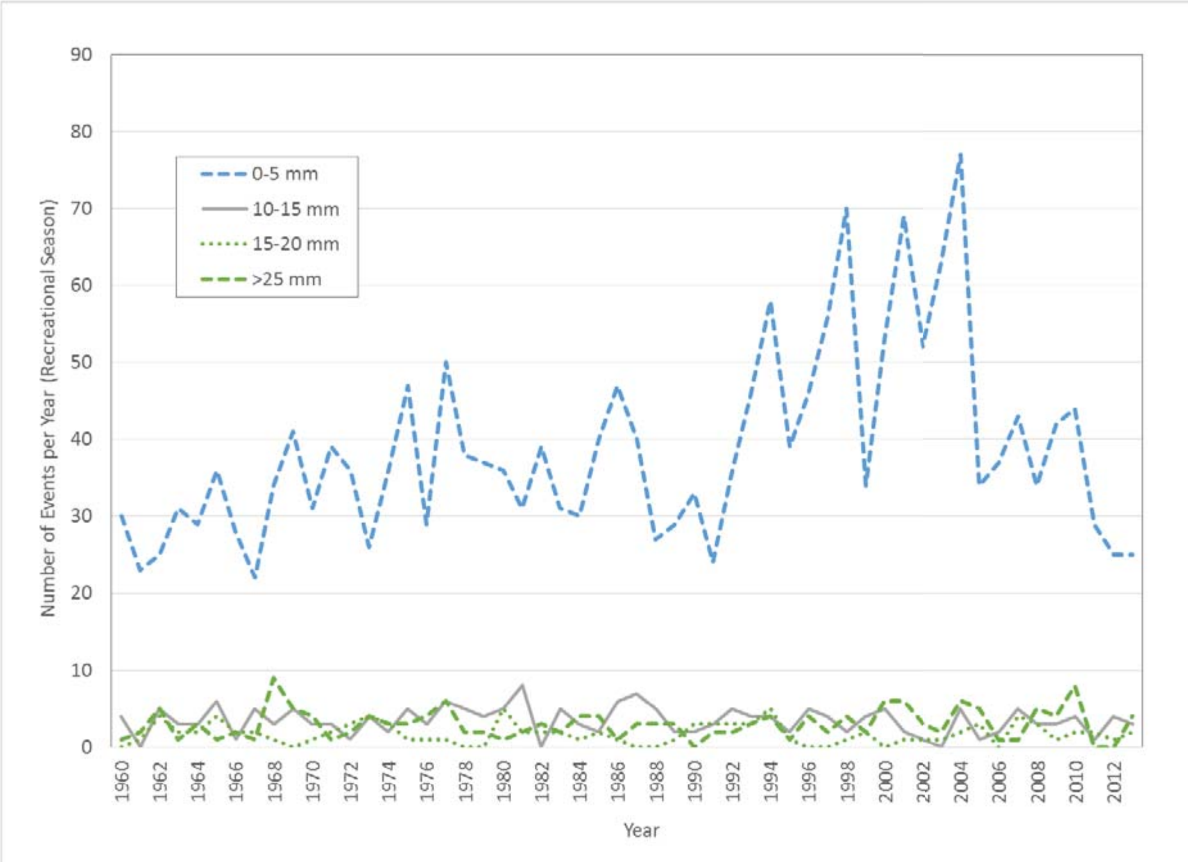

Figure 5-1. Long-term rainfall trends for select accumulated rainfall increments

The impact and rate of change associated with climate change means future trends are uncertain, and consideration should be made for how to respond if conditions worsen. For the CSO program, GI and RTC have been identified as opportunities improving the performance levels achievable through the CSO program. The implementation strategy also prioritizes sewer separation work upfront which makes the program more resilient to climate change as any additional runoff generated from climate change impacts will primarily be directed to land drainage sewers. Additionally, the City will be monitoring and tracking weather patterns to assess any impact to the CSO Master Plan including the use of 1992 as the representative year.

5.2 Opportunities

Opportunities to improve or enhance the CSO Master Plan were identified during its development. These can be realized through a number of different ways and are described in the following subsections.

5.2.1 Green Infrastructure

GI is included in the program to reduce CSO volume by preventing or delaying runoff entry into the CS system. Additionally, GI has the potential to offset any impacts associated with climate change, and will provide climate change resiliency.

There is a number of specific local issues that are unlike those in other large jurisdictions that should be evaluated prior to adopting GI for the CSO Master Plan, such as:

- **Infiltration rates:** Some GI options rely on infiltration, and the clay soils found locally have very low rates that would affect the storage recovery time.

- **Year-round performance:** The effectiveness of GI would decline in the winter months, because of frozen soils and a slowdown in natural soil infiltration processes, limiting their performance for snowmelt.
- **Freeze-thaw conditions:** Roadway designs attempt to avoid water being captured below streets because of the damaging effects of freeze-thaw cycles, which may be at odds with use of permeable pavements.
- **Street maintenance:** The use of sand and salt on streets in the winter may have a detrimental effect on GI operation, maintenance and discharge water quality. Snow plowing may be damaging to the facilities.
- **Maintenance requirements:** The factors listed above which could impact GI use will be assessed in terms of additional maintenance required to maintain GI operation. The scale of increased operations and maintenance costs for implementation of GI is needed to be assessed.

The uncertainty with local conditions suggests that it is premature to make definitive recommendations on GI application or identify specific projects. Therefore, in response to Clause 8 of Environment Act Licence No. 3042, a GI approach must await further analysis to determine specific applications and make performance assessments. There are a number of tasks that may be initiated prior to the full-scale implementation of GI.

The following general principles are recommended for review to enable for GI integration into the CSO Master Plan:

- Identify existing GI assets and create a database.
- Prepare a screening procedure to identify suitable locations to apply GI and those locations that may act as pilot sites.
- Pilot studies should be undertaken to evaluate the unknowns and assess the use of GI technologies.
- Functional sizing should be based on proven and sustainable technologies and practices. GI is to initially be considered as a supplementary upgrade for CSO controls, until the GI technology has been tested and proven.
- GI technologies that can be applied opportunistically and economically should proceed. These include rain gardens and bioswales where land is readily available, surface grading is suitable, and costs are competitive.
- GI technologies should be encouraged or promoted for use on private properties, such as rain barrels and rain gardens.
- Policy and guidelines should be developed for GI implementation once the effectiveness and costs have been better established, recognizing that there is likely to be an investment premium for use of these technologies, even with the off-setting benefits of grey infrastructure implementation. This may include the creation and updating of Stormwater and GI design standards and guidelines.

Along with being a requirement under EA No. 3042, the GI program will provide a visible indication of environmentally consciousness and tangible actions by the City.

5.2.2 Real Time Control

The City is working towards system wide RTC optimization of the combined sewer network. This work has the potential to reduce CSO volumes by managing sewer flows with existing sewer system infrastructure. This in turn reduces the amount of sewer separation and other works required. As this work requires a high level of control of the sewer system in combination with permanent monitoring at key locations in the sewer system, it will take time to implement a fully functional RTC system. The City is planning to complete its RTC network in four consecutive phases as follows:

- **Phase 1 (2009-2019):** Flow monitoring, sewer modeling, ICMLive forecasting, Remote Terminal Unit (RTU) panel upgrading

- **Phase 2 (~7-9 years):** Desktop engineering, permanent instrumentation, complete RTU panel upgrades, data collection and validation
- **Phase 3 (~7-10 years):** Asset management replacement plan, static optimization, data collection and validation
- **Phase 4 (>15 years):** Mechanical optimization

5.2.2.1 RTC Implementation

The implemented CSO control options will capture and convey the combined sewage to treatment as described in the dewatering strategy in Section 3.2. This will require flow control and monitoring systems that include pumping, gates, valves, instrumentation, and an automation system to manage them. Refinement of the automation system and its level of sophistication is the premise behind RTC implementation and will depend on the types of control options selected and how the system is intended to be used. Initial planning of the automation system needs to at minimum incorporate the dewatering strategy for the orderly transfer of the additional captured combined sewage to treatment. The use of more sophisticated RTC systems will further manage, improve, and optimize the in-system operations and allow for additional combined sewage to be captured with little to no impact on interceptor or treatment capacity constraints.

The CSO Master Plan includes recommendations for gravity flow controllers for districts utilizing gravity flow collection to the interceptor system, and installation of flow monitors and pumping controls on all LSs. This will permit every sewer district's discharge rate to the interceptor to be monitored and altered dynamically during a WWF event. The dewatering strategy is intended to provide a constant rate of flow into the interceptor during the dewatering period, sized to the peak capacity of either WWF or the interceptor capacity, whichever is limiting. The SCADA system will be relied on for RTC implementation, to collect data and control pumping rates and gravity discharge rates. The RTC system will provide the logic function and automation in which these discharge rates are dynamically changed during WWF events.

The proposed control system will maximize operation of the existing system for uniform rainfalls. The main benefit provided by RTC program opportunity is by expanding to a global system that can respond to spatially distributed rainfalls, and potentially to rainfall prediction.

A well thought out strategy will be necessary for implementation of a successful RTC system. RTC is closely tied to the day to day collection system monitoring completed by SCADA operators at this time. Implementation must account for risks of failure on operation of the collection system, and allow for appropriate manual overrides. Not all collection systems will benefit from the most complex implementation, depending on requirements, organizational structure, and physical aspects of the collection system.

Advanced RTC may extend to global predictive controls with storm tracking or rainfall measurements used in real time data to calculate future storm flows to be generated in the collections system. The use of these highly complex RTC systems have not been considered at this stage of the CSO Master Plan, but have been prioritized to be studied in the future as an opportunity to the current CSO Master Plan approach.

5.2.3 Floatables Management

Combined sewage discharges are a known source of floatables. They contain street litter captured by storm inlets and sanitary matter disposed of with sanitary sewage, which can make its way to the rivers during CSOs.

The floatables issue was investigated in detail under the 2002 CSO Study. Floatables were captured successively for 20 rainfall events from the Alexander, Bannatyne, Mission, and Cockburn CS districts primary outfalls through use of a boom placed on the river. The investigation also included Lot 16 Drain, which is a separate stormwater discharge. The captured floatables were then quantified, classified, and categorized for the series of 20 rainfall events. The amounts of floatables captured are shown in Figure 5-2.

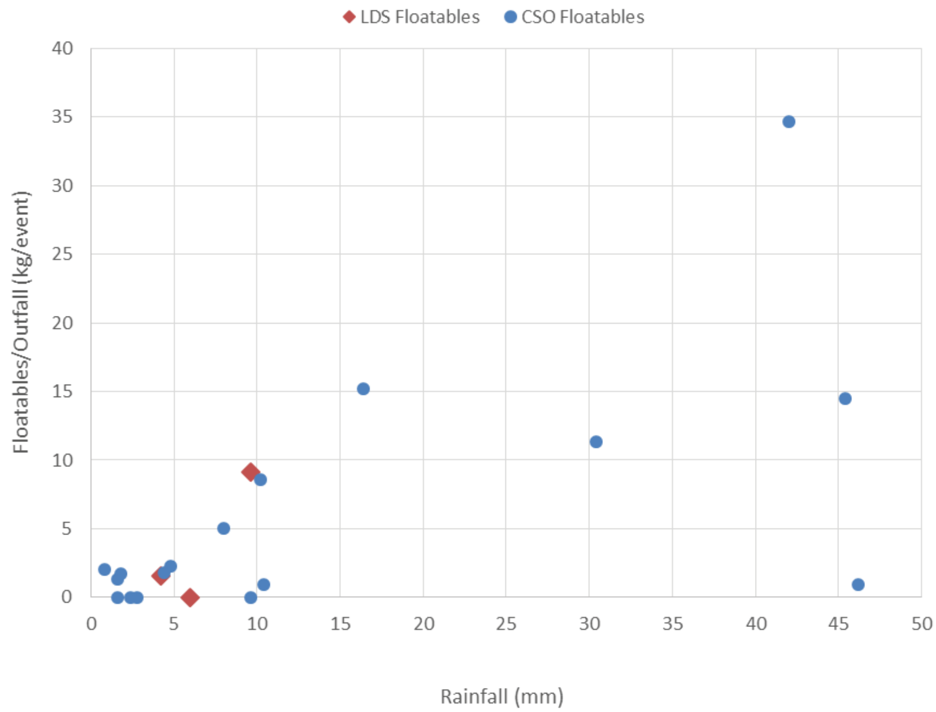

Figure 5-2. Floatables Collected from Primary Outfalls During 1996/1997 Rainfall Events

The highest loadings from each district is about 15 kg per event, with the exception of one event that had a total of 34.7 kg. The study did not report on the size of individual materials or provide a volume for the floatables captured. It did identify a spread flat area, being the area that the floatables covered when spread on the ground, which was about 6 m^2 for the 15 kg captures, and 19.5 m^2 for the 34.7 kg capture.

The study also found the following:

- The amount of floatables was highly variable for each district.
- The floatables loading rate averaged 0.13 kg per 1,000 m^3 for the five locations tested and was highest for the Alexander district at 0.4 kg per 1,000 m^3 of overflow.
- The major components were found to be natural debris (49 percent), followed by surface films (grease and scum), plastics (16 percent), paper products (8 percent), hygienic products (4 percent), and a small amount of other material.
- About 74 percent of the floatables were attributed to street litter and 26 percent from sanitary sewage.

The study only collected floatables from the primary outfalls, and not from the secondary or relief outfalls that may also be located in the districts.

Overall, the 2002 CSO Study concluded that floatable discharges were not a system-wide problem and improved floatable control could be achieved through selective targeting of CS outfalls. Another recommendation of the study was that source control should be the primary route of controlling floatables before more permanent end-of-pipe measures are implemented at the outfalls.

5.2.3.1 Master Plan Screening Approach

Control Option No. 1 includes off-line screening in each sewer district where it was determined to be operable and hydraulically feasible, and where sewer separation would not be implemented. In each applicable case, the primary outfall has a proposed off-line screen installed that would capture floatables from the first flush of an overflow. The off-line approach is necessary to avoid placing screens on the direct discharge line which may blind off and increase the risk of basement flooding. The technical approach is described in Section 3.3.3 and the type of screens and the screening installation arrangement is described in more detail in Part 3C.

There are many challenges associated with the use of screens. Common challenges are listed below:

- Limited space available at the outfall locations for screening infrastructure.
- Issues with land use for screens.
- Odour concerns where screens neighbor residential communities.
- Public acceptance and approvals.
- Relative short operating life of screens and require frequent replacement. Capital cost intensive over time.
- Difficulty in construction, and disruption to neighboring areas.
- O&M intensive; build up of screenings and screening removal systems mandatory.
- Health and Safety risks for O&M staff working in confined spaces within screening chambers.
- Implementation of screening at all outfalls will transport screenings within CS system and interceptor system to the headworks at STPs. Significant increase in screenings received at each plant would occur, likely requiring headworks upgrades at each STP.

5.2.3.2 Alternative Floatables Management Approach

The City has identified source control as a potential alternative to the off-line, end-of-pipe screening for floatables management. It is expected to achieve similar results while eliminating the end-of-pipe screening and avoid the high capital and long-term O&M costs and other risks associated with screening facilities. The City intends to carry out investigations and a demonstration project to evaluate its performance.

The approach will be similar to the ongoing approach being undertaken by the City of Ottawa. Source control techniques will include more frequent street cleaning, catch-basin cleaning to remove floatable material from surface runoff before it enters the sewer system, and public education to reduce the sanitary components from entering the plumbing systems.

The floatables management plan will include a trial period to evaluate the alternative within a 10 year testing timeframe, to better define the benefits and costs associated with source control floatables management as compared to screening floatables management:

- Site-specific testing would be carried out on trial districts to quantify the existing “as-is” conditions, with end-of-pipe floatables captured and quantified during storm events of various intensities, similar to the approach used in the 2002 CSO Study.
- Source control in terms of increased street and catch basin cleaning would be applied to the trial districts, with end-of-pipe floatables again being captured and quantified for comparison to the “as-is” situation.
- Observation would be made of the rivers and riverbanks to identify floatables from CSO sources and assess the river use impairment, and potential program benefits.

- The source control actions taken would be monitored and documented, to better understand the level of effort, costs, and efficacy of the various techniques.
- The level of improvement would be evaluated and compared to the expected performance of the first-flush end-of-pipe screening approach as currently recommended for the CSO Master Plan.
- An evaluation report would be prepared to document the performance, ease of implementation, sustainability, operation, level of effort, and costs.

This assessment will lead to a better understanding of system floatables and determine the best long-term approach to dealing with floatables as part of the CSO Master Plan. As discussed within Section 3.5, the districts of Jessie, Marion and Polson do not allow the installation of the typical screening facility due to hydraulic constraints. These districts will be ideal to allow pilot study demonstration projects to be implemented. An allowance has been included in the cost estimates for these districts, equivalent to the capital costs required for a similar level of in-line storage implementation. This allowance will be utilized to pilot this alternative floatables management approach.

5.2.4 Project Innovation

The CSO Master Plan was completed at a planning level for project optimization and cost-effectiveness evaluations. A stated objective of the assignment was to use tried and true technologies and approaches and avoid riskier options that may have potential cost savings. It is essential as part of finding opportunities for innovation and cost-effectiveness evaluations, that the program prioritization be revisited as new information becomes available during the implementation of the CSO Master Plan.

5.2.5 Engineering Refinements

Value engineering provides a structured method for reviewing the costs and benefits of conceptual plans, from the perspective of adding value. Value engineering exercises should be carried out early in the conceptual design stage to achieve best value for money in the projects.

The DEPs for each of the combined sewer districts has been developed to a conceptual level. As shown in Figure 5-3, the solutions recommended in the DEP for each district will be further developed through the value management and additional studies through design to construction.

Figure 5-3. Key Stages For Solutions In District Engineering Plans

5.2.6 Public Engagement

The CSO Master Plan will impact all residents directly through an increase in sewer rates, and from traffic disruptions related to the CSO mitigation construction work. Implementation of the Scenario 1 program will result in triple the annual sewer separation work currently undertaken by the City of Winnipeg. The public's opinion and buy-in is important to the actual and perceived success of the program and can best be managed through a structured communication program. Communicating what is going on in specific neighborhoods and why, and managing expectations is essential to the success of the CSO Master Plan.

5.2.7 Industry and Community Collaboration

A program of this scope will create opportunities for partnerships and collaboration with industry and community groups to create mutually positive benefits. Industry is intent in promoting green aspects of their organizations through environmentally positive initiatives and may be willing to invest in technologies that could benefit the CSO Master Plan through storm water reduction or other site specific means.

There are existing community groups such as Save Our Seine that are aware of the environmental benefits of such programs and are already promoting the ideas and benefits of green technology. The City will continue to work with these groups to promote and educate all stakeholders about the CSO Master Plan.

5.2.8 Aspirational Goal

The City's Preliminary Proposal recognized that future goals may be established to exceed the 85 percent capture limit and identified this as the aspiration goal. The City's intended approach for achieving increased volume capture was through progressively higher amounts of sewer separation. The relevant metric for this approach was identified in the document as percent capture. The methodology would be similar to that adopted by Ottawa, in which the ultimate goal could be to achieve 100 percent capture, in which case combined sewers would eventually be completely eliminated and replaced with a separated two-pipe system.

6. Next Steps and Future Considerations

The CSO Master Plan sets out a path forward to reduce the volume of combined sewer overflows by 2,300,000 m^3. Acceptance of the CSO Master Plan will require the City to adopt this large and costly long-term program impacting about one third of the serviced sewer area in the City.

Once complete, the CSO program will increase the estimated level of capture of combined sewage from 74 to 85 percent. The program will demonstrate environmental stewardship and achieve a level of control in compliance with EA No. 3042, and recognized by the U.S. Environmental Protection Agency for the protection of rivers and lakes.

While the program objective is to improve water quality, the program is defined by overflow volumes and is not based on water quality metrics. Reducing the volume of overflow has a corresponding reduction in water quality detriment caused by CSOs. The program will reduce the amount of diluted sanitary sewage discharged to the Red and Assiniboine Rivers, improving the rate of compliance with bacterial limits and providing a reduction of floatable material. There will also be a minimal reduction in nutrient loading to the rivers as CSOs are reduced.

6.1 Next Steps

Following the submission of this report the City will initiate the CSO program which includes the continuation of committed projects identified within the CSO and BFR program. The City will then begin annual reporting as required by EA No. 3042.

6.1.1 Implementation

The program implementation has assumed a startup period of four years following submission of this CSO Master Plan. During this startup period the City will continue with its ongoing committed projects and initiate pilot studies and water quality assessments to prepare for the 2030 update.

6.1.2 Secure Funding

The City has assessed the program costs and has determined that carrying out the CSO program concurrent with its other commitments is unaffordable to its utility rate payers. Assistance from the senior levels of government will be required to complete the program based on Control Option No. 1 in accordance with EA No. 3042. Funding and cost sharing arrangements should be reassessed following selection of the implementation period. Consideration of the CEC recommendation for one-third shared funding from each level of government will be required.

An increased future commitment for migration to Control Option No. 2 may require further affordability assessments, and increased commitments from the senior levels of government. This will be evaluated as part of the 2030 CSO Master Plan Update.

The Water and Waste Department will transition from the master planning phase to program management for the implementation phase following acceptance by MSD of the CSO Master Plan recommendations and confirmation of funding commitments. If the City is directed to proceed with the CSO Master Plan without any funding assistance or with reduced funding commitments from the senior levels of governments, the City will comply however the program completion timeline will be based on the City's current maximum affordability cap of $30 million per year.

6.1.3 Pilot Studies

Floatable materials control and GI pilot studies and evaluations will be completed to better understand their suitability and benefit to the CSO reduction objectives. These pilot studies will be initiated once the

CSO Master Plan is approved by MSD. Pilot projects will also be carried out for each control option technology that has not been installed in the City prior to full scale implementation.

6.1.4 Regulatory Liaison

Continued collaboration between the City and MSD will help to maintain direction towards the regulatory objectives while balancing the degree of change required by the City to meet its obligations. Updates regarding CSO reporting and improvements towards 85 percent capture target, pilot studies underway and their findings, and internal works to improve the CSO Master Plan implementation will be provided to MSD are part of regular update meetings.

6.1.5 2030 CSO Master Plan Update

The CSO Master Plan update, scheduled for 2030 may substantially increase the program requirements. Close collaboration with MSD on regulatory issues will be required throughout the evaluation period to arrive at a manageable and practicable solution. The update will report on the continued system analysis and the results of the program since the submission of the CSO Master Plan in 2019. This update is expected to include the following:

- Update on results to date: volume of CSO, number of events, money invested.
- Discussion on path forward to meet the Control Option No. 2 water quality target.
- Conceptual cost estimate to move an increased capture rate beyond 85 percent.
- New timeline and implementation schedule for this migration.
- Assessment of potential Climate Change impacts since 2019 Master Plan submission.
- Update on pilot studies, alternative floatables management, RTC and GI work.

6.1.6 Annual Progress Reporting

Clause 13 of EA No. 3042 triggers annual progress reporting to begin after the MSD has accepted the proposed CSO Master Plan. This includes a summary of planned and completed projects and an estimate of the system performance utilizing the 1992 Representative Year.

6.2 Future Considerations

A major benefit of the CSO Master Plan is a reduction in bacteria entering the rivers from the CS system. However, the contribution of the CS system in comparison to other sources is small. Other mutually beneficial initiatives will need to be reviewed and undertaken to maintain the balance between environmental benefit and affordability. There are a number of items that will need to be considered during the implementation of the program.

6.2.1 Watershed Approach

A holistic watershed approach for the reduction of nutrient and bacteria loadings, both to the City of Winnipeg and to the Lake Winnipeg Watershed, would provide additional benefits to the water quality objectives of EA No. 3042. Watershed based solutions could lead to additional reductions in a more cost effective way reducing the cost burden. Further steps toward building the watershed approach might logically involve expanding the stakeholder program beyond the City of Winnipeg, explicitly involving more stakeholders from the Lake Friendly Stewards Alliance, and Provincial/State authorities from the upper reaches of the watersheds.

6.2.2 Incentives

Incentives may be considered for homeowners and business owners that voluntarily disconnect or reduce their contribution to the CS system. This could be in the form of rebates or discounts for incorporating stormwater reduction technology on a property. The City of Winnipeg previously implemented a subsidy that encouraged the disconnection of foundation drains through the installation of a sump pump system. This may be implemented once more in an effort to further reduce the WWF entering the collection system.

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Appendix A
Environment Act Licence No. 3042

Manitoba
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Environmental Approvals Branch
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File No. 3205.10
Environment Act Licence No. 3042

November 24, 2017

Chris Carroll, P.Eng., MBA
Manager of Wastewater Services Division
110-1199 Pacific Avenue
Winnipeg, MB R3E 3S8
Email: ccarroll@winnipeg.ca

Dear Mr. Carroll:

This letter is in response to your submission of Combined Sewer Overflow (CSO) Master Plan Preliminary Proposal dated December 18, 2015 and additional information submitted July 22, 2016 assessing five CSO control limits and selecting a control limit for management of CSOs in the City of Winnipeg as required by Clause 11 of Environment Act Licence No. 3042.

Clause 11 of Environment Act Licence No. 3042 requires that the preliminary proposal at minimum consist of an evaluation of the following CSO control alternatives:

- A maximum of four overflow events per year;
- Zero combined sewer overflows; and
- A minimum of 85% capture of wet weather flow from the CSO and the reduction of CSO to a maximum of four overflow events per year.

The December 18, 2015 CSO Master Plan Preliminary Proposal evaluated the following control alternatives:

- Control Option No. 1: 85% capture in a representative year
- Control Option No. 2: Four overflows in a representative year
- Control Option No. 3: Zero overflows in a representative year
- Control Option No. 4: No more than four overflows per year
- Control Option No. 5: Complete sewer separation

The preliminary proposal recommended that the 85% capture in a Representative Year control limit be selected as the alternative for the CSO Master Plan using the 1992 representative year. The preliminary proposal stated that the proposed control limit is expandable in order to meet any potential future regulatory requirements, will meet the 85 percent capture benchmark, and will capture floatables from every combined sewer district.

The December 18, 2015 CSO Master Plan Preliminary Proposal and additional information submitted on July 22, 2016 meet the intent of Clause No. 11 of Environment Act Licence No. 3042. Based on the revised preliminary proposal and subsequent meetings with departmental representatives, I am hereby approving the CSO Master Plan Preliminary Proposal dated December 18, 2015 and additional information submitted on July 22, 2016 with the condition that Control Option No. 1 be implemented in such a way so that Control Option No. 2 may eventually be phased in.

Accordingly, please submit to me for approval a Master Plan including detailed engineering plans, proposed monitoring plans, and an implementation schedule for Control Option No. 1 as identified in your CSO Master Plan Preliminary Proposal on or before August 31, 2019 and for Control Option No. 2 as identified in your CSO Master Plan Preliminary Proposal on or before April 30, 2030.

The City of Winnipeg shall implement the CSO Master Plan for Control Option No. 1 by December 31, 2045, unless otherwise approved by the Director.

Should you have any questions regarding the foregoing, please contact Asit Dey, Environment Engineer, at (204)945-2614 or by email at Asit.Dey@gov.mb.ca.

Yours sincerely,

Tracey Braun

Tracey Braun, M.Sc.
Director

c: Duane Griffin/Patrick Coote, City of Winnipeg
Don Labossiere/Donna Smiley/Yvonne Hawryliuk, Sustainable Development
Public Registries

Appendix B
Licence Clarifications

Winnipeg

Water and Waste Department

Licence Clarifications

Environment Act Licence No. 3042

October 2015

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Acronyms and Definitions

Definitions are consistent with Environment Act Licence No. 3042 (Licence) where applicable.

City of Winnipeg (City)

Clean Environment Commission (CEC)

Combined Sewer Overflow (CSO) – a discharge to the environment from a combined sewer system.

Dry weather flow (DWF) – Flow entering sewers during dry weather from homes and businesses.

Infiltration and Inflow (I&I)

Infiltration is:

- groundwater that infiltrates a sewer system through defective pipes, pipe joints, connections, or manholes; and
- generally measured during seasonally high ground water conditions, during dry weather.

Inflow is:

- water other than sanitary flow that enters a sewer system from sources which include, but are not limited to, roof leaders, cellar drains, yard drains, area drains, drains from wet areas, cross connections between storm sewers and sanitary sewers, catch basins, cooling towers, stormwater, surface runoff (including leaking manhole covers), street wash-water, or drainage; and
- generally measured during wet weather.

Manitoba Conservation and Water Stewardship (MCWS)

Regulatory Working Committee (RWC)

Runoff – Water from rainfall, snowmelt, or other sources that flows over the ground surface, onto the street, through the storm drains at the curb and into the land drainage or combined sewers and into the rivers.

Stormwater – An engineering term for wet weather flow (WWF)

Wet weather flow (WWF) – the combined flow resulting from:

i. wastewater;
ii. infiltration and inflows from foundation drains or other drains resulting from rainfall or snowmelt; and
iii. stormwater runoff generated by either rainfall or snowmelt that enters the combined sewer system.

Executive Summary

A Regulatory Working Committee (RWC) was formed between Manitoba Conservation and Water Stewardship (MCWS) and the City of Winnipeg (City) to deal with technical issues encountered while developing the Combined Sewer Overflow (CSO) Master Plan. To date, the RWC has met on three occasions and has been effective in collaborating on technical issues and Licence interpretations.

This report highlights the main issues and clarifications dealt with by the RWC. The City has recommended the following clarifications be adopted as the development of the CSO Master Plan progresses:

- Use of a Representative Year
- Definition of an Overflow
- Definition of Percent Capture

Use of a Representative Year

The City has proposed that the use of a representative year be included for the alternative control limit evaluations. Representative years are commonly used in the industry as a practical method of dealing with the large amount of hydrologic data, measuring compliance, performance reporting, and overcoming the long computer simulation times needed to process the full rainfall history. In addition, the 2002 CSO Study used a representative year approach, and its continued use will provide consistency with the information presented at the 2003 public hearings and the resulting Clean Environment Commission (CEC) recommendations.

The alternative to a representative year will be addressed with the “no more than” alternative; thereby, providing comprehensive results for both approaches for consideration in the decision process.

Definition of an Overflow

In the Licence, an overflow is calculated using the “overflow event” method. As this method only considers overflows from the worst district and will not account for improvements made to other districts, the City has proposed the use of a district averaging method to supplement this calculation and make it more comprehensive. Overflow averaging, provides a more accurate picture of the overall system performance, and would more accurately reflect CSO program progress. Moreover, overflow average will provide consistency with information presented in the 2002 CSO Study, the 2003 public hearings and the resulting CEC recommendations.

Definition of Percent Capture

The City has proposed a method to define the start and end times for the dry weather component used in the percent capture calculation as it was not defined in the Licence. The dry weather component will be calculated based on the start of the precipitation event and continue until the CSO controls return to dry weather conditions. This will be determined by the completion of the dewatering process (emptying of CSO storage facilities) and the ending of wet weather treatment.

In conclusion this clarification document provides additional detail on the rationale for these clarifications and the approaches taken for dealing with technical issues. Moreover, the clarification document is provided for information only. There are no decisions on their acceptability or use required at this time.

1 Clarification No.1 - Use of Representative Year

1.1 Current Condition:

Clause 11 of Environment Act Licence No. 3042 (Licence) requires that a plan be submitted based on evaluation of a minimum of the following alternative control limits:

- a maximum of four overflow events per year;
- zero combined sewer overflows; and
- a minimum of 85% capture of wet weather flow from the combined sewer system and the reduction of combined sewer overflows to a maximum of four overflow events per year.

1.2 Issue with Current:

There are a number of ways to define the combined sewer system performance, and a common understanding of the approach being used is required. One of the methods proposed by the City but not referred to in the Licence is the use of a representative year.

The 2002 CSO Study, which only dealt with the recreational season, made exclusive use of 1992 as the representative year. The result from using this approach were reviewed at the 2003 CEC hearings and reported on by the CEC in their recommendations. It is therefore important that this approach be retained for continuity.

The use of a representative year facilitates evaluation of large hydraulic data sets with large sewer systems. The InfoWorks CS hydraulic and hydrologic model being used includes approximately 17,000 pipes and takes up to five days to run a single full year simulation. Continuous modelling of all 55 years in the long term rainfall record would not be practical, but is reasonably approximated through use of a representative year.

1.3 Proposed Change:

It is proposed that the 85% capture, four overflow and zero overflow control limits be based on use of a representative year. The other two alternatives would not use the representative year. The alternative with no more than four overflows would be based on the full period of record, and the complete separation alternative would use the City's criteria for separate sewer systems.

The complete list of alternative control limits proposed by the City is as follows:

1. 85% capture in a ***representative year***;
2. four overflows in a ***representative year***;
3. zero overflows in a ***representative year***;
4. no more than four overflows per year; and
5. complete sewer separation.

Use of these alternatives conforms to the minimum requirements defined in the Licence. The four overflows plus 85% capture control limit is not explicitly listed since the minimum 85% capture value will be exceeded when the maximum four overflow criteria is met.

Addition of the representative year for the three control limits as shown will provide a direct comparison to the 2002 CSO Study results, and provide a new perspective for it not being used.

1.4 Application of the Representative Year

Using a representative year for control option sizing has the same effect as averaging annual results. A four overflow limit would be met over the long term, but more than four overflows could be expected in half of the years, and fewer than four in the rest.

The representative year evaluation was updated to account for the extended period of record since the 2002 CSO Study, and 1992 was determined to still be an appropriate selection. The evaluation was based on a statistical analysis of the annual events, as well as specific consideration for how the representative year will be applied. A summary of the approach and result is included as Appendix A.

The 1992 representative year has been used in the study to assess the performance of the baseline conditions, current program and the five alternatives in terms of overflow values and water quality impacts. The current program includes ongoing and future separation work at Jefferson, Ferry Road, Riverbend and Cockburn combined sewer districts and sewage treatment plant upgrades.

Use of the representative year would provide a threshold for measuring compliance. Much like design events used in flood control works and the City's basement flooding relief program, any recorded events smaller than the representative year should not cause overflows, while overflows would be permitted for larger events.

Annually, a comparison of the system performance relative to the representative year would be produced. It would show volume reduction resulting from the CSO program upgrades. This will also identify permitted overflows, which would be hard to quantify looking solely at annual varying rainfall.

It is also proposed that the representative year be used as the basis for measuring CSO program implementation progress. As changes are made to the system to meet the selected control limit, the representative year would be used to assess performance improvements. The system configuration would be updated in the hydraulic model and its performance evaluated using the representative year. The change in performance for the 1992 representative year would be entirely attributed to the system changes, thus avoiding normal variation in annual precipitation. The results would be reported for the representative year analysis, as well as in terms of actual year performance.

The design basis for the control limit would be established through the licensing process depending on the chosen control limit. For example, the fifth largest event in the representative year would be used to size control options for the four overflows in a representative year outcome.

1.5 Rationale for Change:

The representative year is an approach commonly used in the industry. It was used for the 2002 CSO Study as well as in similar programs such those being completed in Edmonton, Ottawa and Omaha. It would provide a common basis for control system sizing and regulatory compliance that is not affected by annual variations in precipitation.

The addition of the representative year to the evaluation while retaining the no more than four overflow alternative will permit comparative evaluation of both methods, without precluding either.

2 Clarification No.2 - Definition of an Overflow

2.1 Current Condition:

Environment Act Licence No. 3042 provides the following definition:

- “**overflow event**” means an event that occurs when there is one or more CSOs from a combined sewer system, resulting from a precipitation event. An intervening time of 24 hours or greater separating a CSO from the last prior CSO at the same location is considered to separate one overflow event from another;”

This method counts an overflow every time there is discharge from at least one outfall in the combined sewer area.

2.2 Issue with Current:

There are different methods for counting the number of overflows, and it is important that there be a common understanding of the ones being used. The 2002 CSO Study used a district averaging method as compared to the overflow event definition. The main differences between the two methods are:

- With the overflow event definition, simultaneous overflows from all 79 overflow points located in the 43 combined sewer districts would be counted as a single overflow event. Furthermore, when only one of these overflows it would also be counted as a single overflow event. The metric reported in this way would provide an accurate indication of how many times a CSO occurred somewhere in the system, but very little information on the number of locations contributing, their aerial distribution or discharge volume.
- Reporting on overflows using the overflow event definition would make it difficult to demonstrate progress during the CSO program implementation. The single worst district would define the number of overflows, and by example 42 of the 43 combined sewer districts could be upgraded with no overflows, but the last one would continue to define the number of overflows with no recognition for the progress made.
- Use of the overflow event definition would require the spatial distribution of rainfall to be accounted for in the CSO control sizing. The spatial distribution accounts for pockets of heavy rainfalls occurring at different locations at any time. This means that to achieve a maximum of four overflow events for the entire combined sewer system, the capture volume for each sewer district would have to be much higher than if the overflows were averaged for the combined sewer districts.
- Use of the overflow event definition would be more difficult to apply since historical records and evaluation techniques for spatial distribution patterns across the combined sewer system are limited and there would be a higher degree of uncertainty if used for future rainfall projections.

2.3 Proposed Change:

It is proposed that a comparative evaluation be used by retaining both methods of defining overflows. The district averaging method will be used for the representative year alternatives (85% capture, four overflows per year and zero overflows per year), and the overflow event method for the “no more than four overflow events per year” alternative.

With the district averaging method, discharge from one or more outfalls in a district will be considered an overflow, and the number of overflows for the combined sewer area will be determined by averaging overflows from all the districts (number of district overflows divided by the number of districts):

- A four overflow control limit in a representative year would mean four overflows would be permitted annually from each district.
- A zero overflow control limit in a representative year would mean there would be no overflows for the representative year, based on a uniform rainfall distribution.

An applied example using high (2009) and low (2013) rainfall years was developed for baseline conditions to demonstrate the results from the two methods. Overflows under baseline conditions for all combined sewer districts were identified for the years 2009 and 2013 and compared to the 1992 representative year, as shown in Table 1:

Table 1: Comparison of Annual CSO frequency under Baseline Conditions for the Overflow Definitions

Event Year	District Average	Overflow Events*
1992	25	63 (39)
2009	39	60 (60)
2013	21	50 (40)

** Highest number of overflows from a district (second highest)*

As shown in the table there are widely different results between the methods for baseline conditions.

Table 2 provides a projection of the number of overflows for a CSO program half-way completed. As shown in the table, the overflow events definition does not change. It would not capture the benefit of the work completed and would make it difficult to track and report on progress.

Table 2: Comparison of Annual CSO frequency for the Overflow Definitions 2

Event Year	District Average	Overflow Events*
1992	18	63 (39)
2009	20	60 (60)
2013	11	50 (40)

** Highest number of overflows from a district (second highest)*

Simulated monthly results for the three years are listed on an annual reporting basis in Appendix B.

2.4 Rationale for Change:

The district averaging approach for measuring overflows has been proposed to provide continuity with the 2002 CSO Study a basis for comparisons with the overflow event definition.

The Licence definition provides an accurate indicator of the number of times overflows occur, but would be more difficult to achieve and would not provide a good indicator of program progress.

Retaining both in the study will permit a comparative evaluation of both methods without excluding either

.

3 Clarification No.3 - Definition of Percent Capture

3.1 Current Condition:

Environment Act Licence No. 3042 provides the following definition:

- "**percent capture**" means the volume of wet weather flow treated in comparison to the volume of wet weather flow collected on a percentage basis.

Percent capture must be considered along with the definition of wet weather flow (WWF), which is defined in the Licence as follows:

- **"wet weather flow"** means the combined flow resulting from:

    i) wastewater

    ii) infiltration and inflows from foundation drains or other drains resulting from rainfall or snowmelt; and

    iii) stormwater runoff generated by either rainfall or snowmelt that enters the combined sewer system

Expanding on these definitions results in percent capture being defined as:

- <u>Percent Capture</u>:

  = (WWF-CSO)/WWF x 100%

  = [(wastewater + inflow&infiltration + stormwater) – CSO] / (wastewater + inflow&infiltration + stormwater) x 100%

3.2 Issue with Current:

The use of percent capture as a CSO metric is reasonable and acceptable, and only requires clarification on how the inputs are quantified:

- Actual measurement of wet weather flows will be used when available or estimated through computer modelling when unavailable, and in either case requires a definition for how they are defined.
- Modelling results will be used for the study and analysis and are to be representative of the intended method of field measurements.

The parameter in need of clarification is the end of a wet weather event, which is difficult to define because of its classic long trailing limb caused by the delayed runoff from inflow and infiltration.

3.3 Proposed Change:

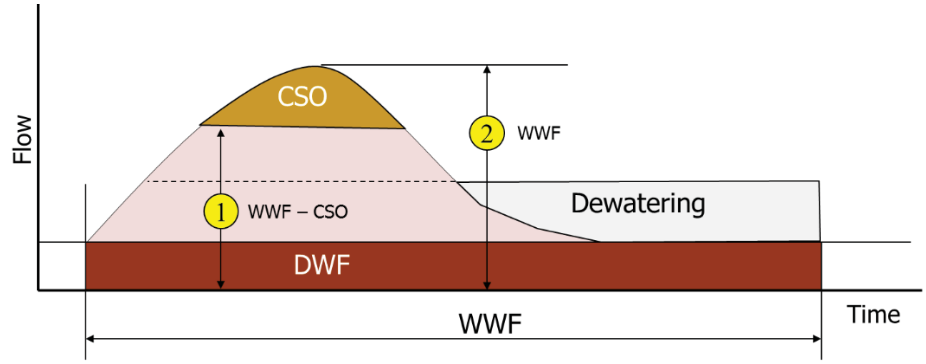
It is proposed that the percent capture definition be modified to include a method for determining the wastewater component for the percent capture:

- **"percent capture"** means the volume of wet weather flow treated in comparison to the volume of wet weather flow collected on a percentage basis; as measured from the start of the precipitation event until the CSO controls return to dry weather conditions, determined by the completion of the dewatering process and the ending of wet weather treatment.

The dewatering process refers to the emptying of combined sewage from CSO storage facilities.

The calculation method is illustrated in Figure 1 below.

Figure 1: Illustration of Percent Capture Calculation



- Percent capture is determined in the illustration as area 1 divided by area 2, and is reported as a percentage estimated using the hydraulic model. (No 2 in the diagram = No. 1 plus CSO volume).
- The percent capture will then be determined by the percent capture formula above (No. 1 divided by No. 2).

3.4 Rationale for Change:

The addition of starting and ending points allows for the calculation of a discrete volume for the metric.

Appendix A - Representative Year

Use of a Representative Year

It is common practice to use a representative year for alternative evaluations in CSO studies, since it provides reasonable results using a much more manageable data set compared to the long term rainfall record. It is also frequently used as a basis for defining regulatory control limits. A representative year was used in the 2002 CSO Study and for other similar studies in municipalities including Edmonton, Ottawa and Omaha, which were the locations that participated in the CSO Master Plan peer review.

Representative years are selected by evaluating all the years in the long term rainfall record and picking the one with the best fit. For the master plan, this includes review of precipitation in the recreational (May through September) and non-recreational (October through April) seasons and the river flow conditions.

There are no standard methods for selection of a representative year, but there are several examples of how it has been done elsewhere. Most of the methods used are specific to the unique characteristics of the location, taking into account both meteorological and compliance considerations.

It cannot be expected that any year will be equally representative for all conditions, so there must be consideration for its impacts on the level of control and types of controls being used. The primary consideration in selecting a year was for the recreational season to be representative, since it is the period with the highest precipitation and the most critical for sizing of CSO storage options. The objective for the non-recreational season and river flows was to avoid any extreme irregularities.

Recreation Season Precipitation

The recreational season precipitation was reviewed from several perspectives:

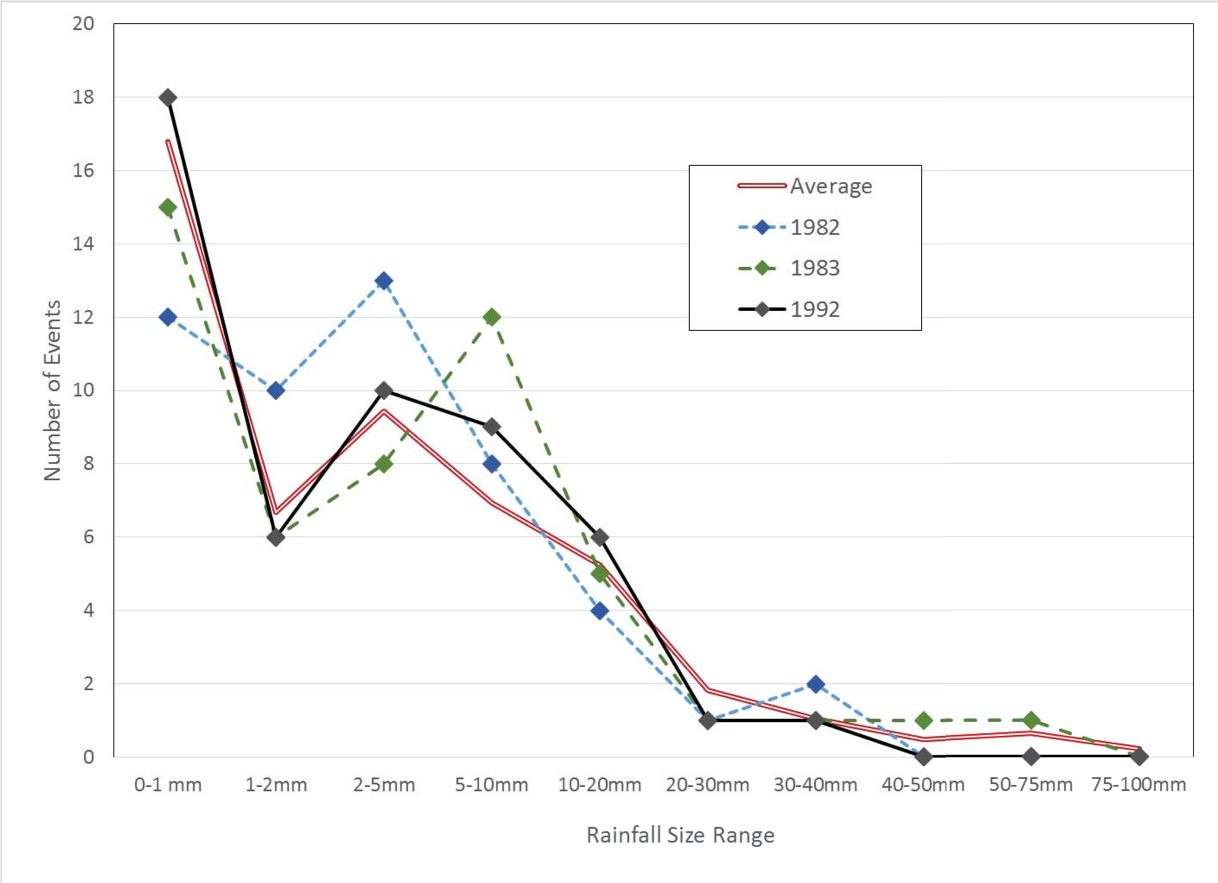
1. The first review was based on storm size groupings, as was done for the 2002 CSO Study.
2. The second review was a statistical assessment of the precipitation intensity.
3. The third was a review of critical events that would directly affect CSO program sizing.

1) Storm Size Groupings

Precipitation events for each year of the long term record were partitioned into precipitation event totals and then compared to the long term average.

The best fit for a representative year was found to be 1992, as was the case for the 2002 CSO Study. The results of the storm grouping for 1992, along with those for 1982 and 1983 are shown in Figure1 below.

Figure 1: Storm Size Grouping Evaluation for the Representative Year Evaluation



2) Statistical Assessment

A continuous hourly precipitation record was compiled for the period from 1960 to the present for use in the statistical analysis. The record was then used to generate the following annual statistics:

- Total recreation season rainfall (mm)
- Number of events during the season
- Peak rainfall intensity recorded (mm/h)
- Standard deviation of event intensity (mm/h)
- Hourly rainfall frequency in excess of impervious runoff threshold (2.5 mm/h)
- Hourly rainfall frequency in excess of pervious runoff threshold (6.4 mm/h)
- Hourly rainfall frequency in excess of relatively large intensity thresholds (12.8, 19.2 and 25.4 mm/h)
- Average event duration (h)
- Standard deviation of antecedent period (h)

A summary of the results for the statistical analysis is presented in Table 1.

Table 1. Hourly Rainfall Analysis Summary for the Recreational Season

Site	Year	RAINFALL					HOURLY RAINFALL ABOVE (mm/hr)					ANTECEDENT	
		Total Rainfall (mm)	No. of Events	Peak Intensity (mm/hr)	std-dev (mm/hr)	Avg Duration (hours)	2.5 (0.1 in/hr)	6.4 (0.25 in/hr)	12.8 (0.5 in/hr)	19.2 (0.75 in/hr)	25.4 (1.0 in/hr)	Avg. Duration (hours)	std-dev (hours)
Station 5023222 Winnipeg Richardson International Airport Latitude: 49.92 Longitude: -97.23	1960	208.5	42	6.4	7.2	5.3	24	1	0	0	0	80.4	82.3
	1961	148.3	31	15.7	7.6	5.3	14	3	1	0	0	109	146.3
	1962	512.5	48	34.8	16.5	6.4	53	22	6	2	2	62.5	59
	1963	264.2	48	17.8	8.6	4.5	36	5	2	0	0	70.4	63.2
	1964	256.7	39	24.4	12.6	5.3	32	9	1	1	0	86	104.1
	1965	332	56	14.7	6.9	6.1	38	6	1	0	0	59	58.8
	1966	281.5	42	32.5	12.2	4.7	28	5	2	2	2	81.3	84.6
	1967	247.5	34	32	11.5	4.2	24	9	3	2	2	100.3	133.5
	1968	519.5	53	39.4	15.6	7	60	17	3	2	1	59.6	55.2
	1969	400.6	59	15.5	10.4	5.3	47	10	2	0	0	56	51.2
	1970	400.4	49	38.1	13.2	6.4	35	10	5	2	1	66	64.4
	1971	295.6	59	11.7	6.2	4	40	8	0	0	0	58	57
	1972	238.5	46	34.5	8.1	3.4	25	5	1	1	1	74.1	69.3
	1973	424.9	49	29.7	11.1	5.3	50	14	4	2	1	66.6	59.5
	1974	357.4	53	28.4	13.8	6.2	35	7	2	1	1	62.3	53.5
	1975	388.7	65	27.9	11.1	4.3	32	15	5	4	1	51.9	58.1
	1976	299.6	43	21.8	10.1	4.3	34	9	3	1	0	78.1	81.9
	1977	593.5	79	21.3	12.2	4.9	59	21	8	2	0	40.2	50.2
	1978	325.8	55	20.8	10.8	5.3	41	6	2	1	0	60.6	58.6
	1979	236.4	50	39.3	8.5	5.4	22	3	1	1	1	66.3	68.4
	1980	267.9	53	15	7.1	5.7	25	9	1	0	0	63.4	71.1
	1981	353.1	53	20.5	9.4	5.8	31	11	3	1	0	63.4	64.8
	1982	300.5	51	22.7	9.2	5.3	31	9	2	1	0	65.6	62.1
	1983	335.7	51	23.5	10.6	4.7	31	12	3	3	0	67.1	78
	1984	374.4	43	55.3	15.1	5.8	33	11	4	2	2	77	74.5
	1985	406.2	59	18.4	14.4	6.1	46	9	2	0	0	55.1	61.9
	1986	266.6	61	17.6	6.8	4.1	29	7	3	0	0	55.6	71.1
	1987	334.1	56	23.4	10.1	4.9	35	7	4	1	0	59.5	56.4
	1988	264.9	38	24.3	11.7	5.1	29	7	3	2	0	85.8	83
	1989	277.2	41	14.1	11.5	6.1	38	8	2	0	0	77.5	71.5
	1990	196.5	46	19.8	5.9	4.3	17	3	2	1	0	75.2	83.2
	1991	330.8	41	19.3	10.5	7.4	33	11	3	1	0	81.4	101.7
	1992	279.4	52	14.9	7.5	5.7	26	5	1	0	0	63.3	58.7
	1993	509.7	70	41.4	15.4	5.9	46	13	6	4	3	46.3	45.9
Station 502S001 Winnipeg Airport Latitude: 49.92 Longitude: -97.23	2007	319.6	64	13.4	5.9	3.6	35	10	1	0	0	52.1	59.4
	2008	392.9	51	19.2	12	5.4	43	10	2	1	0	63.6	57.5
	2009	323.9	57	25.3	9.8	5	29	5	2	2	0	58.3	58.3
	2013	300.6	43	25.3	9	3.7	28	10	5	2	0	81.1	72.8
10th percentile		237.9	40.4	14.5	6.9	4.1	24	4.4	1	0	0	54.2	54.7
20th percentile		264.5	42.4	15.6	7.5	4.3	26.8	5	1	0	0	58.1	57.7
30th percentile		277.4	46	18.5	8.7	4.7	29	7	2	0.1	0	59.7	58.7
40th percentile		298.8	48.8	20.4	9.7	5.1	31	7.8	2	1	0	63.1	59.5
50th percentile		321.8	51	22.3	10.4	5.3	33	9	2	1	0	64.6	63.8
60th percentile		332.4	53	24.3	11.1	5.3	35	9.2	3	1	0	66.7	69.7
70th percentile		357	54.8	27.6	11.7	5.7	37.8	10	3	2	0.9	75.1	72.6
80th percentile		397.4	58.2	32.3	12.5	6	42.2	11	4	2	1	79.5	82.1
90th percentile		450.3	61.9	38.5	14.6	6.3	47.9	14.3	5	2	2	82.7	89.7

Table 1 Notes:

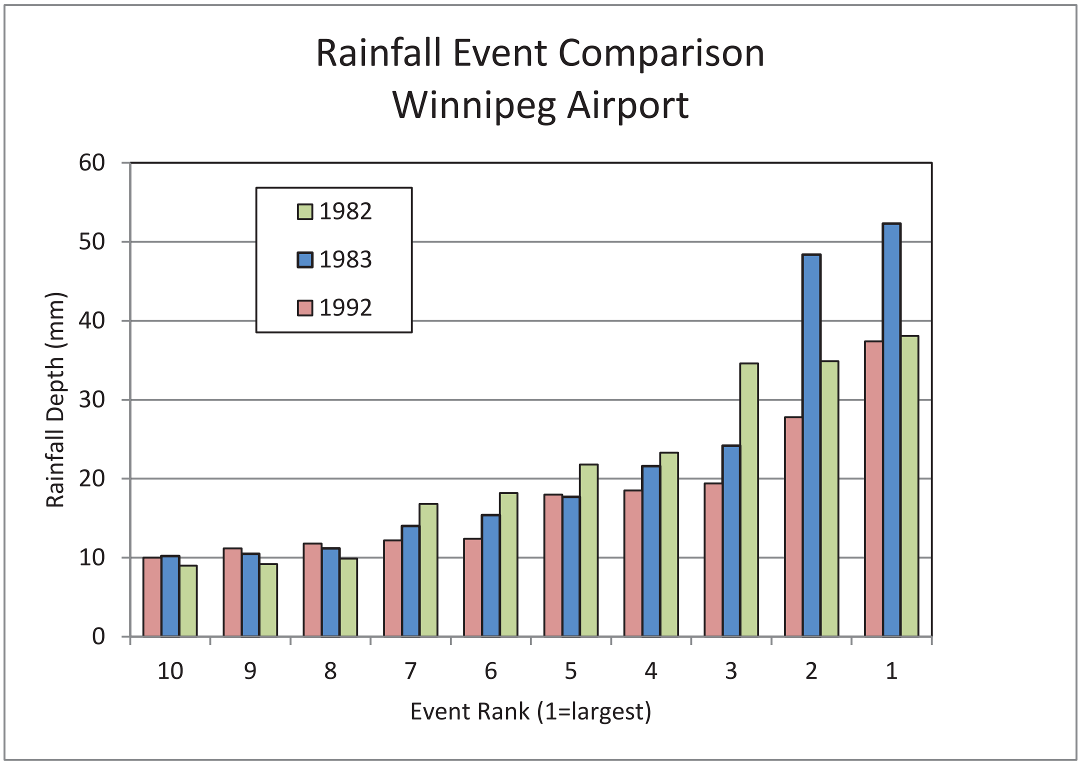
- The table includes only the data used for the statistical analysis
- Only years with 98% data coverage are included
- Some years used infill data from adjacent gauges to extend data set
- Richardson Airport gauge has hourly data from 1960 to 1994. Some years were excluded because of missing data e.g. 1994
- Richardson gauge typically operates from mid-April into November
- There is a gap in rainfall coverage from 1995 to 1999
- In 1999 new Airport gauge initiated and is providing data to date.
- New Airport gauge data limited and provides only 4 valid years. Data infill not yet applied to extend data set. More valid years may result.

The year 1982 was the best fit for these conditions, with the year 1983 also being a good fit. The rainfall intensities for 1992 are shown to be lower than average even though the totals were representative. This reflects on the type of storm.

3) Critical Events

The three years, 1982, 1983 and 1992 were reviewed for critical event sizing. As shown in Figure 2 the two largest events for 1983 were much larger than those for the other two years and would significantly overestimate the zero overflow control limit.

Figure 2: Comparison of the Large Events



Year-Round Precipitation Evaluation

A summary of the statistical results for full year and seasonally are included in Table 2. The seasonal variations were considered to be acceptable for any of the three years.

Table 2. Statistical Summary of Annual and Seasonal Rainfall

Year	Annual Precipitation (mm)			Winter Precipitation (mm)			Recreational Season Precipitation (mm)		
	Rain	Snow	Total	Rain	Snow	Total	Rain	Snow	Total
1982	420	75	484	118	75	182	302	0	302
1983	404	90	480	68	90	143	336	0	336
1992	362	142	478	37	142	152	326	0	326

40th - 60th Percentile

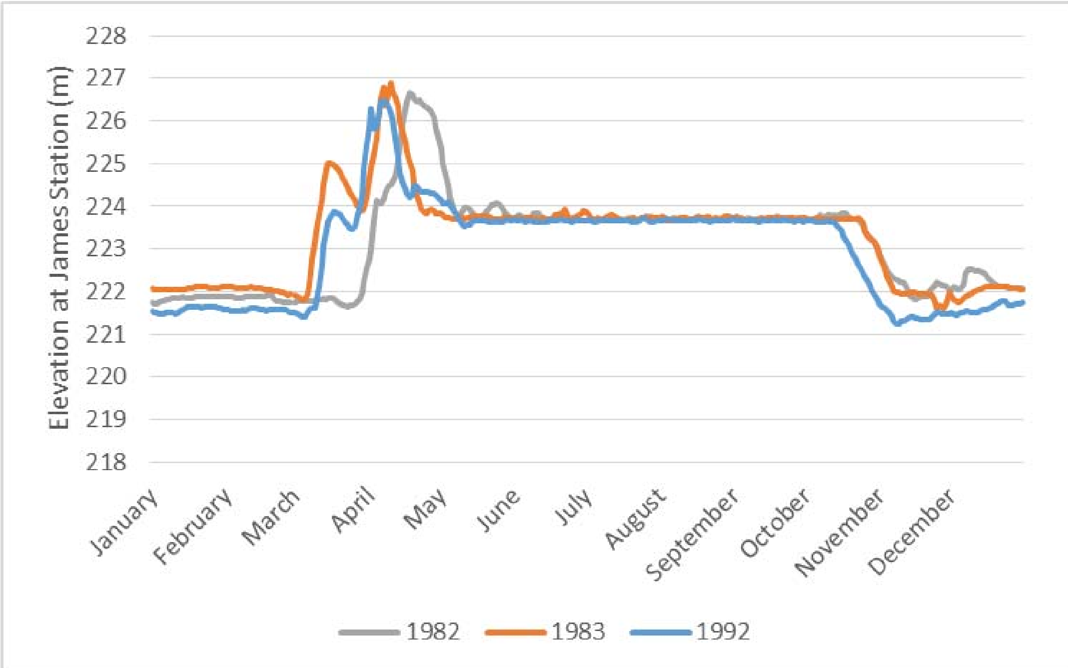
Table 2 Notes:

- Analysis based on daily rainfall volumes
- Refer to Table 1 for the full dataset summary

River Condition Evaluation

River conditions for the full period of record were identified and used to develop ranges, and confirm 1982, 1983 and 1992 were within normal ranges. The annual flows were found to be highly variable for all three years, but for most months they were within acceptable limits, and would not affect the selection of a representative year. The results are shown in terms of river levels at James Station in Figure 3.

Figure 3: River Levels at James Station



Runoff Evaluation

Continuous InfoWorks runs were made for both 1982 and 1992, with the resulting runoff volumes for baseline conditions shown in Table 3.

Table 3. Runoff Volume Summary 1982 and 1992 for Largest and 5th Largest Rainfall Events

Event	1982 CSO Volume (m^3)	1992 CSO Volume (m^3)
Largest Storm	1,161,000	690,000
5th Largest Storm	473,000	337,000

The evaluation indicates that even though the annual statistics are similar for both years, 1982 would be much more difficult to meet for the four overflow and zero overflow control limits. The difference in results relate to the specific conditions at the time of the rainfalls, including the duration and patterns for the specific rainfalls and antecedent conditions.

Final Selection

The representative year evaluation indicated that the years 1982, 1983 and 1992 all exhibited good fits for some conditions, but none of the years was best overall. A final review was made considering the most probable use of the representative year for sizing of the CSO program, based on the following considerations:

- Storm Group Sizing – most applicable to percent capture and number of overflows evaluations

- Statistical Assessment – most applicable to CSO discharge rates and end of pipe treatment options

- Critical Events – most applicable to sizing of CSO storage options

With the CSO program focusing on storage options for the four overflow or larger control limit alternatives, it can be concluded the critical events assessment is the most important factor in the representative year evaluation. In terms of critical events, the years 1982 and 1992 provide the best fit, since the largest storm for 1983 is far larger than the others and was considered non-representative.

Between the two remaining years, 1992 was selected as the representative year for the following reasons:

- The 1992 large event rainfalls are already high compared to long term standards, and even more so for 1982. It was therefore concluded that since 1982 is even larger, it would produce an overly conservative design requirement for CSO controls.
- 1992 was the best fit for storm size grouping, and therefore would be the most representative for percent capture and number of overflow assessments
- Selection of 1992 would provide continuity with the 2002 CSO Study.

Appendix B – 1992, 2009, 2013 Hydraulic Model Results

Water and Waste Department Combined Sewer Overflow (CSO) Monthly Tracking Spreadsheet for Federal Government and Provincial Reporting					
				1992	
OP #	Overflow Point Name	Overflow Point Location (nearest intersection)	Asset Number	Yearly Effluent Volume Deposited (m^3)	Yearly Number of Days Effluent Deposited
1	Cockburn	Cockburn ST S @ Churchill DR	S-MA60012037	164,713	8.5
2	Osborne	Osborne ST @ Churchill DR	S-MA70006325	0	0.0
3	Kingston	Kingston ROW @ Dunkirk DR	S-MA50014591	0	0.0
4	Mager	Mager DR W @ St Mary's RD	S-MA70007510	22,652	2.2
5	Baltimore	Baltimore RD @ Churchill DR	S-MA60013599	58,903	2.5
6	Metcalfe	Metcalfe AVE @ St Mary's RD	S-MA70011115	10,335	1.8
7	Eccles East	Eccles ST @ Churchill DR	S-MA70022370	0	0.0
8	Eccles West	Eccles ST @ Churchill DR	S-MA70006655	0	0.0
9	Churchill	Churchill DR @ Hay ST	S-MA70005806	10,708	12.4
10	Jessie	Jessie AVE @ Osborne ST	S-MA70016174	188,655	5.7
11	Walmer	Walmer ST @ Lyndale DR	S-MA70008060	3,395	7.0
12	Marion	Poulin DR @ Lyndale DR	S-MA50008337	23,362	0.9
13	Despins	Despins ST @ Tache AVE	S-MA70087426	28,007	2.1
14	Dumoulin	Dumoulin ST @ Tache AVE	S-MA70047759	46,869	4.2
15	La Verendrye	La Verendrye ST @ Tache AVE	S-MA70017688	14,796	2.9
16	Lombard	Lombard AVE @ Mill ST	S-MA70012338	0	0.0
17	McDermot	McDermot AVE @ Ship ST	S-MA20013332	135,181	17.1
18	Bannatyne	Bannatyne AVE @ Ship ST	S-MA70000991	24,440	1.0
19	Galt	Galt AVE @ Duncan ST	S-MA70021229	20,730	2.3
20	Mission	Mission ST @ Archibald ST	S-MA70016004	19,695	1.0
21	Roland	Watt ST @ Archibald ST	S-MA40011011	301,103	6.7
22	Syndicate	Syndicate ST @ Rover AVE	S-MA70003283	38,589	4.1

Water and Waste Department Combined Sewer Overflow (CSO) Monthly Tracking Spreadsheet for Federal Government and Provincial Reporting					
OP #	Overflow Point Name	Overflow Point Location (nearest intersection)	Asset Number	1992	
				Yearly Effluent Volume Deposited (m^3)	Yearly Number of Days Effluent Deposited
23	Selkirk	Selkirk AVE @ Austin ST N	S-MA70007427	138,250	7.2
24	Pritchard	Pritchard AVE @ Austin ST N	S-MA00017936	0	0.0
25	Burrows	Burrows AVE @ Main ST	S-MA00017926	21,451	27.2
26	Aberdeen	Aberdeen AVE @ Main ST	S-MA00017914	0	0.0
27	Hart	Hart AVE @ Glenwood CRES	S-MA70043042	202,666	8.0
28	St John's	St John's AVE @ Fowler ST	S-MA70007551	342,728	4.8
29	Bredin	Bredin DR @ Henderson HWY	S-MA40005212	0	0.0
30	Polson	Polson AVE @ Scotia ST	S-MA00017967	80,896	4.9
31	Munroe	Munroe AVE @ Henderson HWY	S-MA70017186	430,508	14.1
32	Inkster	Inkster BLVD @ Scotia ST	S-MA00017939	354,689	5.5
33	Jefferson	Jefferson AVE @ Scotia ST	S-MA70007473	273,800	6.4
34	Linden	Linden AVE @ Kildonan DR	S-MA70016792	13,883	3.2
35	Newton	Newton AVE @ Scotia ST	S-MA00017645	6,971	3.8
36	Armstrong	Armstrong AVE @ Scotia ST	S-MA00017633	714,379	10.4
37	Kildonan Park (Rainbow Stage)	Kildonan Park @ SE Corner	S-MA70069313	0	0.0
38	Hawthorne	Hawthorne AVE @ Kildonan DR	S-MA70062167	33,266	3.5
39	Whellams	Whellams LANE @ Tamarind DR	S-MA70042861	0	0.0
40	Woodhaven	Woodhaven BLVD @ Assiniboine AVE	S-MA70019662	12,321	2.4
41	Olive	Olive ST @ Assiniboine CRES	S-MA20005373	0	0.0
42	Strathmillan	Strathmillan RD @ Portage AVE	S-MA70053789	39,590	6.8
43	Conway	Conway ST @ Portage AVE	S-MA70016333	65,328	4.3
44	Deer Lodge	Deer Lodge PL @	S-	86	0.0

Water and Waste Department Combined Sewer Overflow (CSO) Monthly Tracking Spreadsheet for Federal Government and Provincial Reporting					
OP #	Overflow Point Name	Overflow Point Location (nearest intersection)	Asset Number	1992	
				Yearly Effluent Volume Deposited (m^3)	Yearly Number of Days Effluent Deposited
		Deer Lodge PL	MA70028291		
45	Douglas Park	Douglas Park RD @ Portage AVE	S-MA20008519	662	0.2
46	Ferry Road	Ferry RD @ Assiniboine AVE	S-MA70019346	124,340	21.1
47	Chataway	Chataway BLVD @ Wellington CRES	S-MA70029012	14,658	4.3
48	Doncaster	Doncaster ST @ Wellington CRES	S-MA70019277	30,180	7.9
49	Parkside	Parkside DR @ Assiniboine AVE	S-MA20008800	2,983	1.3
50	Riverbend	Riverbend CRES @ Portage AVE	S-MA20008967	87,370	4.3
51	Academy	Academy RD @ Wellington CRES	S-MA60006673	0	0.0
52	Tylehurst	Tylehurst ST @ Wolseley AVE W	S-MA20020018	182,373	9.1
53	Lindsay	Lindsay ST @ Wellington CRES	S-MA70024441	48,383	33.2
54	Clifton	Clifton ST @ Wolseley AVE	S-MA70008731	109,895	6.1
55	Ash	Ash ST @ Wellington CRES	S-MA70033504	300,268	11.4
56	Aubrey S.R.S. Outfall	Aubrey ST @ Palmerston AVE	S-MA70017585	0	0
57	Aubrey	Aubrey ST @ Palmerston AVE	S-MA70017579	245,669	9.1
58	Ruby	Ruby ST @ Palmerston AVE	S-MA70022480	5,523	21.3
59	Arlington	Arlington ST @ Palmerston AVE	S-MA70053466	0	0.0
60	Canora	Canora ST @ Palmerston AVE	S-MA70017866	711	1.8
61	Cornish C.S. Outfall	Cornish AVE @ Maryland ST	S-MA20013630	2,639	0.6
62	Grosvenor	Grosvenor AVE @ Wellington CRES	S-MA70002491	352	0.5
63	Cornish	Cornish AVE @ Langside ST	S-MA70033535	81,129	7.8
64	Spence	Spence ST @ Balmoral ST	S-MA70103641	39,251	5.2
65	Colony	Colony ST @ Granite WAY (Mostyn)	S-MA20014505	50,309	3.8

Water and Waste Department Combined Sewer Overflow (CSO) Monthly Tracking Spreadsheet for Federal Government and Provincial Reporting					
OP #	Overflow Point Name	Overflow Point Location (nearest intersection)	Asset Number	1992	
				Yearly Effluent Volume Deposited (m^3)	Yearly Number of Days Effluent Deposited
66	Kennedy	Kennedy ST @ Assiniboine AVE	S-MA70068974	3,827	0.4
67	Fort Rouge Park	River AVE @ Cauchon ST	S-MA60020193	124	0.3
68	Hargrave	Hargrave ST @ Assiniboine AVE	S-MA20014087	870	1.1
69	Donald	Donald ST @ Assiniboine AVE	S-MA20014095	1,101	1.2
70	Mayfair	Mayfair AVE @ Queen Elizabeth WAY	S-MA70004387	11,039	0.6
71	Assiniboine	Assiniboine AVE @ Main ST	S-MA70008123	5,036	2.3
72	Strathcona	Strathcona ST @ Portage AVE	S-MA20011477	38,746	55.6
73	Plinguet	Plinguet ST @ Archibald ST	S-MA70041411	0	0.0
74	Cherrier	Cherrier ST @ Dufresne AVE	S-MA50002504	0	0.0
75	Doucet	Doucet ST @ Dufresne AVE	S-MA50002528	0	0.0
76	Prosper	Prosper ST @ Evans ST	S-MA50002566	0	0.0
77	Dubuc	Dubuc ST @ Seine ST	S-MA70022443	0	0.0
78	Gareau	Gareau ST @ Evans ST	S-MA70033704	0	0.0
79	Comanche	Comanche RD @ Iroquois BAY	S-MA50010965	0	0.0
80	Aubrey Flood (Pumped)	Aubrey ST @ Palmerston AVE	S-MA70017556	0	0.0
81	Clifton Flood (Pumped)	Clifton ST @ Wolseley AVE	S-MA70042741	4,757	0.1
82	Cornish Flood (Pumped)	Cornish AVE @ Sherbrook Bridge	S-MA70017433	607	0.0
83	Despins Flood (Pumped)	Despins ST @ Tache AVE	S-MA70087428	2,538	0.1
84	Dumoulin Flood (Pumped)	Dumoulin ST @ Tache AVE	S-MA70016522	25	0.0
85	Marion Flood (Pumped)	Poulin DR @ Lyndale DR	S-MA70105998	7,110	0.1
86	La Verendrye Flood (Pumped)	La Verendrye ST @ Tache AVE	S-MA70109090	202	0.0

Water and Waste Department Combined Sewer Overflow (CSO) Monthly Tracking Spreadsheet for Federal Government and Provincial Reporting

OP #	Overflow Point Name	Overflow Point Location (nearest intersection)	Asset Number	1992 Yearly Effluent Volume Deposited (m³)	1992 Yearly Number of Days Effluent Deposited
87	Cockburn Flood (Pumped)	Cockburn ST S @ Churchill DR	S-MA60012037	0	0.0
88	Linden Flood (Pumped)	Linden AVE @ Kildonan DR	S-MA70016792	0	0.0
89	Ash Flood (Pumped)	Ash ST @ Wellington CRES	S-MA70016005	6,562	0.1

NOTE: Based on Hydraulic Modelling Results covering the representative year 1992

LEGEND:

Overflow Points Associated with **N.E.W.P.C.C.**	Overflow Points Associated with **S.E.W.P.C.C**	Overflow Points Associated with **W.E.W.P.C.C.**		
Indicates Overflow Point **Is Monitored**	Indicates Overflow Point **Is Monitored**	Indicates Overflow Point **Is Monitored**	Please note that the above results are based on the current 2013 Regional Model and no outfall monitors were installed during this period of 1992.	
Indicates Overflow Point **Not Monitored**	Indicates Overflow Point **Not Monitored**	Indicates Overflow Point **Not Monitored**		

Water and Waste Department Combined Sewer Overflow (CSO) Monthly Tracking Spreadsheet for Federal Government and Provincial Reporting					
				2009	
OP #	Overflow Point Name	Overflow Point Location (nearest intersection)	Asset Number	Yearly Effluent Volume Deposited (m^3)	Yearly Number of Days Effluent Deposited
1	Cockburn	Cockburn ST S @ Churchill DR	S-MA60012037	20,230	14.0
2	Osborne	Osborne ST @ Churchill DR	S-MA70006325	2,930	2.0
3	Kingston	Kingston ROW @ Dunkirk DR	S-MA50014591	0	0.0
4	Mager	Mager DR W @ St Mary's RD	S-MA70007510	4,390	3.0
5	Baltimore	Baltimore RD @ Churchill DR	S-MA60013599	5,090	3.5
6	Metcalfe	Metcalfe AVE @ St Mary's RD	S-MA70011115	4,190	2.9
7	Eccles East	Eccles ST @ Churchill DR	S-MA70022370	100	0.1
8	Eccles West	Eccles ST @ Churchill DR	S-MA70006655	410	0.3
9	Churchill	Churchill DR @ Hay ST	S-MA70005806	31,470	21.9
10	Jessie	Jessie AVE @ Osborne ST	S-MA70016174	387,127	10.6
11	Walmer	Walmer ST @ Lyndale DR	S-MA70008060	15,989	22.6
12	Marion	Poulin DR @ Lyndale DR	S-MA50008337	81,714	3.5
13	Despins	Despins ST @ Tache AVE	S-MA70087426	92,171	5.1
14	Dumoulin	Dumoulin ST @ Tache AVE	S-MA70047759	110,558	11.8
15	La Verendrye	La Verendrye ST @ Tache AVE	S-MA70017688	31,394	4.6
16	Lombard	Lombard AVE @ Mill ST	S-MA70012338	10	0.0
17	McDermot	McDermot AVE @ Ship ST	S-MA20013332	311,712	25.1
18	Bannatyne	Bannatyne AVE @ Ship ST	S-MA70000991	90,680	2.5
19	Galt	Galt AVE @ Duncan ST	S-MA70021229	63,997	4.4
20	Mission	Mission ST @ Archibald ST	S-MA70016004	118,237	3.8
21	Roland	Watt ST @ Archibald ST	S-MA40011011	598,880	9.9
22	Syndicate	Syndicate ST @ Rover AVE	S-MA70003283	74,019	5.8

Water and Waste Department Combined Sewer Overflow (CSO) Monthly Tracking Spreadsheet for Federal Government and Provincial Reporting					
				2009	
OP #	Overflow Point Name	Overflow Point Location (nearest intersection)	Asset Number	Yearly Effluent Volume Deposited (m^3)	Yearly Number of Days Effluent Deposited
23	Selkirk	Selkirk AVE @ Austin ST N	S-MA70007427	244,130	10.3
24	Pritchard	Pritchard AVE @ Austin ST N	S-MA00017936	0	0.0
25	Burrows	Burrows AVE @ Main ST	S-MA00017926	83,044	41.5
26	Aberdeen	Aberdeen AVE @ Main ST	S-MA00017914	0	0.0
27	Hart	Hart AVE @ Glenwood CRES	S-MA70043042	342,306	10.8
28	St John's	St John's AVE @ Fowler ST	S-MA70007551	670,955	9.0
29	Bredin	Bredin DR @ Henderson HWY	S-MA40005212	167	0.1
30	Polson	Polson AVE @ Scotia ST	S-MA00017967	224,366	9.2
31	Munroe	Munroe AVE @ Henderson HWY	S-MA70017186	568,608	20.0
32	Inkster	Inkster BLVD @ Scotia ST	S-MA00017939	678,829	7.8
33	Jefferson	Jefferson AVE @ Scotia ST	S-MA70007473	517,828	8.5
34	Linden	Linden AVE @ Kildonan DR	S-MA70016792	84,363	10.9
35	Newton	Newton AVE @ Scotia ST	S-MA00017645	56,205	6.3
36	Armstrong	Armstrong AVE @ Scotia ST	S-MA00017633	1,171,809	13.9
37	Kildonan Park (Rainbow Stage)	Kildonan Park @ SE Corner	S-MA70069313	0	0.0
38	Hawthorne	Hawthorne AVE @ Kildonan DR	S-MA70062167	156,591	9.5
39	Whellams	Whellams LANE @ Tamarind DR	S-MA70042861	4,490	0.3
40	Woodhaven	Woodhaven BLVD @ Assiniboine AVE	S-MA70019662	7,330	5.1
41	Olive	Olive ST @ Assiniboine CRES	S-MA20005373	70	0.0
42	Strathmillan	Strathmillan RD @ Portage AVE	S-MA70053789	27,710	19.2
43	Conway	Conway ST @ Portage AVE	S-MA70016333	13,540	9.4
44	Deer Lodge	Deer Lodge PL @	S-	1,390	0.2

Water and Waste Department Combined Sewer Overflow (CSO) Monthly Tracking Spreadsheet for Federal Government and Provincial Reporting					
				2009	
OP #	Overflow Point Name	Overflow Point Location (nearest intersection)	Asset Number	Yearly Effluent Volume Deposited (m^3)	Yearly Number of Days Effluent Deposited
		Deer Lodge PL	MA70028291		
45	Douglas Park	Douglas Park RD @ Portage AVE	S-MA20008519	2,019	0.4
46	Ferry Road	Ferry RD @ Assiniboine AVE	S-MA70019346	260,030	35.5
47	Chataway	Chataway BLVD @ Wellington CRES	S-MA70029012	37,102	8.8
48	Doncaster	Doncaster ST @ Wellington CRES	S-MA70019277	63,104	11.1
49	Parkside	Parkside DR @ Assiniboine AVE	S-MA20008800	6,869	1.8
50	Riverbend	Riverbend CRES @ Portage AVE	S-MA20008967	181,405	6.0
51	Academy	Academy RD @ Wellington CRES	S-MA60006673	32	0.1
52	Tylehurst	Tylehurst ST @ Wolseley AVE W	S-MA20020018	280,036	12.0
53	Lindsay	Lindsay ST @ Wellington CRES	S-MA70024441	146,666	40.1
54	Clifton	Clifton ST @ Wolseley AVE	S-MA70008731	290,942	13.4
55	Ash	Ash ST @ Wellington CRES	S-MA70033504	603,618	24.2
56	Aubrey S.R.S. Outfall	Aubrey ST @ Palmerston AVE	S-MA70017585	20,271	29.5
57	Aubrey	Aubrey ST @ Palmerston AVE	S-MA70017579	465,462	14.3
58	Ruby	Ruby ST @ Palmerston AVE	S-MA70022480	18,621	27.1
59	Arlington	Arlington ST @ Palmerston AVE	S-MA70053466	150	0.1
60	Canora	Canora ST @ Palmerston AVE	S-MA70017866	6,940	5.2
61	Cornish C.S. Outfall	Cornish AVE @ Maryland ST	S-MA20013630	10,463	2.0
62	Grosvenor	Grosvenor AVE @ Wellington CRES	S-MA70002491	15,011	1.5
63	Cornish	Cornish AVE @ Langside ST	S-MA70033535	197,109	14.7
64	Spence	Spence ST @ Balmoral ST	S-MA70103641	143,657	24.3
65	Colony	Colony ST @ Granite WAY (Mostyn)	S-MA20014505	123,219	7.1

Water and Waste Department Combined Sewer Overflow (CSO) Monthly Tracking Spreadsheet for Federal Government and Provincial Reporting					
				2009	
OP #	Overflow Point Name	Overflow Point Location (nearest intersection)	Asset Number	Yearly Effluent Volume Deposited (m^3)	Yearly Number of Days Effluent Deposited
66	Kennedy	Kennedy ST @ Assiniboine AVE	S-MA70068974	11,803	0.9
67	Fort Rouge Park	River AVE @ Cauchon ST	S-MA60020193	8,128	3.8
68	Hargrave	Hargrave ST @ Assiniboine AVE	S-MA20014087	3,628	2.1
69	Donald	Donald ST @ Assiniboine AVE	S-MA20014095	12,311	3.6
70	Mayfair	Mayfair AVE @ Queen Elizabeth WAY	S-MA70004387	36,241	1.7
71	Assiniboine	Assiniboine AVE @ Main ST	S-MA70008123	36,557	7.8
72	Strathcona	Strathcona ST @ Portage AVE	S-MA20011477	108,389	45.8
73	Plinguet	Plinguet ST @ Archibald ST	S-MA70041411	0	0.0
74	Cherrier	Cherrier ST @ Dufresne AVE	S-MA50002504	0	0.0
75	Doucet	Doucet ST @ Dufresne AVE	S-MA50002528	0	0.0
76	Prosper	Prosper ST @ Evans ST	S-MA50002566	0	0.0
77	Dubuc	Dubuc ST @ Seine ST	S-MA70022443	0	0.0
78	Gareau	Gareau ST @ Evans ST	S-MA70033704	0	0.0
79	Comanche	Comanche RD @ Iroquois BAY	S-MA50010965	0	0.0
80	Aubrey Flood (Pumped)	Aubrey ST @ Palmerston AVE	S-MA70017556	28,116	0.2
81	Clifton Flood (Pumped)	Clifton ST @ Wolseley AVE	S-MA70042741	30,198	0.3
82	Cornish Flood (Pumped)	Cornish AVE @ Sherbrook Bridge	S-MA70017433	9,763	0.2
83	Despins Flood (Pumped)	Despins ST @ Tache AVE	S-MA70087428	26,101	0.4
84	Dumoulin Flood (Pumped)	Dumoulin ST @ Tache AVE	S-MA70016522	0	0.0
85	Marion Flood (Pumped)	Poulin DR @ Lyndale DR	S-MA70105998	34,937	0.3
86	La Verendrye Flood (Pumped)	La Verendrye ST @ Tache AVE	S-MA70109090	2,858	0.2

Water and Waste Department Combined Sewer Overflow (CSO) Monthly Tracking Spreadsheet for Federal Government and Provincial Reporting					
				2009	
OP #	Overflow Point Name	Overflow Point Location (nearest intersection)	Asset Number	Yearly Effluent Volume Deposited (m^3)	Yearly Number of Days Effluent Deposited
87	Cockburn Flood (Pumped)	Cockburn ST S @ Churchill DR	S-MA60012037	0	0.0
88	Linden Flood (Pumped)	Linden AVE @ Kildonan DR	S-MA70016792	0	0.0
89	Ash Flood (Pumped)	Ash ST @ Wellington CRES	S-MA70016005	27,259	0.3

NOTE: Based on Hydraulic Modelling Results covering the representative year 2009

LEGEND:				
Overflow Points Associated with **N.E.W.P.C.C.**	Overflow Points Associated with **S.E.W.P.C.C**	Overflow Points Associated with **W.E.W.P.C.C.**		
Indicates Overflow Point **Is Monitored**	Indicates Overflow Point **Is Monitored**	Indicates Overflow Point **Is Monitored**	Please note that the above results are based on the current 2013 Regional Model and no outfall monitors were installed during this period of 2009	
Indicates Overflow Point **Not Monitored**	Indicates Overflow Point **Not Monitored**	Indicates Overflow Point **Not Monitored**		

Water and Waste Department Combined Sewer Overflow (CSO) Monthly Tracking Spreadsheet for Federal Government and Provincial Reporting					
				2013	
OP #	Overflow Point Name	Overflow Point Location (nearest intersection)	Asset Number	Yearly Effluent Volume Deposited (m^3)	Yearly Number of Days Effluent Deposited
1	Cockburn	Cockburn ST S @ Churchill DR	S-MA60012037	160,301	4.7
2	Osborne	Osborne ST @ Churchill DR	S-MA70006325	1,488	0.8
3	Kingston	Kingston ROW @ Dunkirk DR	S-MA50014591	0	0.0
4	Mager	Mager DR W @ St Mary's RD	S-MA70007510	34,896	1.7
5	Baltimore	Baltimore RD @ Churchill DR	S-MA60013599	88,810	1.9
6	Metcalfe	Metcalfe AVE @ St Mary's RD	S-MA70011115	18,246	1.8
7	Eccles East	Eccles ST @ Churchill DR	S-MA70022370	58	0.0
8	Eccles West	Eccles ST @ Churchill DR	S-MA70006655	1,675	0.1
9	Churchill	Churchill DR @ Hay ST	S-MA70005806	10,395	6.9
10	Jessie	Jessie AVE @ Osborne ST	S-MA70016174	203,475	2.9
11	Walmer	Walmer ST @ Lyndale DR	S-MA70008060	3,949	3.3
12	Marion	Poulin DR @ Lyndale DR	S-MA50008337	25,406	0.6
13	Despins	Despins ST @ Tache AVE	S-MA70087426	48,196	1.9
14	Dumoulin	Dumoulin ST @ Tache AVE	S-MA70047759	55,105	3.4
15	La Verendrye	La Verendrye ST @ Tache AVE	S-MA70017688	17,885	2.2
16	Lombard	Lombard AVE @ Mill ST	S-MA70012338	0	0.0
17	McDermot	McDermot AVE @ Ship ST	S-MA20013332	174,786	9.8
18	Bannatyne	Bannatyne AVE @ Ship ST	S-MA70000991	55,414	1.1
19	Galt	Galt AVE @ Duncan ST	S-MA70021229	34,842	2.0
20	Mission	Mission ST @ Archibald ST	S-MA70016004	49,038	1.1
21	Roland	Watt ST @ Archibald ST	S-MA40011011	400,549	3.8
22	Syndicate	Syndicate ST @ Rover AVE	S-MA70003283	50,839	2.6

Water and Waste Department Combined Sewer Overflow (CSO) Monthly Tracking Spreadsheet for Federal Government and Provincial Reporting					
				2013	
OP #	Overflow Point Name	Overflow Point Location (nearest intersection)	Asset Number	Yearly Effluent Volume Deposited (m³)	Yearly Number of Days Effluent Deposited
23	Selkirk	Selkirk AVE @ Austin ST N	S-MA70007427	163,064	5.0
24	Pritchard	Pritchard AVE @ Austin ST N	S-MA00017936	0	0.0
25	Burrows	Burrows AVE @ Main ST	S-MA00017926	54,489	16.4
26	Aberdeen	Aberdeen AVE @ Main ST	S-MA00017914	0	0.0
27	Hart	Hart AVE @ Glenwood CRES	S-MA70043042	208,499	4.4
28	St John's	St John's AVE @ Fowler ST	S-MA70007551	452,478	3.4
29	Bredin	Bredin DR @ Henderson HWY	S-MA40005212	59	0.0
30	Polson	Polson AVE @ Scotia ST	S-MA00017967	111,277	3.1
31	Munroe	Munroe AVE @ Henderson HWY	S-MA70017186	317,551	9.9
32	Inkster	Inkster BLVD @ Scotia ST	S-MA00017939	399,008	3.2
33	Jefferson	Jefferson AVE @ Scotia ST	S-MA70007473	312,996	3.7
34	Linden	Linden AVE @ Kildonan DR	S-MA70016792	18,264	2.0
35	Newton	Newton AVE @ Scotia ST	S-MA00017645	44,400	4.9
36	Armstrong	Armstrong AVE @ Scotia ST	S-MA00017633	720,714	6.6
37	Kildonan Park (Rainbow Stage)	Kildonan Park @ SE Corner	S-MA70069313	0	0.0
38	Hawthorne	Hawthorne AVE @ Kildonan DR	S-MA70062167	44,386	2.1
39	Whellams	Whellams LANE @ Tamarind DR	S-MA70042861	0	0.0
40	Woodhaven	Woodhaven BLVD @ Assiniboine AVE	S-MA70019662	18,665	1.9
41	Olive	Olive ST @ Assiniboine CRES	S-MA20005373	0	0.0
42	Strathmillan	Strathmillan RD @ Portage AVE	S-MA70053789	41,135	4.2
43	Conway	Conway ST @ Portage AVE	S-MA70016333	83,162	2.7
44	Deer Lodge	Deer Lodge PL @	S-	756	0.2

Water and Waste Department Combined Sewer Overflow (CSO) Monthly Tracking Spreadsheet for Federal Government and Provincial Reporting					
				2013	
OP #	Overflow Point Name	Overflow Point Location (nearest intersection)	Asset Number	Yearly Effluent Volume Deposited (m^3)	Yearly Number of Days Effluent Deposited
		Deer Lodge PL	MA70028291		
45	Douglas Park	Douglas Park RD @ Portage AVE	S-MA20008519	1,991	0.4
46	Ferry Road	Ferry RD @ Assiniboine AVE	S-MA70019346	134,724	15.4
47	Chataway	Chataway BLVD @ Wellington CRES	S-MA70029012	19,034	2.6
48	Doncaster	Doncaster ST @ Wellington CRES	S-MA70019277	43,093	6.5
49	Parkside	Parkside DR @ Assiniboine AVE	S-MA20008800	5,889	1.1
50	Riverbend	Riverbend CRES @ Portage AVE	S-MA20008967	124,458	2.9
51	Academy	Academy RD @ Wellington CRES	S-MA60006673	7	0.0
52	Tylehurst	Tylehurst ST @ Wolseley AVE W	S-MA20020018	193,646	5.6
53	Lindsay	Lindsay ST @ Wellington CRES	S-MA70024441	83,007	23.3
54	Clifton	Clifton ST @ Wolseley AVE	S-MA70008731	109,874	3.5
55	Ash	Ash ST @ Wellington CRES	S-MA70033504	219,575	6.5
56	Aubrey S.R.S. Outfall	Aubrey ST @ Palmerston AVE	S-MA70017585	5,944	19.9
57	Aubrey	Aubrey ST @ Palmerston AVE	S-MA70017579	182,169	5.0
58	Ruby	Ruby ST @ Palmerston AVE	S-MA70022480	5,208	21.3
59	Arlington	Arlington ST @ Palmerston AVE	S-MA70053466	32	0.0
60	Canora	Canora ST @ Palmerston AVE	S-MA70017866	2,147	2.4
61	Cornish C.S. Outfall	Cornish AVE @ Maryland ST	S-MA20013630	6,262	0.8
62	Grosvenor	Grosvenor AVE @ Wellington CRES	S-MA70002491	6,729	1.9
63	Cornish	Cornish AVE @ Langside ST	S-MA70033535	68,297	4.2
64	Spence	Spence ST @ Balmoral ST	S-MA70103641	70,471	3.8
65	Colony	Colony ST @ Granite WAY (Mostyn)	S-MA20014505	61,253	2.5

Water and Waste Department Combined Sewer Overflow (CSO) Monthly Tracking Spreadsheet for Federal Government and Provincial Reporting

OP #	Overflow Point Name	Overflow Point Location (nearest intersection)	Asset Number	2013	
				Yearly Effluent Volume Deposited (m^3)	Yearly Number of Days Effluent Deposited
66	Kennedy	Kennedy ST @ Assiniboine AVE	S-MA70068974	10,233	0.6
67	Fort Rouge Park	River AVE @ Cauchon ST	S-MA60020193	2,726	2.0
68	Hargrave	Hargrave ST @ Assiniboine AVE	S-MA20014087	3,032	1.0
69	Donald	Donald ST @ Assiniboine AVE	S-MA20014095	5,905	2.6
70	Mayfair	Mayfair AVE @ Queen Elizabeth WAY	S-MA70004387	26,313	0.8
71	Assiniboine	Assiniboine AVE @ Main ST	S-MA70008123	21,470	3.6
72	Strathcona	Strathcona ST @ Portage AVE	S-MA20011477	58,637	32.0
73	Plinguet	Plinguet ST @ Archibald ST	S-MA70041411	0	0.0
74	Cherrier	Cherrier ST @ Dufresne AVE	S-MA50002504	0	0.0
75	Doucet	Doucet ST @ Dufresne AVE	S-MA50002528	0	0.0
76	Prosper	Prosper ST @ Evans ST	S-MA50002566	0	0.0
77	Dubuc	Dubuc ST @ Seine ST	S-MA70022443	0	0.0
78	Gareau	Gareau ST @ Evans ST	S-MA70033704	0	0.0
79	Comanche	Comanche RD @ Iroquois BAY	S-MA50010965	0	0.0
80	Aubrey Flood (Pumped)	Aubrey ST @ Palmerston AVE	S-MA70017556	23,540	0.2
81	Clifton Flood (Pumped)	Clifton ST @ Wolseley AVE	S-MA70042741	25,986	0.3
82	Cornish Flood (Pumped)	Cornish AVE @ Sherbrook Bridge	S-MA70017433	6,012	0.1
83	Despins Flood (Pumped)	Despins ST @ Tache AVE	S-MA70087428	19,150	0.4
84	Dumoulin Flood (Pumped)	Dumoulin ST @ Tache AVE	S-MA70016522	0	0.0
85	Marion Flood (Pumped)	Poulin DR @ Lyndale DR	S-MA70105998	24,184	0.3
86	La Verendrye Flood (Pumped)	La Verendrye ST @ Tache AVE	S-MA70109090	1,555	0.1

Water and Waste Department Combined Sewer Overflow (CSO) Monthly Tracking Spreadsheet for Federal Government and Provincial Reporting					
				2013	
OP #	Overflow Point Name	Overflow Point Location (nearest intersection)	Asset Number	Yearly Effluent Volume Deposited (m^3)	Yearly Number of Days Effluent Deposited
87	Cockburn Flood (Pumped)	Cockburn ST S @ Churchill DR	S-MA60012037	0	0.0
88	Linden Flood (Pumped)	Linden AVE @ Kildonan DR	S-MA70016792	0	0.0
89	Ash Flood (Pumped)	Ash ST @ Wellington CRES	S-MA70016005	20,600	0.3

NOTE: Based on Hydraulic Modelling Results covering the representative year 2013

LEGEND:				
Overflow Points Associated with **N.E.W.P.C.C.**	Overflow Points Associated with **S.E.W.P.C.C**	Overflow Points Associated with **W.E.W.P.C.C.**		
Indicates Overflow Point **Is Monitored**	Indicates Overflow Point **Is Monitored**	Indicates Overflow Point **Is Monitored**	Please note that the above results are based on the current 2013 Regional Model and no validation against outfall monitor data has taken place	
Indicates Overflow Point **Not Monitored**	Indicates Overflow Point **Not Monitored**	Indicates Overflow Point **Not Monitored**		

Winnipeg

Water and Waste Department • Service des eaux et des déchets

Licence Clarification

Environment Act Licence No. 3042

July, 25 2018

1 Table of Contents

Acronyms and Definitions

Cumulative List of Acronyms and Definitions used in Clarifications

Definitions are consistent with Environment Act Licence No. 3042 (Licence) where applicable.

City of Winnipeg (City)

Clean Environment Commission (CEC)

Combined Sewer Overflow (CSO) – a discharge to the environment from a combined sewer system.

Dry weather flow (DWF) – Flow entering sewers during dry weather from homes and businesses.

Infiltration and Inflow (I&I)

Infiltration is:

- groundwater that infiltrates a sewer system through defective pipes, pipe joints, connections, or manholes; and
- generally measured during seasonally high ground water conditions, during dry weather.

Inflow is:

- water other than sanitary flow that enters a sewer system from sources which include, but are not limited to, roof leaders, foundation drains, yard drains, area drains, drains from wet areas, cross connections between storm sewers and sanitary sewers, catch basins, cooling towers, stormwater, surface runoff (including leaking manhole covers), or drainage; and
- generally measured during wet weather.

Manitoba Conservation and Water Stewardship (MCWS)

Manitoba Sustainable Development (MSD)

Regulatory Working Committee (RWC)

Runoff – Water from rainfall, snowmelt, or other sources that flows over the ground surface, to the storm drains at the curb and into the land drainage or combined sewers and into the rivers.

Stormwater – An engineering term for wet weather flow (WWF)

Wet weather flow (WWF) – the combined flow resulting from:

i. wastewater;

ii. infiltration and inflows from foundation drains or other drains resulting from rainfall or snowmelt; and

iii. stormwater runoff generated by either rainfall or snowmelt that enters the combined sewer system.

Executive Summary

A Regulatory Working Committee (RWC) was formed between Manitoba Sustainable Development (MSD) and the City of Winnipeg (City) to deal with technical issues encountered while developing the Combined Sewer Overflow (CSO) Master Plan (MP). To date, the RWC has met on six occasions and has been effective in collaborating on technical issues and Licence interpretations.

This report identifies the first request for clarification under Environment Act Licence No. 3042 since submission of the Preliminary Proposal and receipt of approval from MSD to proceed on November 24, 2017.

The clarification addresses the conditions under which the City provides a revised CSO MP to phase in Control Option No.2, after implementation of Control Option No. 1.

As discussed at RWC meeting No. 6 on June 15, 2018, the City raised issues and concerns with migration to Control Option No. 2. This submission is therefore intended to identify the issues and provide the basis for the clarification, for consideration by MSD.

The issues relate to using different performance measurements for each control option; Control Option 1 is based on system-wide percent capture and Control Option 2 is based on a number of allowable overflows for each district. As MSD have directed the City to migrate to Control Option 2 in the future the migration would create a change in the performance measurements and reporting approach.

As discussed at RWC meeting No.6, MSD's objective was to achieve 98% CSO volume capture in a representative year as provided for by Control Option 2, without a requirement for the number of overflows.

It is therefore recommended that the clarification modify the phase in requirement to achieve 98% CSO volume capture in a representative year, instead of phasing in to Control Option No. 2, This will ensure alignment with Control Option 1 and continual consistent performance measurement through the phase in..

Upon approval, the City will continue the current CSO Master Plan development based on implementation of Control Option No. 1, with consideration for a percent capture migration strategy.

The analysis with regards migration to 98% Capture in a Representative Year will be evaluated and reported on by April 30, 2030 in a revised CSO MP.

1 Clarification for Control Option 2 Phase In

1.1 Current Condition:

The CSO Master Plan Preliminary Proposal was submitted on December 18, 2015 in accordance with Environment Act Licence No. 3042 (Licence). The submission included an evaluation of five alternative control options, and a recommendation that Control Option No. 1 for 85% Capture in a Representative Year (85% Capture) be approval by the Director.

The Director approved of the Preliminary Proposal on November 24, 2017 with the condition that "Control Option No. 1 be implemented in such a way so that Control Option No. 2 may eventually be phased in."

1.2 Issue with Current:

While the Preliminary Proposal did recognize an aspiration goal to deal with future upgrades, there are issues that arise with the direct phase in from Control Option No.1 to Control Option 2.

The two control options are based on different control objectives, as noted from their descriptions:

- Control Option 1: 85% Capture in a Representative Year
- Control Option 2: Four overflows in a Representative Year

Control Option 1 requires that 85% of the wastewater be captured on a system-wide basis. This allows for high levels of control in some combined sewer districts while others may have lower levels of control provided the overall objective of 85% capture is achieved.

Control Option 2 by comparison requires that each combined sewer district meet the four-overflow target limit for the representative year. Upon achieving the four-overflow limit, the system-wide level of wastewater capture was estimated at 98%, but with this not being a regulatory objective.

The phase in approach may therefore commit funding for Control Option 1 that is not required to meet the objectives for Control Option 2. By example, the most cost-effective implementation plan for a combined district under Control Option 1 may be complete separation, but approach would not be selected for Control Option 2, since the resulting performance would exceed the four-overflow objective.

1.3 Proposed Change:

It is proposed that the licence conditions identified within the letter of November 24, 2017 be changed as follows:

Fourth last paragraph from:

> *"...with the condition that Control Option No. 1 be implemented in such a way so that Control Option No. 2 may eventually be phased in."*

to:

> *"...with the condition that Control Option No. 1 be implemented in such a way so that 98% Capture in a Representative Year may eventually be phased in."*

Third last paragraph from:

> *"…schedule for Control Option 1…on or before August 31, 2019 and for Control Option No. 2…on or before April 30, 2030."*

to:

> *"…schedule for Control Option 1…on or before August 31, 2019 and for 98% Capture in a Representative Year…on or before April 30, 2030."*

Replacing "Control Option 2" with "98% Capture" addresses the concern that 98% capture was not considered in the Preliminary Proposal as a Control Alternative, and its performance may not be identical to Control Option 2.

1.4 Rationale for Change:

Migration from Control Option 1 to Control Option 2 would not be cost effective because they are not building blocks for each other. Sequential completion of the control options would result in an over commitment of funds needed to achieve the Control Option 2 performance objectives.

Changing the phase in requirement to "98% Capture in a Representative Year" would avoid many of the issues, and achieve a nearly similar and more cost-effective result. The change would permit complete separation of selected combined sewer districts to continue since full separation would contribute to the performance objectives.

The proposed change will maintain consistence in performance measurement through the life of the CSO MP implementation.

Manitoba
Conservation and Water Stewardship

Climate Change and Environmental Protection Division
Environmental Approvals Branch
123 Main Street, Suite 160, Winnipeg, Manitoba R3C 1A5
T 204 945-8321 **F** 204 945-5229
www.gov.mb.ca/conservation/eal

CLIENT FILE NO.: 3205.00

September 4, 2013

Diane Sacher, P.Eng.,
Director, Water and Waste Department
City of Winnipeg,
112 — 1199 Pacific Avenue
Winnipeg MB R3E 3S8

Dear Ms. Sacher:

Enclosed is **Environment Act Licence No. 3042** dated September 4, 2013 issued to the **City of Winnipeg** for the operation of the Development being the existing combined sewers and overflow structures located within the City of Winnipeg with discharge of wastewater into the Assiniboine River and Red River.

In addition to the enclosed Licence requirements, please be informed that all other applicable federal, provincial and municipal regulations and by-laws must be complied with. A Notice of Alteration must be filed with the Director for approval prior to any alteration to the Development as licensed.

For further information on the administration and application of the Licence, please feel free to contact the undersigned at 204-945-7071.

Pursuant to Section 27 of *The Environment Act*, this licensing decision may be appealed by any person who is affected by the issuance of this Licence to the Minister of Conservation and Water Stewardship within 30 days of the date of the Licence.

Yours truly,

"original signed by"

Tracey Braun, M.Sc.
Director
Environment Act

c: Don Labossiere, Director, Environmental Compliance and Enforcement
Public Registries

NOTE: **Confirmation of Receipt of this Licence No. 3042 *(by the Licencee only)* is required by the Director of Environmental Approvals. Please acknowledge receipt by signing in the space provided below and faxing a copy (letter only) to the Department by September 18, 2013.**

On behalf of the City of Winnipeg **Date**

****A COPY OF THE LICENCE MUST BE KEPT ON SITE AT THE DEVELOPMENT AT ALL TIMES****

THE ENVIRONMENT ACT
LOI SUR L'ENVIRONNEMENT

Manitoba

LICENCE

Licence No. / Licence n° 3042

Issue Date / Date de délivrance September 4, 2013

In accordance with *The Environment Act* (C.C.S.M. c. E125) /
Conformément à *la Loi sur l'environnement* (C.P.L.M. c. E125)

Pursuant to Section 11 / Conformément au Paragraphe 11

THIS LICENCE IS ISSUED TO: / CETTE LICENCE EST DONNÉE À :

CITY OF WINNIPEG;
"the Licencee"

for the operation of the Development being the combined sewers and overflow structures located within the City of Winnipeg with discharge of wastewater into the Assiniboine River and Red River and associated tributaries, and subject to the following specifications, limits, terms and conditions:

DEFINITIONS

In this Licence,

"accredited laboratory" means an analytical facility accredited by the Standard Council of Canada (SCC), or accredited by another accrediting agency recognized by Manitoba Conservation to be equivalent to the SCC, or be able to demonstrate, upon request, that it has the quality assurance/quality control (QA/QC) procedures in place equivalent to accreditation based on the international standard ISO/IEC 17025, or otherwise approved by the Director;

"approved" means approved by the Director in writing;

"average dry weather flow" means the average daily volume of wastewater entering the combined sewer system in dry weather;

"combined sewer system" means a wastewater collection system which conveys wastewaters (domestic, commercial and industrial wastewaters) and stormwater runoff through a single-pipe system to a sewage treatment plant or treatment works;

****A COPY OF THE LICENCE MUST BE KEPT ON SITE AT THE DEVELOPMENT AT ALL TIMES****

"combined sewer overflow (CSO)" means a discharge to the environment from a combined sewer system;

"Director" means an employee so designated pursuant to *The Environment Act*;

"effluent" means treated wastewater flowing or pumped out of the combined sewer system;

"enhanced primary treatment" means wastewater treatment that utilizes a chemical coagulant/flocculant to remove suspended matter and soluble organic matter;

"Environment Officer" means an employee so appointed pursuant to *The Environment Act*;

"Escherichia coli (E. coli) " means the species of bacteria in the fecal coliform group found in large numbers in the gastrointestinal tract and feces of warm-blooded animals and man, whose presence is considered indicative of fresh fecal contamination, and is used as an indicator organism for the presence of less easily detected pathogenic bacteria;

"fecal coliform" means aerobic and facultative, Gram-negative, nonspore-forming, rod-shaped bacteria capable of growth at 44.5° C, and associated with fecal matter of warm-blooded animals;

"five-day biochemical oxygen demand (BOD_5)" means that part of the oxygen demand usually associated with biochemical oxidation of organic matter within five days at a temperature of 20° C;

"floatable material" means items such as, but not limited to, plastics and other floating debris (e.g., oil, grease, toilet paper, and sanitary items);

"grab sample" means a quantity of wastewater taken at a given place and time;

"MPN Index" means the most probable number of coliform organisms in a given volume of wastewater which, in accordance with statistical theory, would yield the observed test result with the greatest frequency;

"overflow event" means an event that occurs when there is one or more CSOs from a combined sewer system, resulting from a precipitation event. An intervening time of 24 hours or greater separating a CSO from the last prior CSO at the same location is considered to separate one overflow event from another;

"overflow point" means a point of a wastewater collection system via which wastewater may be deposited in water or a place and beyond which its owner or operator no longer exercises control over the quality of wastewater;

"percent capture" means the volume of wet weather flow treated in comparison to the volume of wet weather flow collected on a percentage basis;

"real time" means the actual time at which an event occurs;

"sewershed" means the area drained by a particular network of sewers;

"Standard Methods for the Examination of Water and Wastewater" means the most recent edition of Standard Methods for the Examination of Water and Wastewater, published jointly by the American Public Health Association, the American Waterworks Association and the Water Environment Association;

"wastewater" means the spent or used water from domestic, industrial and commercial sources that contains dissolved and suspended matter;

"wastewater collection system" means the sewer and pumping system used for the collection and conveyance of domestic, commercial and industrial wastewater;

"wet weather flow" means the combined flow resulting from:

i) wastewater;
ii) infiltration and inflows from foundation drains or other drains resulting from rainfall or snowmelt; and
iii) stormwater runoff generated by either rainfall or snowmelt that enters the combined sewer system; and

"wet weather period" means the spring thaw period and any period of precipitation capable of generating inflow to a combined sewer system that exceeds the capability of the system to convey wet weather flows to a sewage treatment plant.

GENERAL TERMS AND CONDITIONS

This Section of the Licence contains requirements intended to provide guidance to the Licencee in implementing practices to ensure that the environment is maintained in such a manner as to sustain a high quality of life, including social and economic development, recreation and leisure for present and future Manitobans.

Compliance with Licence

1. The Licencee shall direct all wastewater generated within the City of Winnipeg to sewage treatment plants operating under the authority of an Environment Act Licence or discharge wastewater to receiving waters in accordance with this Licence.

Future Sampling

2. In addition to any of the limits, terms and conditions specified in this Licence, the Licencee shall, upon the request of the Director:

a) sample, monitor, analyze and/or investigate specific areas of concern regarding any segment, component or aspect of pollutant storage, containment, treatment, handling, disposal or emission systems, for such pollutants or ambient quality, aquatic toxicity, leachate characteristics and discharge or emission rates, for such duration and at such frequencies as may be specified;
b) determine the environmental impact associated with the release of any pollutant(s) from the Development; or
c) provide the Director, within such time as may be specified, with such reports, drawings, specifications, analytical data, descriptions of sampling and analytical procedures being used, bioassay data, flow rate measurements and such other information as may from time to time be requested.

Sampling Methods

3. The Licencee shall, unless otherwise specified in this Licence:
   a) carry out all preservations and analyses on liquid samples in accordance with the methods prescribed in "Standard Methods for the Examination of Water and Wastewater" or in accordance with an equivalent analytical methodology approved by the Director;
   b) have all analytical determinations undertaken by an accredited laboratory; and
   c) report the results to the Director, in writing or in a format acceptable to the Director, within 60 days of the samples being taken, or within another timeframe acceptable to the Director.

Equipment Breakdown

4. The Licencee shall, in the case of physical or mechanical equipment breakdown or process upset where such breakdown or process upset results or may result in the release of a pollutant in an amount or concentration, or at a level or rate of release, that causes or may cause a significant adverse effect, immediately report the event by calling 204-944-4888 (toll-free 1-855-944-4888). The report shall indicate the nature of the event, the time and estimated duration of the event and the reason for the event.

5. The Licencee shall, following the reporting of an event pursuant to Clause 4,
   a) identify the repairs required to the mechanical equipment;
   b) undertake all repairs to minimize unauthorized discharges of a pollutant;
   c) complete the repairs in accordance with any written instructions of the Director; and
   d) submit a report to the Director about the causes of breakdown and measures taken, within one week of the repairs being done.

Reporting Format

6. The Licencee shall submit all information required to be provided to the Director under this Licence, in writing, in such form (including number of copies), and of such content

as may be required by the Director, and each submission shall be clearly labeled with the Licence Number and Client File Number associated with this Licence.

SPECIFICATIONS, LIMITS, TERMS AND CONDITIONS

Avoid CSOs

7. The Licencee shall operate the combined sewer system and wastewater collection system such that there are no combined sewer overflows except during wet weather periods.

New or Upgraded Developments

8. The Licencee shall not increase the frequency or volume of combined sewer overflows in any sewershed due to new and upgraded land development activities and shall use green technology and innovative practices in the design and operation of all new and upgraded storm and wastewater infrastructures.

Public Education Plan

9. The Licencee shall, on or before December 31, 2013, submit to the Director, a public education program plan documenting how information on combined sewer overflows will be made available to the public.

Public Notification System

10. The Licencee shall, on or before December 31, 2015, submit to the Director for approval, a plan regarding the development and implementation of an internet-based public notification system for all discharges from combined sewer overflow points, including an assessment of making this notification available on a real time basis.

CSO Master Plan

11. The Licencee shall, on or before December 31, 2015, submit a preliminary proposal for approval by the Director, pursuant to Section 14(3) of *The Environment Act,* for the combined sewer overflow system.

    The plan proposed above would consist of an evaluation of a minimum of the following CSO control alternatives:
    - A maximum of four overflow events per year;
    - zero combined sewer overflows; and
    - a minimum of 85 percent capture of wet weather flow from the combined sewer system and the reduction of combined sewer overflows to a maximum of four overflow events per year.

The Licencee shall, on or before December 31, 2017, file a final Master Plan, including the detailed engineering plans, proposed monitoring plan, and implementation schedule for the approved design identified in the preliminary plan above. The Master Plan is to be filed for approval by the Director. The Licencee shall implement the plan by December 31, 2030, unless otherwise approved by the Director.

Effluent Quality Limits

12. The Licencee shall demonstrate, in the Master Plan submitted pursuant to Clause 11, the prevention of floatable materials, and that the quality of the CSO effluent will be equivalent to that specified for primary treatment to 85% or more of the wastewater collected in the CSO system during wet weather periods. The following effluent quality limits summarize what is expected from primary treatment:
    a) five day biochemical oxygen demand (BOD5) not to exceed 50 mg/l;
    b) total suspended solids not to exceed 50 mg/l;
    c) total phosphorus not to exceed 1 mg/l; and
    d) E. coli not to exceed 1000 per 100 ml.

Annual Progress Reporting

13. The Licencee shall, upon approval of the Master Plan submitted pursuant to Clause 11 of this Licence, implement the plan such that progress towards meeting the required level of treatment is demonstrated annually by submission of an annual report, due March 31 of each year for the preceding calendar year. Annual submissions shall include the progress made on the plan pursuant to Clause 11 including monitoring results and the work plan for the subsequent calendar year.

MONITORING AND REPORTING

Reporting

14. The Licencee shall, prior to December 31, 2013, develop a notification plan acceptable to the Director for each overflow event.

Interim Monitoring

15. The Licencee shall by January 31, 2014 submit a plan to the Director for approval of an interim combined sewer overflow monitoring program for implementation between May 1, 2014 and the date upon which the final master plan is approved by the Director. The plan shall identify locations to be sampled, rationale for these locations, and sampling frequency. The plan also shall identify constituents to be monitored including, but not limited to:
    a) organic content as indicated by the five-day biochemical oxygen demand (BOD_5) and expressed as milligrams per litre;

b) total suspended solids as expressed as milligrams per litre;
c) total phosphorus content as expressed as milligrams per litre;
d) total nitrogen content as expressed as milligrams per litre;
e) total ammonia content as expressed as milligrams per liter;
f) pH; and
g) *E*.coli content as indicated by the MPN index and expressed as MPN per 100 millilitres of sample.

Record Keeping

16. The Licencee shall:
   a) during each year maintain records of:
      i) grab sample dates and locations;
      ii) summaries of laboratory analytical results of the grab samples; and
      iii) combined sewer overflow dates;
   b) make the records being maintained pursuant to sub-Clause 16 a) of this Licence available to an Environment Officer upon request and, within three months of the end of each year, post the results on the public notification site required by Clause 10 of this Licence.

REVIEW AND REVOCATION

A. If, in the opinion of the Director, the Licencee has exceeded or is exceeding or has or is failing to meet the specifications, limits, terms, or conditions set out in this Licence, the Director may, temporarily or permanently, revoke this Licence.

B. If, in the opinion of the Director, new evidence warrants a change in the specifications, limits, terms or conditions of this Licence, the Director may require the filing of a new proposal pursuant to Section 11 of *The Environment Act*.

"original signed by"

Tracey Braun, M.Sc.
Director
Environment Act

Client File No.: 3205.00

Appendix C
Basis of Estimate Technical Memorandum

CSO Master Plan

Basis of Estimate
Technical Memorandum

August 2019

City of Winnipeg

CSO Master Plan

Project No:	470010CH
Document Title:	Basis of Estimate Technical Memorandum
Revision:	02
Date:	August 2019
Client Name:	City of Winnipeg
Project Manager:	John Berry
File Name:	CSO_MP_BasisofEstimate_Final_08012019.docx

Jacobs Engineering Group Inc.

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Document History and Status

Revision	Date	Description	By	Review	Approved
0	02-2019	DRAFT	SG	ES	
1	04-2019	2nd DRAFT	VN	SG, PP	
2	08-2019	Final	SG	JB	DJT

Contents

Tables

Figures

Acronyms and Abbreviations

AACE	Association for the Advancement of Cost Engineering
CS	combined sewer
CSO	Combined Sewer Overflow
GI	green infrastructure
LBIS	land-based information system
LDS	land drainage sewer
ML/d	megalitre(s) per day
MSD	Manitoba Sustainable Development
MRST	Manitoba Retail Sales Tax
NSWL	normal summer water level
O&M	operations and maintenance
PACC	Program Alternative Cost Calculator – costing tool
PV	present value
SCADA	supervisory control and data acquisition
SRS	storm relief sewer
STP	sewage treatment plant
TBM	tunnel boring machine
WWF	wet weather flow
WWS	wastewater sewer

1. Introduction

The objective of this document is to summarize the basis for the cost estimates developed for the Combined Sewer Overflow (CSO) Master Plan. As part of the Master Plan, it was necessary to develop a clear framework to support the capital investment required to control the release of untreated wastewater discharged from combined sewer infrastructure in the City of Winnipeg (City) in accordance with Environment Act No. 3042 (EA No. 3042) issued by Manitoba Sustainable Development (MSD).

The cost estimates for the CSO Master Plan were initially developed during the Preliminary Proposal phase when the alternative plans and control limits were being assessed. The submission of the Preliminary Proposal led to the selection of one of the alternative plans which was subsequently further refined as part of the CSO Master Plan development.

As part of the Preliminary Proposal phase, five alternative limits for CSO control were identified as follows:

- Control Option No. 1: 85 Percent Capture in a Representative Year
- Control Option No. 2: Four Overflows in a Representative Year
- Control Option No. 3: Zero Overflows in a Representative Year
- Control Option No. 4: No More Than Four Overflows per Year
- Control Option No. 5: Complete Sewer Separation

The Preliminary Proposal included a cost estimate for each of the alternative control plans as identified in Table 1-1. The estimated cost of the program ranged from $1.2 billion to $4.1 billion in 2014 dollars including a plus 50 percent estimating allowance for budget review purposes.

Table 1-1. Preliminary Proposal Alternative Plan Cost Estimates (2014 Dollars)

Description	Capital Cost	Capital Cost + 50% Allowance	Present Value Lifecycle Cost
Control Option No. 1: 85% Capture in a Representative Year	$ 830,000,000	$1,245,000,000	$ 970,000,000
Control Option No. 2: Four Overflows in a Representative Year	$1,720,000,000	$2,580,000,000	$1,850,000,000
Control Option No. 3: Zero Overflows in a Representative Year	$2,170,000,000	$3,255,000,000	$2,310,000,000
Control Option No. 4: No More than Four Overflows per Year [a]	$2,300,000,000	$3,450,000,000	$2,450,000,000
Control Option No. 5: Complete Sewer Separation	$2,760,000,000	$4,140,000,000	$2,790,000,000

[a] Control Option No. 4 is extrapolated from Control Option No. 3.

In December 2015, the City submitted the Preliminary Proposal to MSD recommending Control Option No. 1. The City received written approval dated November 17, 2017 from MSD to proceed with Control Option No. 1. The approval stated the program should be implemented before the end of 2045 or as otherwise agreed by the Director. The 2045 date would mean the timeline for the complete implementation of all the CSO Master Plan upgrades spans approximately 25 years.

2. CSO Master Plan Cost Update

The Preliminary Proposal recommendation of Control Option No. 1 was the starting point for the CSO Master Plan. Identifiable differences between the Preliminary Proposal and the Master Plan cost estimates account for the progression from an initial estimate used to compare a series of alternative plans for the entire system, to an estimate focusing on a specific level of CSO control for each sewer district.

The estimates reflect changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of Green Infrastructure (GI) enhancements. The calculation of the CSO Master Plan and Preliminary Proposal cost estimate were based on the following assumptions:

- Capital costs and O&M costs are reported in terms of present value.
- The CSO Master Plan includes a fixed allowance of 10 percent for GI which was not included in the Preliminary Proposal.
- The Preliminary Proposal capital cost is in 2014 dollar values whereas the Master Plan capital cost is based on the control options configurations for each sewer district engineering plan and in 2019 dollar values.

A comparison of the Preliminary Proposal and CSO Master Plan cost estimates for Control Option No. 1 is provided in Table 2-1.

Table 2-1. Preliminary Proposal and Master Plan Capital Cost Comparison

Item	2014 Preliminary Proposal Cost Estimate (2014 Dollars)	2014 Preliminary Proposal Cost Estimate (2019 Dollars) [a]	2019 Master Plan Cost Estimate (2019 Dollars)
Class 5 Estimated Capital Cost	$ 830,000,000	$ 963,000,000	$1,045,800,000
Green Infrastructure Allowance (10%)	Not Included	Not Included	$ 104,600,000
Subtotal – Capital Cost	**$ 830,000,000**	**$ 963,000,000**	**$1,150,400,000**
Class 5 Estimate Range: (-50% to + 100%)	($415,000,000 to $1,660,000,000)	($481,500,000 to $1,926,100,000)	($575,200,000 to $2,300,800,000)
Capital Cost + 50% Estimating Allowance	$1,245,000,000 [b]	$1,445,500,000	$1,725,600,000
Capital Cost for Budgeting Purposes	**$1,660,000,000**	**$1,926,100,000**	**$2,300,800,000**

[a] 2019 dollar value is based on 3% inflation per year
[b] Cost as identified in the Preliminary Proposal

As agreed with the City, the upper range of the Class 5 estimate (+$100%) is used for budgeting purposes giving a total capital cost of $2,3 Billion for the CSO Master Plan. In the Preliminary Proposal, a different approach was used whereby the total capital cost was reported as $1,2 Million using +50% of the base estimate. Using the same approach and removing the GI allowance would equate to $1,569 Million which is approximately 26 percent higher than that reported for the Preliminary Proposal and this increase in estimated cost is attributed to the following:

- Construction cost escalation from 2014 to 2019 equating to about 16 percent.
- An increase in the amount of sewer separation projects selected for control options, which have a higher capital cost, but lower operating costs.

3. Definition of Project Costs

Conceptual level Class 5 capital cost estimates were developed for the control solutions proposed for each sewer district as follows:

- Local costs were applied where local estimates were readily available for items such as sewer and chamber installations.
  - Local unit rates based on typical local values were used to estimate the value of sewer separation work.
- A cost estimation tool was used for generating costs for other technologies that have not been previously applied in the City. This tool utilized projects completed in other cities and applied correction factors to adjust to expected Winnipeg conditions.

Cost estimates were developed in conjunction with Jacobs' internal tool, Program Alternative Cost Calculator (PACC), and later adjusted for economic factors local to the City. The PACC is a spreadsheet tool created to assist in the developing Class 5 estimates for linear infrastructure programs. The unit costs within the PACC are derived from broad-based historical pricing data from other markets for materials, equipment and labour. The unit costs from the PACC were adjusted to align with local costs for Winnipeg. Labour and material costs, competitive market conditions, final project details, implementation schedule, and other factors were applied.

The objective of the CSO Master Plan cost estimates is to compare control options at a district level and to serve as a basis to guide the City's annual capital budget allocations for program implementation.

The CSO Master Plan cost estimates are reported in terms of Present Value (PV) costs comprised of the following two components:

(i) Capital Cost – This represents the one-time, fixed expense to construct the sewer system control upgrades and is estimated in current dollar values (2019); and

(ii) Lifecycle Cost – This represents the annual operations and maintenance (O&M) investment derived in current dollars then projected over the life of the asset at an annual escalation factor. This is explained further in Section 3.2 Lifecycle Cost Assumptions

The CSO Master Plan has assumed construction costs are based on a conventional design-bid-build project delivery method. Hence allowances have been made for project administration, engineering and construction. It was also assumed that the control options implemented at each sewer district would consist of conventional sewer system infrastructure.

A base construction cost for each control technology proposed within a sewer district was established using outputs from the hydraulic model evaluations and applying parametric cost curves and localized unit costs. The parametric cost curves are based on local historical cost data for control options when available and supplemented with information from the Jacobs' PACC tool where limited local experience is available. The control technology estimating assumptions are included in Section 4. The estimated capital cost for each sewer district includes the addition of the following components which have been added to the base construction cost:

- Engineering Design: 13 percent
- Project Design Contingency: 30 percent
- Program Management: 2 percent
- Manitoba Retail Sales Tax (MRST): 8 percent
  - MRST applies only to tangible personal property. It has been included for all CSO Master Plan components to remain conservative. It will be applicable to some projects or parts of projects and not

others, which is subject to interpretation, and may require tax department clarification at the time of construction.

- Green Infrastructure (GI) has been accounted for by applying a 10 percent markup to the capital cost and assumes that some GI will be completed in every sewer district. Additional unit costs are available from the *Green Infrastructure* (CH2M et al., 2014) technical memorandum.

3.1 Capital Cost Exclusions

There are a number of items outside of what is included in the cost estimates, but which are assumed to be covered as part of the estimating contingency and allowances. These include items such as stakeholder consultations, traffic management and utility relocations. Additionally, there are other items that may impact the overall cost of the CSO Master Plan but are not included within the cost estimates provided. These items are described as follows:

Finance and Administration

A finance and administration allowance of 3.25 percent.

Federal Goods and Services Tax (GST)

GST is currently 5 percent but is not included because of municipal exemptions.

Sewage Treatment Plant Upgrading

Additional combined sewage captured under the CSO program will be routed to the sewage treatment plants for wet weather flow (WWF) treatment. Upgrades have been completed or are underway for WWF treatment at the sewage treatment plants. The capital and operating costs of all WWF treatment has not been included in the CSO program estimates.

Land Acquisition

At the planning level, the details of sewer system upgrade components within each CSO district are not entirely defined. The broad-based nature of the various upgrade options means that some of the CSO controls may be retrofitted into existing infrastructure (e.g. in-line storage), whereas other control options may require additional land for off-line storage or treatment. In either case, there may be a need for additional land to serve as permanent or temporary workspace for construction, maintenance, staging, materials handling, or to house the final works.

In built-up urban environments, the availability of sufficient workspace to carry out the work is limited. Although the need to acquire large parcels of land to perform Sewer system improvements can be mitigated somewhat using trenchless installation methods, there will always be a need for temporary workspace for contractor staging.

The cost for staging areas, lane rentals on city streets, rental of vacant parcels, and/or expropriation was excluded. Typically, only at the concept-level can the extent of land acquisition be identified. Then it can be further defined through the preliminary design stage, prior to be ultimately being delineated during detailed design. Hence it could not be included at the current stage.

Geotechnical Investigations

While many of the CSO control installations will occur at the same site as currently installed sewer infrastructure, there are locations where additional storage is to be provided in a new location where the subsurface ground conditions need to be characterized. This is particularly true where deep excavations are necessary or where a trenchless methodology is being considered. In these situations, detailed site investigations are recommended to capture special geotechnical considerations. At other locations for other control options such as sewer separation, the level of investigation will be identified on a case by case basis.

Trenchless methods for installation of new works is preferred by the City for sewer replacement and sewer relief projects to minimize disruption to adjacent neighbourhoods and minimize surface restoration.

The application of trenchless methods is highly contingent upon geotechnical suitability of the underlying soil conditions for it to be feasible. The CSO program is likely to require the construction of larger diameter sewers installed at greater depths. At the planning stage, a cost for geotechnical investigations was excluded due to the variability at each site and the variability of the type of trenchless methods used.

Program Support Services

The capital cost does not include field services by internal resources, consulting services, and contracts for carrying out or supporting the engineering evaluations, pilot testing, and real time control works in support of program management.

Operations and Maintenance

Operations and Maintenance (O&M) is not included in the capital cost estimate prepared for the CSO Master Plan but has been included in the lifecycle analysis and program implementation planning. Lifecycle cost assumptions for O&M are described in Section 3.2.

3.2 Lifecycle Cost Assumptions

The lifecycle cost estimates were developed based on assumptions about O&M requirements for each control technology. The main assumptions used for the lifecycle cost analysis included the following:

- The estimating process uses a PV approach for annual O&M costs, assuming a 35-year lifecycle with a 3 percent discount rate.
- O&M costs were determined on an individual asset basis and account for annual expenses such as energy, materials, and chemicals, as well as periodic replacement maintenance. Periodic replacement maintenance costs were derived based on a percent of capital cost applied at 10, 20 and 30 year intervals.

More specific assumptions relating to each control technology are applied in the estimates as follows:

Labour

- The cost of labour, including benefits, for all asset maintenance was assumed to be $35 per hour. This value is based on the high end of the 2016 to 2021 collective agreement with an allowance for future increases. A crew of three individuals with a maintenance vehicle has an assumed costing rate of $150 per hour.

Control Option Maintenance

- Sewer and Tunnel
  - $4 per linear metre per year.
- In-line Storage
  - 3 hours of labour per week, or 156 hours per year.
  - An additional 2 hours of labour were included per wet weather event.
- Screens
  - 3 hours of labour per week, or 156 hours per year.
  - An additional 8 hours were added per wet weather event.
  - For mechanical screens, an average operational duration is 4 hours per event.
- Off-line Storage Tank and Tunnel
  - 8 hours of labour per week, or 416 hours per year.
  - An additional 8 hours for a tank were added per wet weather event.

- An additional 4 hours for a tunnel were added per wet weather event.

- Pumping Station
  - 4 hours of labour per week, or 208 hours per year.
  - An additional 4 hours were added per wet weather event.
  - An average pumping duration is 24 hours per event.
- Gravity Flow Controllers
  - 4 hours per week, or 208 hours annually.

Utilities

- Energy costs were based on annual volume and total dynamic head pumped, assuming a pump efficiency of 75%, a motor efficiency of 95%, and variable frequency drive efficiency of 98%. Electricity costs were estimated to be $0.05 per kilowatt-hour.

The life span of each asset type (conveyance or facility) or part of a facility (such as superstructure, foundation, tankage, mechanical, or electrical) has been taken into consideration. Periodic equipment replacement costs have been added over the program duration as required on a percentage of capital cost basis as shown in **Table 3-1**. Remaining residual value for assets at the end of the analysis period was not considered in the estimates.

Table 3-1. Periodic Equipment Replacement Cost

Design Item	Periodic Percentage of Capital Cost Replaced		
	10 Years	20 Years	30 Years
Off-line Storage	5%	14%	5%
Control Gate	5%	14%	5%
Screens	0%	10%	0%
Submersible Pump Stations	20%	25%	0%
Tunnel	10%	15%	5%
Flow Control	0%	10%	0%

4. Control Options Cost Assumptions

A parametric costing tool was used to provide the initial cost curves for a wide range of control options. All construction costs include the general requirements for contracting, as well as the contractor's labour, materials, overhead, and profit. Therefore, the construction costs are equivalent to prices received for design-bid-build tenders and exclude markups for contract contingency, engineering, and taxes.

To apply the parametric costing tool, costs were converted to Winnipeg conditions based on the *Engineering News-Record Construction Cost Index* (ENRCCI) for November 2018 (ENR, 2018). Since there is no ENRCCI for Winnipeg, a current ENRCCI was adjusted using the RS Means Index of 99.7; this adjustment sets the ENRCCI index used in the tool for Winnipeg, Manitoba, Canada in November of 2018 at 11150.

The approach and assumptions for costing each type of control option are summarized in the following subsections.

4.1 Gravity Sewers and Tunnels

Construction costs for gravity sewers and tunnels are sensitive to the installation method, pipe size, and depth. In the City, there is a high level of experience using pipe diameters smaller than 2100 mm. 2100 mm is the representative diameter assumed for a tunnel. A large dataset of local costs is available for smaller diameter sewers, so these unit costs were applied directly to the proposed CSO Master Plan work. The unit costs used for sewer and tunnel construction are shown on Figure 4-1.

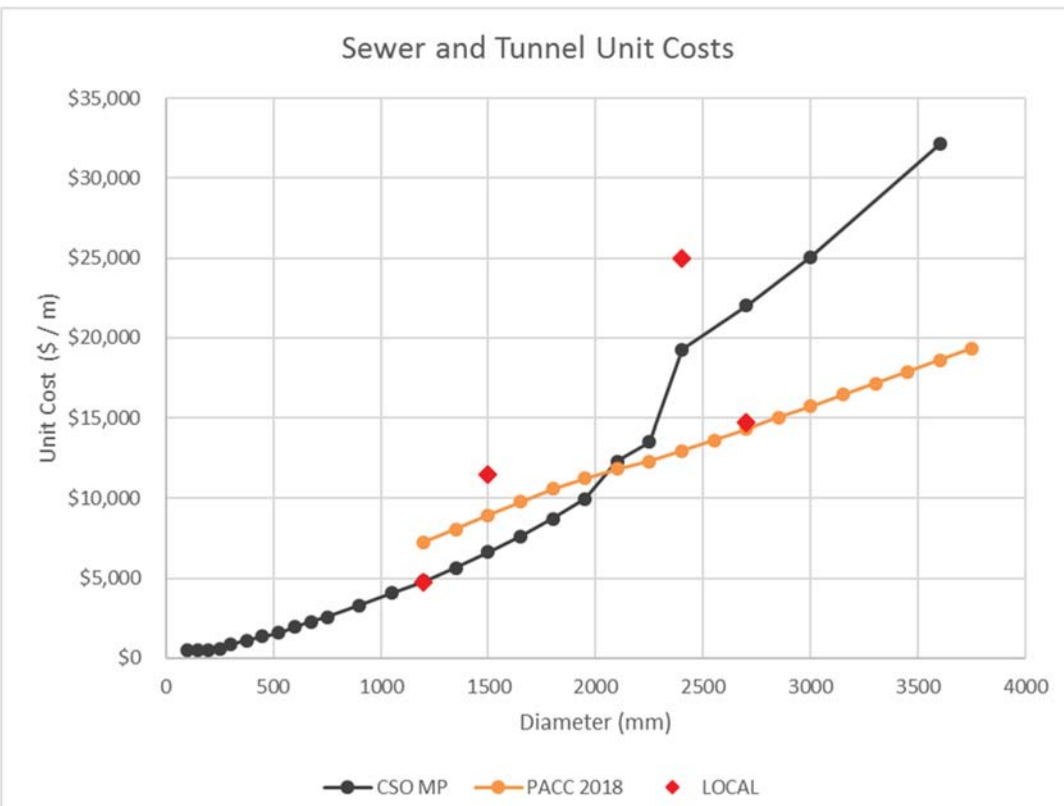

Figure 4-1. Sewer and Tunnel Unit Cost Curves

The majority of sewer installation in the City has been carried out using a horizontal coring method. This coring technique has been successful for pipe diameters up to about 900 mm. Alternative local methods have been used to install up to a 1500 mm diameter pipe. Unit costs for larger diameter pipes were extrapolated where insufficient historical pricing data was available; above 2100 mm. Although there are a few recent examples, tunnelling projects in the City are limited over the last few decades. A comparison of recent local costs to the parametric cost tool was completed. As shown in Figure 4-1, the PACC unit costs are higher than the CSO Master Plan cost at the smaller diameters and lower for larger diameter sewers. Some recent local pipe installation costs for larger diameter pipe are included as a diamond on Figure 4-1as a comparison. The CSO Master Plan costs were applied for the entire range of diameters and are assumed to be conservative at the larger diameters to include the appropriate assumptions and unknowns.

The unit costs associated with the parametric costing tool include following assumptions:

- Tunnel boring machine (TBM) for pipe diameters > 2100 mm diameter;
- Use of micro-TBM for ≤ 2100 mm diameter;
- All tunneling methods assume mixed-face tunneling that accounts for handling both soil and rock along the length of the tunnel construction

Parametric unit costs include the following:

- Mobilization and demobilization
- Purchase or rental of tunneling equipment
- Pipe supply and installation by tunneling
- Launching and receiving shafts, quantities based on the following assumptions:
  - Micro-TBM: 300 m drive
  - TBM: 300 m drive
- A 10% multiplier for dewatering during construction
- A 30% multiplier for mixed-face tunneling for either micro-tunneling or TBM
- Reinstatement or restoration costs for pavement or boulevards at shaft locations

The localized unit costs for sewer installation include the following:

- Local installation methods
- Shoring and dewatering
- Manholes/Shafts
- Restoration

Items not included in the unit costs are as follows:

- Sewer and service connections
- Utility relocations
- Capital cost markups – included on top of base construction cost within the contingency
- O&M – included with the lifecycle cost and program evaluations

4.2 Sewer Separation

The City has previously completed sewer separation on an opportunistic basis under the Basement Flooding Relief program, and any previously committed projects continuing through the CSO Master Plan. Sewer separation reduces the volume of combined sewage collected, thereby reducing the CSO program storage volumes required, the conveyance requirements to the treatment plants, and the size and operating costs of treatment facilities. Two approaches were reviewed in the development of cost estimates for sewer separation as follows:

1) Installation of a new dedicated land drainage sewer (LDS) in Combined Sewer (CS) districts to collect road drainage and discharge it directly to the river. The existing CSs are reserved strictly for conveyance of domestic wastewater and rainfall derived inflow and infiltration. Foundation drainage would continue to flow to the CS system.

2) Convert the existing CS to serve strictly as an LDS. This requires construction of a new wastewater sewer trunk to accept domestic wastewater and flows from reconnected foundation connections. This method was only applied in the estimate in special cases where specific benefits were identified. However, this method of separation should be considered any time a sewer district is being assessed for separation.

Costs for sewer separation were estimated using sewer data exported from the City's land-based information system (LBIS) database. In order to approximate the amount of separation required to achieve complete separation of a sewer district, the existing amount of separation completed within a sewer district must be determined. A length of pipe installation to separate the remainder of the district is then calculated based on the existing amount of separation.

The basis of the approach is to assume a new LDS system equal in length to the original CS system servicing that same area would be required to complete the LDS separation. A number of steps were used to determine an approximate length of new sewer required as follows:

1) The length of the different types of sewer within a sewer district were taken from the LBIS.

2) The length of sewer within a range of diameters was totaled for each type (CS, WSS, SRS, LDS).

3) The following calculation was then applied to determine the length of remaining unseparated combined sewer:

$$\text{Total Length Unseparated} = \text{Total CS Length} * \left[1 - \frac{(\text{Total LDS Length} + \text{Total SRS Length})}{(\text{Total CS Length} + \text{Total WWS Length})}\right]$$

The following assumptions were applied to calculate the separation length remaining in a sewer district:

- Combined sewers: All sewers with a CS flow type within a district were used to calculate the separation lengths.
- Land drainage sewers: All LDSs were assumed to represent separate areas.
- Storm relief sewers: Relief sewers present a special situation, since they do not directly receive wastewater flows and could be converted to LDS. Relief sewers would typically be undersized as a separate LDS on their own, but they are large enough to significantly contribute to a new separate LDS system. They have been assumed as separate when present.
- Wastewater sewers: All WWSs were assumed to represent a separate area.
- Areas identified as separate were assumed to be adequate without any further modifications.

Once an unseparated length was determined for each sewer district, this was verified with a secondary check of the LBIS network. A percent reduction of total length was applied if any differences are found or if known sewer separation has taken place that is not accounted for in the LBIS. An example would be the ongoing separation work in the Cockburn, Jefferson East, or Ferry Road sewer districts, which is not represented in the LBIS. Once the unseparated length is manually validated, a ratio of typical pipe sizes installed in a sewer district is applied to this length. The corresponding ratios and applicable median unit costs for the size range are listed in Table 4-1.

Table 4-1. Separation Pipe Unit Costs and Ratios

Size (mm)	% of Unseparated CS Length	Unit Cost
Size (mm)	% of Unseparated CS Length	Unit Cost
<500	44%	$ 984
500-900	20%	$ 2,122
900-1200	14%	$ 4,059
1200-1800	12%	$ 7,133

An example calculation for the Dumoulin sewer district is shown below.

Table 4-2. Separation Length Summary - Example

Sewer District	Total CS Length (m)	Total WWS Length (m)	Total LDS Length (m)	Total SRS Length (m)	Total Sanitary Length (m)	Separate or Relieved (%)	Separation Remaining (%)	Total Length not Separated (m)
Dumoulin	5971	320	2318	344	6291	42.3	57.7	3444

$$\text{Total Length Unseparated} = \text{Total CS Length} * \left[1 - \frac{(\text{Total LDS Length} + \text{Total SRS Length})}{(\text{Total CS Length} + \text{Total WWS Length})}\right]$$

$$\text{Total Length Unseparated} = 5971 * \left[1 - \frac{(2318 + 344)}{(5971 + 320)}\right]$$

$$\text{Total Length Unseparated} = 5971 * \left[1 - \frac{(2662)}{(6291)}\right]$$

$$\text{Total Length Unseparated} = 3444 \text{ m}$$

Table 4-3. Separation Cost Summary - Example

Size (mm)	% of Unseparated CS Length	Length	Unit Cost	Cost
<500	44%	1515	$ 984	$1,490,760
500-900	20%	689	$ 2,122	$1,462,058
900-1200	14%	482	$ 4,059	$1,956,438
1200-1800	12%	413	$ 7,133	$2,945,929
>1800	10%	344	$19,277	$6,631,288
			Dumoulin Cost to Separate	**$14,486,473**

4.3 In-line Storage

In-line storage is created by increasing the control elevation at the primary weir in the CS system. To facilitate the in-line storage, control gates are proposed at the primary CS diversions near the outfall. Control gates may also serve to divert flows into adjacent screening chambers for capture of floatables as discussed in Section 4.4.

The in-line storage concept assumes the following:

- Control gates were limited to a maximum height of half the trunk diameter to mitigate back-water effects upstream of the gate location. The basement flood risk for pre and post control option installation was evaluated to maintain the same level of protection (i.e. – no increase in HGL was allowed).
- Where normal summer river levels are higher than the in-line storage depth, control gate configuration will need to be reconsidered, since the discharge is inherently controlled by the river backwater pressure on the flap gate.
- The Grande Water Management Systems TRU-BEND gate was selected as the “representative product” because it meets the general intent and has been manufactured for use in CSs. The gate is hinged at its base, which allows it to completely lower for high flows, and is operated by a counterweight mechanism which minimizes mechanical and electrical malfunctions.
- The TRU-BEND gates, for most locations, can be manufactured and applied to meet the half pipe height requirements. Only for trunk sewers that are greater than three metres will there potentially be a restriction of control gate construction for this half pipe diameter height. The control gate has a maximum standard height of 1.5 m, so any sewer with a diameter greater than 3.0 m and a gate installed from invert would not meet the half pipe height without modification.

The cost estimates assume that control gates would be installed in a newly constructed chamber along the existing sewer alignment where possible. Dry weather flow would continue to be diverted by the existing primary weir upstream of the control gate. The control gate would be installed as close to the primary weir and off-take as possible and may be integrated in a single chamber. This will be reassessed for each installation during preliminary design. The control gate would activate, rise up and begin to capture flow when the level in the sewer increased above the primary weir elevation.

Installation of the chamber and gate is similar to existing gate chambers installed along the riverbank; therefore, the unit cost can be developed and compared to existing local installation costs. A unit cost approach based on the existing trunk size was used so that variance in costs could be shown. The unit cost curve for the installation of a control gate is shown in Figure 4-2.

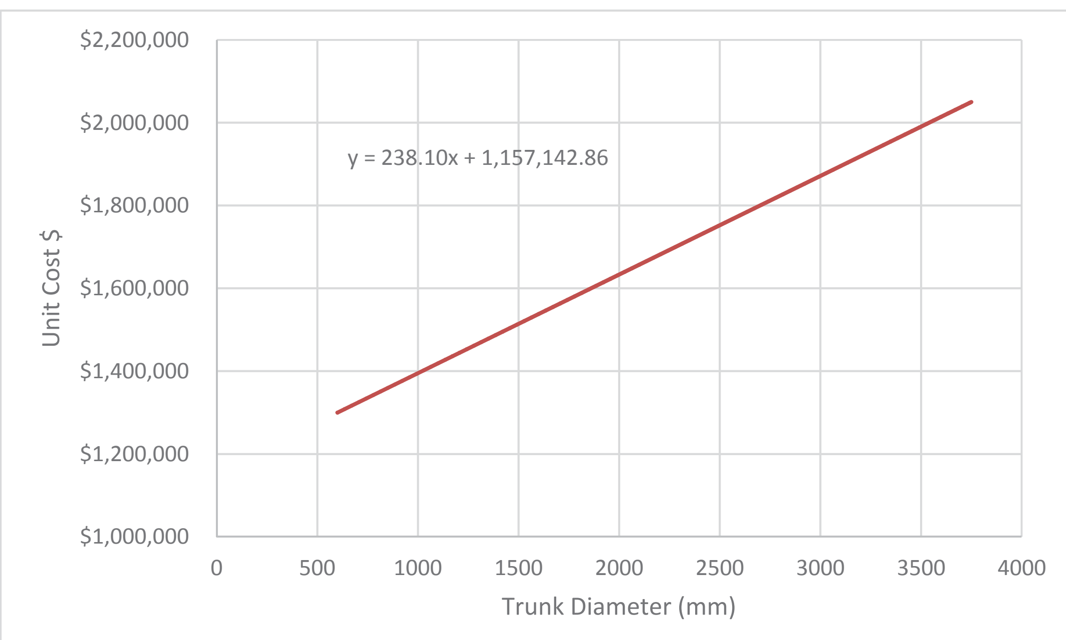

Figure 4-2. In-line Storage Control Gate Cost Curve

The base construction costs include the following:

- Gate chamber construction
- Gate and ancillary equipment

The base construction costs do not include the following:

- Instrumentation
- Capital cost markups – included on top of base construction cost within the contingency
- O&M – included with the lifecycle cost and program evaluations

4.4 Screens

Where hydraulic capacity allows, it is recommended that a portion of the overflow at each district's primary outfall be screened. The partial screening approach achieves the following objectives:

- Preserves the hydraulic capacity under high flows to avoid basement flooding;
- Captures a higher percentage of the first flush (and corresponding floatables).

Screening typically requires the presence of a control gate or increase in static weir height to provide the necessary head. A side-weir would be installed in the control gate chamber immediately upstream of the control gate. When the in-line depth of storage reaches the screen side weir, the bypass will flow to the screen and only the screened flow will discharge to the river. All CSO will be screened until the control gate drops to its lowered position. After lowering, the control gate will no longer provide additional CS capture beyond that already provided by the primary weir. This will allow the combined sewage to discharge to the receiving stream without screening, as a permitted CSO.

The off-line screening concept assumes the following:

- An extension to the control gate chamber will be used to house the screens and ancillary equipment, with a channel or pipe installed to return the screened flow to the outfall and into the river.
- The Grande ACU-SCREEN has been used as the "representative product". It is a mechanically cleaned screen that has been widely used for CSO screening applications.
- The maximum flow through the screen has been calculated with the InfoWorks hydraulic model. An engineering evaluation is required to determine the optimal flow rate and screen sizing.
- The screenings collected will be diverted back to the lift station or gravity interceptor connection and transferred to a sewage treatment plant. Pumps will be required to transfer the screenings where sufficient hydraulic capacity is not available.

As the design screened flow rate increases, a larger screen area is required. Additionally, a decrease in available hydraulic head also increases the screen area required. The required screen area dictates the chamber size to house the screening equipment. Screening unit cost rates are shown on Figure 4-3.

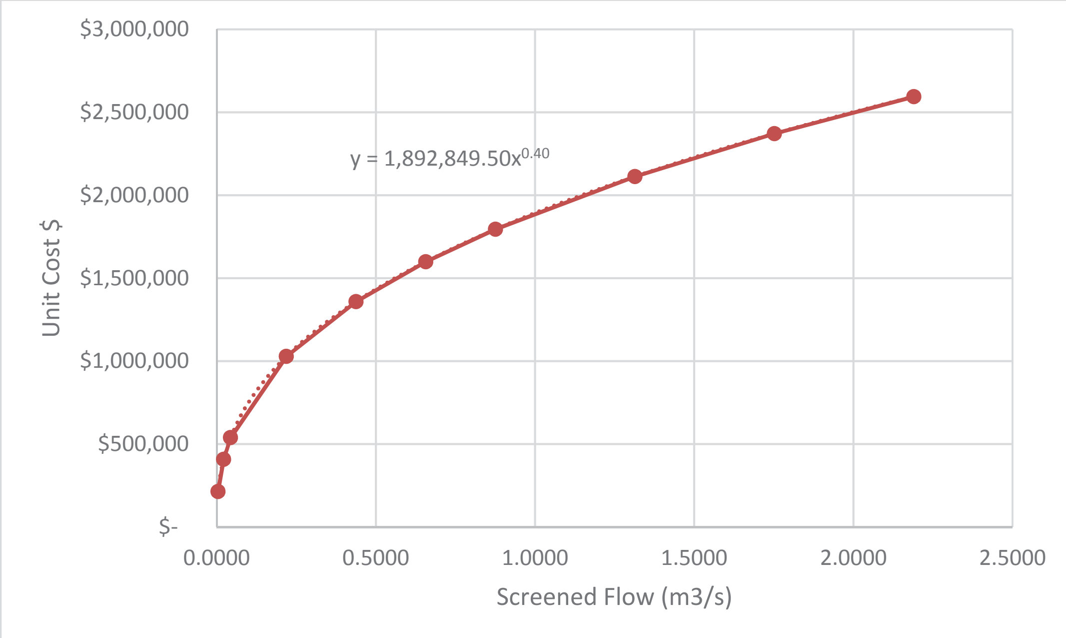

Figure 4-3. Screening Unit Cost Curve

The base construction costs include the following:

- Screening chamber construction
- Screens

The base construction costs do not include the following:

- Instrumentation
- Screening pumps or piping
- Odour control
- Cost related to additional floatable material collection transferred to plant
- Capital cost markups – included on top of base construction cost within the contingency
- O&M – included with the lifecycle cost and program evaluations

4.5 Latent Storage

Latent storage utilizes available capacity in the existing SRS system. The latent component is the volume that would normally be full to the river level elevation. The river level provides force on the flap gate to allow sewer levels to rise and equalize. During wet weather, when the system level increases above the river, the flap gate opens, and flow is released. A lift station is proposed to be installed to dewater the latent storage and pump it to the CS system. The dewatered volume acts as available storage for the next wet weather event.

Flap gate control can be added to the SRS outfall, which allows this latent volume to be trapped behind the flap gate even under low river level conditions. As part of the latent storage design, each location was evaluated based on the representative year river level conditions to confirm if the required latent storage volume capture is provided without flap gate control added. If the latent storage volume potential was high, but not realized during NSWL river conditions, flap gate control was recommended. Flap gate control uses a latch to hold the gate closed until a high level set point is reached and the flap gate is signaled to release. The latch is not sold as a separate product; therefore, it was assumed that new gates equipped with the latch would be installed in all locations where flap gate control is required.

The cost estimates for latent storage without flap gate control are based on pumping station costs as discussed in Section 4.7. The latent dewatering rate assumes that the storage will be dewatered within 24 hours and has an appropriately sized pump to allow this. The costs for construction of a new chamber or modifications to the existing chamber for the flap gate control are based on similar work completed in the City

The latent storage concept assumes the following:

- A new lift station and latent storage force main piping for dewatering the latent storage is required to transfer the stored flows back to the collection system.
- Where applicable, a controllable flap gate is installed to replace the existing flap gate within the existing gate chambers, with only minor modifications.
- The Grande Acu-Gate was selected as the "representative product" for flap gate control.

The base construction cost includes the following:

- Modification of the gate chamber and installation of the ACU-GATE
- Installation of a submersible lift station
- Piping
- Instrumentation

The base construction costs do not include the following:

- Capital cost markups – included on top of base construction cost within the contingency
- O&M – included with the lifecycle cost and program evaluations
- Odour control

4.6 Off-line Storage Tank

The CSO Master Plan includes construction of new, off-line storage tanks for temporary storage of wastewater flows from combined sewers. The tanks would be deep, buried concrete tanks with minimal superstructure. Near surface off-line storage tanks have been used unless otherwise stated.

A feature of the near surface storage tanks is the requirement for the sewage to be lifted from the CSs where it is collected into the tanks. This can be accomplished by construction of new low lift pumping stations or, in some cases, by retrofitting existing flood pumping stations with piping to the storage basins. The near surface position minimizes the excavation and cost of construction and the uncertainty in working near riverbanks with poor soil conditions.

The storage tanks have been assumed to be constructed of concrete and sized in terms of 2,500 m^3 modules measuring approximately 20 m x 50 m x 2.5 m depth.

Following a peer review process completed during the development of the Preliminary Proposal, it was found that the parametric cost estimates were low relative to experience elsewhere. As such, a unit cost of \$3500 per m^3 of off-line storage provided during the peer review was used. This unit rate was adjusted to 2019 dollars using 3 percent inflation per year equating to approximately \$4000 per m^3 for a 2500 m^3 tank. The dollar per volume decreases as the amount of storage increases. The cost curve in Figure 4-4 shows both the PACC cost range (dashed) and the alternative curve based on the peer review value of \$4000 per m^3. The alternative curve was ultimately adopted to estimate costs for off-line storage tanks.

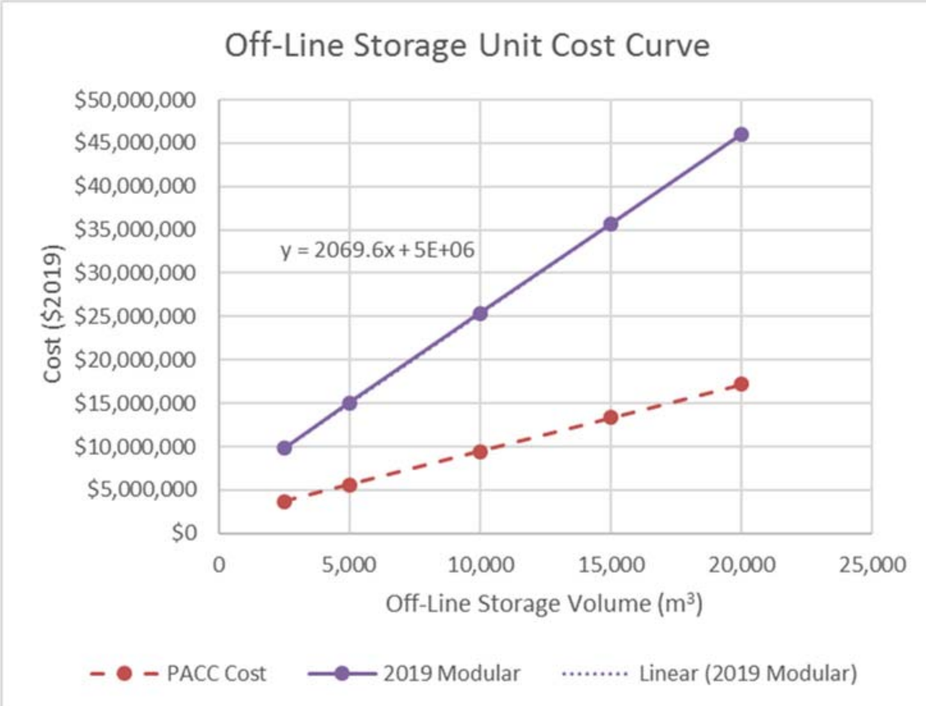

Figure 4-4. Off-line Storage Unit Cost Curve

The cost curve was adjusted for local conditions as shown on Figure 4-4. Local conditions will require storage tanks to be built independently for several CS districts and will not benefit from economies of scale. It is, therefore, more appropriate to consider them on a module basis, assuming the construction of a series of modules rather than one large storage tank.

The base construction cost for off-line storage tanks includes the following:

- Construction of cast-in-place concrete tanks
- Dewatering pumps
- Automated flushing system
- Odour control (Assumed as 2% of total off-line tank construction costs)
- Instrumentation

The base construction costs do not include the following:

- Diversion structures
- High lift transfer pumps for filling the storage basins
- Capital cost markups – included on top of base construction cost within the contingency
- O&M – included with the lifecycle cost and program evaluations

4.7 Pumping Stations

The addition of dewatering pumping and control is required for implementation of the proposed CSO control technologies. Pumps are sized to empty the storage elements within a 24 hour period following a wet weather event. The range of pumping configurations is described in the following list:

- Latent Storage – Pumping is required to dewater combined sewage from the SRS system. Standalone lift stations located adjacent to the relief pipes will be installed for this. It is assumed that lift stations with submersible pumps and force main piping to the existing CS will be used.
- Lift Stations – The current system has several dry well lift stations that discharge to the interceptor system. These would continue to operate in the same manner with the CSO program for dry weather flow. Existing lift stations will have to be reassessed as part of an overall real time control strategy to determine the suitability to meet future needs.
- Gravity Discharges – The 16 CS districts which drain by gravity may need to be upgraded with an added level of control, such as flow control valves and flow recorders. The level and type of flow control required would be assessed as part of the overall real time control strategy. .
- Screening Discharge – The floatables collected by the screens would either be manually lifted out or pumped to the lift stations. Screening pumps, if required, will be included with the screen installations.
- Transfer Pumps – Near surface off-line storage tanks require that the combined sewage be pumped into the storage tanks. High rate low-lift pumping stations will be required for this. In some cases, existing flood pumping stations located in districts where off-line storage is planned, may be retrofitted for this use.

There will be opportunities to combine pumping systems to avoid the selection and use of several pumps within each district. The PACC pumping station costs are based on construction of a pump station with below ground submersible or dry well configuration, coarse bar screens, a super structure, valves, piping, controls, and a backup generator.

The base construction cost for pump stations include the following:

- Excavation and construction of a pumping station
- Internal piping and valves
- Pumps, motors, and variable speed drives
- Instrumentation
- Standby generator

The base construction costs do not include the following:

- Odour control
- Capital cost markups – included on top of base construction cost within the contingency
- O&M – included with the lifecycle cost and program evaluations

A cost curve as shown in Figure 4-5 has been developed to estimate construction cost for various sizes of pumping stations. The cost increases based on flow rate with a direct correlation to larger structures, piping and pumps. The cost flattens out in relation to a maximum size of structure and the pumps sizes continue to increase.

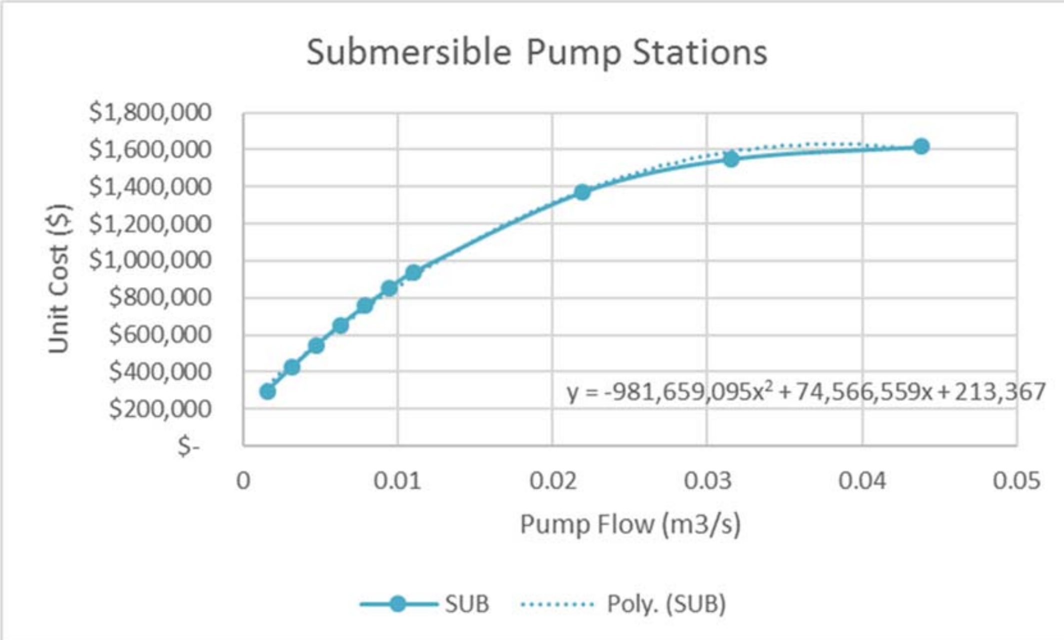

Figure 4-5. Pump Station Unit Cost Curves

The cost for pumping stations will increase with greater installation depths, because of increased excavation and larger pumps to overcome the static head. For this analysis, the pumping stations were assumed to each be relatively shallow, not requiring a depth adjustment. Further reasoning for this assumption for pump station depth is listed below:

- Majority of sewer pipes are located less than 10 m deep;

Force main costs have been estimated based on the pipe unit cost identified in Section 4.2. It is assumed that they would be installed with local methods. There is the potential for a force main cost to increase above what may be expected of a typical sewer installation cost where there are difficult connections or additional appurtenances such as air release / vacuum valves are required. Each force main would be refined for specifics during preliminary and detailed design.

5. Future Cost Estimate Update Considerations

During the development and refinement of the cost estimates, several items were identified for consideration during future cost updates.

- **Type of Sewer Separation**: An independent LDS installation was the primary approach used to estimate the sewer separation costs. Further analysis should be completed to determine additional benefit by partially converting the existing CS and SRS systems to LDS.
- **Proof of Concept:** The CSO Master Plan includes a 10-year period for technology evaluations and pilot studies, intended to validate and gain comfort in the control option selections. This implies that there is a possibility of rejection, which may lead to the need for more costly substitutes.
- **Consequential Upgrades:** The project development process for the CSO Master Plan assumed the works would be carried out independent of existing or other asset condition or upgrading needs. In practice, there may be needs or pressures to integrate indirect upgrades, such as lift station upgrades, water mains, integration of other BFR works, street repairs, or rehabilitation of existing sewers to support the CSO program upgrades.
- **Market Demand Price Changes:** The rapid growth in work and the long-term implementation period increase the risk of construction cost increases. Local engineering and contracting resources are currently not in place to deal with the volume of work projected in the Master Plan. The usual market response to increased demand is an increase in costs. , which may be exacerbated because of the need for specialized skills and limited resources for much of the work.
- **Ancillary Costs:** Labour and utility costs will change throughout the implementation of program. For the CSO Master Plan the main objective was to determine relative cost comparisons between different control option selections. Additional scrutiny should be placed on costs related to these types of items for the purpose of developing O&M budgets.

6. References

Association for the Advancement of Cost Engineering (AACE). 2016. *AACE International Recommended Practice No. 18R-97. Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries. TCM Framework: 7.3 – Cost Estimating and Budgeting*. March 1, 2016.

Engineering News-Record (ENR). 2018. “ENR Cost Indexes in 20 Cities 1978-2018”*. Construction Economics.* Accessed February 11, 2019. https://www.enr.com/economics.

University of Manitoba. 1983. *Geological Engineering Report for Urban Development Winnipeg.* Prepared by the Department of Geological Engineering, University of Manitoba. Accessed February 11, 2019. http://link.lib.umanitoba.ca/portal/Geological-engineering-report-for-urban/GL7umYSGzCE/.

Note:
The PACC costs referenced in this document have been developed from the sources defined in the following bullets and have been updated to local conditions:

- R.S. Means. 2018. Construction Cost Data. Unpublished data accessed online. https://www.rsmeans.com/.
- Richardson 2018. Richardson Process Plant Estimating Standards. CostDataOnLine.com.
- Mechanical Contractors Association of America, Inc. (MCAA) 2018. Web-Based Labor Estimating Manual (WebLEM). http://www.weblem.org/.
- National Electrical Contractors Association (NECA). 2018. 2017-2018 NECA Manual of Labor Units (MLU).
- United States Environmental Protection Agency. Various References and Standards
- Costs from various municipalities’ facilities
- CH2M HILL Canada Limited historical data
- Vendor quotes on equipment and materials, where appropriate
- Estimator judgment

Appendix D
Scenario Workbook Description

Appendix D. Scenario Workbook Description

Programming Workbook

This appendix should be read in conjunction with the figures included in Appendix E from the scenario workbook for each of the three funding scenarios. The scenario workbook was developed to evaluate different funding scenarios for the CSO Master Plan program. It includes capital and O&M cost estimates for each of the projects proposed in the CSO Master Plan. It includes a series of worksheets that are used in combination to lay out the overall program. Each of the worksheets used as part of the program Scenario Workbook tool have been included in Appendix E.

Each worksheet includes the 41 sewer districts with primary outfalls and each sewer district has four rows associated with the different types of control options. The rows list the possible groups of control options for each district, as follows:

1) Sewer Separation (either partial or complete);

2) In-line and latent storage;

3) Off-line tank or tunnel storage, and

4) Totals for the preceding three control options.

Each Worksheet contained within the workbooks is described further as follows:

1) *Figure 1: Project Schedule:*

   The worksheet this figure is based on is strictly a planning tool for simplifying project sequencing and viewing the schedule at a high level. Numbers are entered for specific years of the program on each row where a control option has been identified. The worksheet fills in a colour for the active years and totals the numbers entered for each row for subsequent use in calculating annual budgets.

   The worksheet requires that the last year be entered with a value of "0.5" and is displayed in red. This recognizes that the scale of the project activity for the specific control option recommended at this point should ramp down and extend beyond a one-year duration. In signifying the end of the project, it also triggers the beginning of CSO benefits, and the additional annual operating and maintenance (O&M) costs associated with the control option.

   For all other years in which the project is sequenced to occur, there are variations in the value assigned ranging from "0.6" or lower to "2.0" and higher. These variations allow for slightly more or slightly less funding to be applied to specific projects, in order to maximum the annual budget funding available. Ideally, with no budget funding restrictions, the capital costs associated with each control option would be evenly divided over the years it is to be constructed, resulting a value of "1" applied to each year. However, in order to maximize the funding available for each year, some projects may be slightly scaled back, or other projects may be slighting increased in scale, based on the remaining costs associated with the project, and the remaining budget for that year available. This results in the differing values assigned to the specific years in which the project is underway. This directly impacts the portion of the total capital costs for the control option allocated to that specific year.

   This worksheet can be used in the future as a planning tool to assess project changes or changes to the sequencing of projects. The years that the different control solutions are started and finished can be altered, and its impact on the annual budgeted program costs estimated.

2) *Figure 2: Annual Budgeted Project Costs (With 100% Estimating Allowance):*

   The budget table worksheet that this figure is based on allocating the capital budget estimates into required yearly budgeted amounts, in proportion to the values set on the project scheduling worksheet. For example, if the numbers "1" is entered for several years then the total capital budgets allocated to that control option is split equally between all the years with a "1" entry.

The capital NPV in column "o" totals the NPV of the budgeted capital costs to be expended each year based on the project schedule, in terms of 2019 dollar values.

The budget sum in column "p" totals the annual budgeted capital costs escalated to the year of expenditure.

The table extends to the year 2100 to allow for a comprehensive analysis of both capital and O&M costs for all of the funding scenarios under evaluation for the CSO program.

The columns used in the budget table worksheet have been alphabetically labelled above the column titles. Each of these columns within the budget table worksheet are explained in further detail below.

a) *Project Details:*

   i. Column "a" indicates the percentage of the area of each combined sewer district which would need to be separated to achieve complete sewer separation, called the Balance of Area Separation, based on 2019 estimates. For example a combined district which is completely separated as of 2019, would have a 0 percent Balance of Area Separation.

   ii. Columns "b" to "d" identify whether in-line storage via control gate construction, latent storage, (both standard latent storage and upgraded latent storage solutions requiring flap gate control or additional SRS interconnection construction) and off-line screening facilities have been recommended for that specific district to meet Control Option 1.

   iii. Columns "e" to "g" lists the capital cost estimates in terms of 2019 dollar values for each of the control options recommended for the specific district.

   iv. Column "h" lists the total capital cost estimate for each of the control options recommended for the specific district, in terms of 2019 dollar values.

b) *Additional Operations and Maintenance Cost Budget*

   i. Column "i" lists the estimated average annual additional operations and maintenance costs for the control options recommended for a specific district, in terms of 2019 dollar values. This provides a relative estimate of the future impact the control options recommended for that district will have on operations staff work in the future.

   ii. Column "j" lists the NPV of cumulative total of all additional annual operation and maintenance costs for the control options recommended for a specific district, in terms of 2019 dollar values. O&M costs accrue from the year control option is considered complete, based on the project schedule, and continues to the end 2100.

   iii. Column "k" lists the totals additional annual operation and maintenance costs for the control options recommended for a specific district, escalated to the year of expenditure.

c) *Capital Cost Budget*

   i. Column "l" lists the total capital cost estimate in terms of 2019 dollar values for the control options recommended for the specific district. This capital cost estimate includes 53 percent markup. The components of this markup percentage are detailed in Section 3.6.4 of the Part 2 Technical Report.

   ii. Column "m" lists the estimating allowance applied to the capital cost estimate for the control options recommended for the specific district, at the rate identified in the header. The estimating allowance accounts for estimating uncertainty and has been applied as 100 percent. The reasoning for this allowance is detailed in Section 3.6.6 of the Part 2 Technical Report.

   iii. Column "n" calculates the total capital cost for the control options recommended for the specific district, with the 100% estimating allowance added to the capital cost estimate.

d) Program Budget Summary

i. Column "o" calculates the total NPV of the capital costs for each of the control options recommended for the specific district. This NPV is in terms of 2019 dollar values, based on the specific years the capital costs are incurred as per the project schedule worksheet.

ii. Column "p" calculates the total capital costs for each control option recommended for the specific district, in terms of the year of expenditure. This accounts for the proposed construction date based on the project schedule worksheet.

3) Figure 3: Annual Additional Operations And Maintenance (O&M) Costs:

The worksheet that this figure is based on shows the allocation the estimated additional operations and maintenance costs for each year of the program, based on the project schedule worksheet. The worksheet details are updated automatically populated by entering the value "0.5" in the project scheduling worksheet. This "0.5" confirms that the control option is fully constructed and from that point forward will incur additional operations and maintenance costs. The additional operation and maintenance value allocated to each year is calculated from the annual average additional figure in terms of 2019 dollar values from column "i", factored for inflation based on the year the costs are incurred. The operations and maintenance costs are then extended to the year 2100.

The columns used in the O&M Table worksheet have been alphabetically labelled above the column titles. Each of these columns within the worksheet are explained in further detail below.

a) Project Details:

i. Column "a" indicates the percentage of the area of each combined sewer district which would need to be separated to achieve complete sewer separation, called the Balance of Area Separation, based on 2019 estimates. For example a combined district which is completely separated as of 2019, would have a 0 percent Balance of Area Separation.

ii. Columns "b" to "d" identify whether in-line storage via control gate construction, latent storage, (both standard latent storage and upgraded latent storage solutions requiring flap gate control or additional SRS interconnection construction) and off-line screening facilities have been recommended for that specific district to meet Control Option 1.

iii. Columns "e" to "g" lists the capital cost estimates in terms of 2019 dollar values for each of the control options recommended for the specific district.

iv. Column "h" lists the total capital cost estimate for each of the control options recommended for the specific district, in terms of 2019 dollar values.

b) Additional Operations and Maintenance Cost Budget

i. Column "i" lists the estimated average annual additional operations and maintenance costs for the control options recommended for a specific district, in terms of 2019 dollar values. This provides a relative estimate of the future impact the control options recommended for that district will have on operations staff work in the future.

ii. Column "j" lists the NPV of cumulative total of all additional annual operation and maintenance costs for the control options recommended for a specific district, in terms of 2019 dollar values. O&M costs accrue from the year control option is considered complete, based on the project schedule, and continues to the end 2100.

iii. Column "k" lists the totals additional annual operation and maintenance costs for the control options recommended for a specific district, escalated to the year of expenditure.

c) Capital Cost Budget

i. Column "l" lists the total capital cost estimate in terms of 2019 dollar values for the control options recommended for the specific district. This capital cost estimate includes 53 percent markup. The components of this markup percentage are detailed in Section 3.6.4 of the Part 2 Technical Report.

ii. Column “m” lists the estimating allowance applied to the capital cost estimate for the control options recommended for the specific district, at the rate identified in the header. The estimating allowance accounts for estimating uncertainty and has been applied as 100 percent. The reasoning for this allowance is detailed in Section 3.6.6 of the Part 2 Technical Report.

iii. Column “n” calculates the total capital cost for the control options recommended for the specific district, with the 100% estimating allowance added to the capital cost estimate.

d) *Program Budget Summary*

i. Column “o” calculates the the total NPV of the additional operation and maintenance costs for each of the control options recommended for the specific district. This NPV is in terms of 2019 dollar values, based on the specific years the operation and maintenance costs are incurred as per the project schedule worksheet.

ii. Column “p” calculates the total additional operation and maintenance costs for each control option recommended for the specific district, in terms of the year of expenditure. This accounts for the proposed completion date based on the project schedule worksheet.

4) *Figure 4: Annual Modelled Project Performance:*

The worksheet that this figure is based on documents the specific performance details for each completed project listed in column “f” in terms of annual reduction of CSO in m^3. The annual performance improvement values in the main table are entered automatically based on the project scheduling worksheet.

a) *Project Details:*

i. Column “a” indicates the percentage of the area of each combined sewer district which would need to be separated to achieve complete sewer separation, called the Balance of Area Separation, based on 2019 estimates. For example a combined district which is completely separated as of 2019, would have a 0 percent Balance of Area Separation.

ii. Columns “b” to “d” identify whether in-line storage via control gate construction, latent storage, (both standard latent storage and upgraded latent storage solutions requiring flap gate control or additional SRS interconnection construction) and off-line screening facilities have been recommended for that specific district to meet Control Option 1.

b) *Performance:*

i. Column “e” lists the updated baseline CSO volume reported from the 2018 revised baseline hydraulic model for the specific district. This is evaluated using the 1992 representative year rainfall conditions and normal summer water level river conditions. This represents the CSO overflow performance of the specific district prior to any of the control options recommended in the CSO Master Plan being implemented.

ii. Column “f” lists the annual CSO volume reduction performance reported from the 2018 revised baseline hydraulic model, based on the completion of each of the control options recommended for the specific district. This is evaluated using the 1992 representative year rainfall conditions and normal summer water level river conditions. Each of the control option reductions is attributed after the full installation of the district control option.

iii. The columns following column “f” show the specific annual CSO reductions as each control solution is implemented, as per the project schedule worksheet. The cumulative annual CSO reductions are multiple control options recommended are complete is shown in the row titled “SUBTOTAL” at the bottom of the figure. Below this is the “Total CSO Volume As Control Options Are Implemented”. This tracks the cumulative reduction in the baseline CSO volume for the City of Winnipeg as each control option is implemented.

Appendix E
Scenario Figures

City of Winnipeg - CSO Master Plan

Figure S1-A: Scenario 1 Project Schedule

Winnipeg

JACOBS

Project Identification		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
District	Control Option	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Woodhaven	Sewer Separation																													
	In-Line/Latent Storage																											1	0.5	
	Off-line Storage																													
Strathmillan	Sewer Separation																													
	In-Line/Latent Storage																									1	0.5			
	Off-line Storage																													
Moorgate	Sewer Separation																													
	In-Line/Latent Storage																										1	0.5		
	Off-line Storage																													
Douglas Park	Sewer Separation	0.5																												
	In-Line/Latent Storage																													
	Off-line Storage																													
Ferry Road	Sewer Separation	0.7	0.7	0.7	0.7	1.2	1.2	1.1	1.2	1.1	1.1	1.1	0.5																	
	In-Line/Latent Storage																													
	Off-line Storage																													
Tuxedo	Sewer Separation																			1.5	0.5									
	In-Line/Latent Storage																													
	Off-line Storage																													
Doncaster	Sewer Separation																				1	1	1	1	0.5					
	In-Line/Latent Storage																													
	Off-line Storage																													
Parkside	Sewer Separation	0.5																												
	In-Line/Latent Storage																													
	Off-line Storage																													
Riverbend	Sewer Separation					1.3	1.2	1	1.25	1	0.5																			
	In-Line/Latent Storage																													
	Off-line Storage																													
Tylehurst	Sewer Separation																	1	1	1	1	1	1	0.5						
	In-Line/Latent Storage																													
	Off-line Storage																													
Clifton	Sewer Separation																													
	In-Line/Latent Storage																												1.5	0.5
	Off-line Storage																													
Ash	Sewer Separation																		1.05	1	1	1	0.5							
	In-Line/Latent Storage																									1	0.5			
	Off-line Storage																													
Aubrey	Sewer Separation																													
	In-Line/Latent Storage																										1	0.5		
	Off-line Storage																													
Cornish	Sewer Separation																													
	In-Line/Latent Storage																										1	0.5		
	Off-line Storage																													
Colony	Sewer Separation																													
	In-Line/Latent Storage																											1	0.5	
	Off-line Storage																													
River	Sewer Separation																													
	In-Line/Latent Storage																										1	0.5		
	Off-line Storage																													
Assiniboine	Sewer Separation																													
	In-Line/Latent Storage																										0.6	0.5		
	Off-line Storage																													
Cockburn	Sewer Separation	0.7	0.7	0.7	0.7	1.2	1.2	0.5																						
	In-Line/Latent Storage																											1	0.5	
	Off-line Storage																													
Baltimore	Sewer Separation																													
	In-Line/Latent Storage																											0.8	0.5	
	Off-line Storage																													
Metcalfe	Sewer Separation																							0.6	1	0.5				
	In-Line/Latent Storage																													
	Off-line Storage																													
Mager	Sewer Separation																													
	In-Line/Latent Storage																									1	0.5			
	Off-line Storage																													
Jessie	Sewer Separation					0.45	0.65	1	1	0.5																				
	In-Line/Latent Storage																									1	0.5			
	Off-line Storage																													
Marion	Sewer Separation																													
	In-Line/Latent Storage																									1	0.5			
	Off-line Storage																													
Despins	Sewer Separation																					0.425	0.8	1.2	0.5					
	In-Line/Latent Storage																													
	Off-line Storage																													
Dumoulin	Sewer Separation																													
	In-Line/Latent Storage																												1	0.5
	Off-line Storage																													
La Verendrye	Sewer Separation																								1	0.5				
	In-Line/Latent Storage																													
	Off-line Storage																												1	0.5
Bannatyne	Sewer Separation																													
	In-Line/Latent Storage																											1	0.5	
	Off-line Storage																													
Alexander	Sewer Separation																													
	In-Line/Latent Storage																											1	0.5	
	Off-line Storage																													
Mission	Sewer Separation									0.35	0.55	1.1	0.95	1	1	1	1	0.5												
	In-Line/Latent Storage																													
	Off-line Storage																													
Roland	Sewer Separation																													
	In-Line/Latent Storage																								1	0.5				
	Off-line Storage																													
Syndicate	Sewer Separation																													
	In-Line/Latent Storage																									1	0.5			
	Off-line Storage																													
Selkirk	Sewer Separation																													
	In-Line/Latent Storage																												1.5	0.5
	Off-line Storage																													
Hart	Sewer Separation																													
	In-Line/Latent Storage																									1	0.5			
	Off-line Storage																													
St John's	Sewer Separation																													
	In-Line/Latent Storage																												1.5	0.5
	Off-line Storage																													
Polson	Sewer Separation																													
	In-Line/Latent Storage																											0.6	0.5	
	Off-line Storage																													
Munroe	Sewer Separation																													
	In-Line/Latent Storage																										1	0.5		
	Off-line Storage																													
Jefferson	Sewer Separation										0.4	0.2	0.7	0.875	1.15	1.15	1.15	0.9	1	0.5										
	In-Line/Latent Storage																								1	0.5				
	Off-line Storage																													
Linden	Sewer Separation																			0.75	1.25	0.5								
	In-Line/Latent Storage																													
	Off-line Storage																													
Newton	Sewer Separation																													
	In-Line/Latent Storage																								1	0.5				
	Off-line Storage																													
Armstrong	Sewer Separation							0.8	0.85	1	0.9	0.95	1	0.5																
	In-Line/Latent Storage																													
	Off-line Storage																													
Hawthorne	Sewer Separation																													
	In-Line/Latent Storage																								1	0.5				
	Off-line Storage																													

City of Winnipeg - CSO Master Plan

Figure S1-B: Scenario 1 Annual Budgeted Project Costs (With 100% Estimating Allowance)

Inflation	3.0%	Discount Rate	3.0%	NPV	6.0%	Allowance	100.0%

Project Identification		a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p
		1) Project Details								2) Additional O&M Cost Budget			3) Capital Cost Budget			4) Program Budget Summary	
						Project Capital Cost (2019)											
District	Control Option	Balance of Area Separation %	Control Gate	Latent Storage	Screening	In-line Storage Via Control Gate Construction	Latent Storage	Sewer Separation (Complete Or Partial)	Total	Annual (2019)	NPV (2019)	Total to 2100	2019 Capital Cost	100% Estimating Allowance	2019 Estimate	Capital NPV	Budget Sum
Woodhaven	Sewer Separation	95%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x		x	$4,030,000			$4,030,000	$96,243	$1,199,121	$ 28,876,163	$4,030,000	$4,030,000	$8,060,000	$3,784,721	$17,555,947
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$8,060,000		
Strathmillan	Sewer Separation	40%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x		x	$4,580,000			$4,580,000	$95,219	$1,275,362	$ 28,985,828	$4,580,000	$4,580,000	$9,160,000	$4,555,453	$18,806,598
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$9,160,000		
Moorgate	Sewer Separation	70%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x		x	$5,040,000			$5,040,000	$104,434	$1,349,279	$ 31,565,687	$5,040,000	$5,040,000	$10,080,000	$4,871,110	$21,316,334
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$10,080,000		
Douglas Park	Sewer Separation	0%							$1	$0	$0	$ -	$1	$1	$2	$2	$2
	In-Line/Latent Storage								$0				$0	$0	$0	$0	$0
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$2		
Ferry Road	Sewer Separation	70%						$129,360,000	$129,360,000	$84,469	$1,831,307	$ 27,770,981	$129,360,000	$129,360,000	$258,720,000	$220,118,688	$308,144,840
	In-Line/Latent Storage								$0				$0	$0	$0	$0	$0
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$258,720,000		
Tuxedo	Sewer Separation	34%						$8,790,000	$8,790,000	$5,631	$93,156	$ 1,780,004	$8,790,000	$8,790,000	$17,580,000	$10,411,171	$30,153,239
	In-Line/Latent Storage								$0				$0	$0	$0	$0	$0
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$17,580,000		
Doncaster	Sewer Separation	92%						$49,890,000	$49,890,000	$32,764	$471,267	$ 10,108,820	$49,890,000	$49,890,000	$99,780,000	$54,989,745	$184,544,408
	In-Line/Latent Storage								$0				$0	$0	$0	$0	$0
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$99,780,000		
Parkside	Sewer Separation	0%						$1	$1	$0	$0	$ -	$1	$1	$2	$2	$2
	In-Line/Latent Storage								$0				$0	$0	$0	$0	$0
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$2		
Riverbend	Sewer Separation	79%						$76,590,000	$76,590,000	$50,169	$1,161,918	$ 16,631,149	$76,590,000	$76,590,000	$153,180,000	$128,514,525	$183,934,663
	In-Line/Latent Storage								$0				$0	$0	$0	$0	$0
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$153,180,000		
Tylehurst	Sewer Separation	85%						$86,670,000	$86,670,000	$56,824	$846,714	$ 17,644,633	$86,670,000	$86,670,000	$173,340,000	$101,276,506	$302,356,981
	In-Line/Latent Storage								$0				$0	$0	$0	$0	$0
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$173,340,000		
Clifton	Sewer Separation	68%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x	x	x	$7,880,000	$2,410,000		$10,290,000	$240,608	$2,890,109	$ 71,639,912	$10,290,000	$10,290,000	$20,580,000	$9,412,572	$46,056,984
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$20,580,000		
Ash	Sewer Separation	83%						$29,100,000	$29,100,000	$18,942	$292,318	$ 5,917,997	$29,100,000	$29,100,000	$58,200,000	$33,989,497	$101,404,708
	In-Line/Latent Storage		x	x	x	$9,980,000	$2,600,000		$12,580,000	$244,191	$3,270,679	$ 74,334,423	$12,580,000	$12,580,000	$25,160,000	$12,512,575	$51,656,551
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$83,360,000		
Aubrey	Sewer Separation	69%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x	x	x	$11,140,000	$330,000		$11,470,000	$296,921	$3,836,184	$ 89,745,580	$11,470,000	$11,470,000	$22,940,000	$11,085,642	$48,511,578
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$22,940,000		
Cornish	Sewer Separation	74%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x	x	x	$4,810,000	$2,400,000		$7,210,000	$185,319	$2,394,308	$ 56,013,621	$7,210,000	$7,210,000	$14,420,000	$6,968,394	$30,494,201
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$14,420,000		
Colony	Sewer Separation	47%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x	x	x	$6,420,000	$2,350,000		$8,770,000	$229,858	$2,863,858	$ 68,964,877	$8,770,000	$8,770,000	$17,540,000	$8,236,228	$38,204,877
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$17,540,000		
River	Sewer Separation	46%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage				x				$2,950,000	$48,634	$628,341	$ 14,699,707	$2,950,000	$2,950,000	$5,900,000	$2,851,146	$12,476,823
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$5,900,000		
Assiniboine	Sewer Separation	56%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage				x				$6,790,000	$157,675	$2,037,146	$ 47,657,998	$6,790,000	$6,790,000	$13,580,000	$6,539,741	$28,821,234
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$13,580,000		
Cockburn	Sewer Separation	80%						$56,280,000	$56,280,000	$36,859	$941,560	$ 12,358,880	$56,280,000	$56,280,000	$112,560,000	$102,954,512	$123,762,771
	In-Line/Latent Storage		x		x	$4,900,000			$4,900,000	$82,933	$1,033,285	$ 24,882,645	$4,900,000	$4,900,000	$9,800,000	$4,601,769	$21,345,940
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$122,360,000		
Baltimore	Sewer Separation	63%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x	x	x	$5,190,000	$1,500,000		$6,690,000	$164,330	$2,047,435	$ 49,304,512	$6,690,000	$6,690,000	$13,380,000	$6,273,618	$29,188,136
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$13,380,000		
Metcalfe	Sewer Separation	88%						$17,430,000	$17,430,000	$17,918	$248,729	$ 5,491,838	$17,430,000	$17,430,000	$34,860,000	$18,039,965	$68,718,117
	In-Line/Latent Storage								$0				$0	$0	$0	$0	$0
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$34,860,000		
Mager	Sewer Separation	26%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x		x	$4,300,000			$4,300,000	$77,814	$1,042,232	$ 23,687,344	$4,300,000	$4,300,000	$8,600,000	$4,276,953	$17,656,850
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$8,600,000		
Jessie	Sewer Separation	85%						$25,900,000	$25,900,000	$16,894	$404,311	$ 5,622,406	$25,900,000	$25,900,000	$51,800,000	$43,473,849	$62,121,414
	In-Line/Latent Storage		x			$2,540,000			$2,540,000	$49,146	$658,258	$ 14,960,582	$2,540,000	$2,540,000	$5,080,000	$2,526,386	$10,429,860
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$56,880,000		
Marion	Sewer Separation	69%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x	x		$2,700,000	$2,200,000		$4,900,000	$133,614	$1,789,621	$ 40,673,662	$4,900,000	$4,900,000	$9,800,000	$4,873,738	$20,120,596
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$9,800,000		
Despins	Sewer Separation	36%						$39,980,000	$39,980,000	$26,109	$375,541	$ 8,055,466	$39,980,000	$39,980,000	$79,960,000	$43,015,116	$151,498,921
	In-Line/Latent Storage								$0				$0	$0	$0	$0	$0
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$79,960,000		
Dumoulin	Sewer Separation	58%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x		x	$4,170,000			$4,170,000	$94,707	$1,137,596	$ 28,198,689	$4,170,000	$4,170,000	$8,340,000	$3,805,364	$18,710,806
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$8,340,000		
La Verendrye	Sewer Separation	8%						$2,080,000	$2,080,000	$1,536	$21,322	$ 470,791	$2,080,000	$2,080,000	$4,160,000	$2,129,110	$8,292,221
	In-Line/Latent Storage								$0				$0	$0	$0	$0	$0
	Off-line Storage								$1,060,000	$10,750	$129,126	$ 3,200,761	$1,060,000	$1,060,000	$2,120,000	$967,311	$4,756,224
	TOTAL														$6,280,000		
Bannatyne	Sewer Separation	56%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage			x	x		$5,260,000		$5,260,000	$93,172	$1,160,851	$ 27,954,583	$5,260,000	$5,260,000	$10,520,000	$4,939,859	$22,914,214
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$10,520,000		
Alexander	Sewer Separation	80%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage				x				$3,960,000	$71,159	$886,584	$ 21,349,929	$3,960,000	$3,960,000	$7,920,000	$3,718,981	$17,251,005
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$7,920,000		
Mission	Sewer Separation	79%						$130,320,000	$130,320,000	$84,981	$1,557,903	$ 27,296,023	$130,320,000	$130,320,000	$260,640,000	$183,783,302	$375,095,243
	In-Line/Latent Storage								$0				$0	$0	$0	$0	$0
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$260,640,000		
Roland	Sewer Separation	72%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x	x	x	$4,520,000	$2,800,000		$7,320,000	$168,426	$2,338,049	$ 51,623,278	$7,320,000	$7,320,000	$14,640,000	$7,492,828	$29,182,240
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$14,640,000		
Syndicate	Sewer Separation	58%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x		x	$4,230,000			$4,230,000	$104,434	$1,398,785	$ 31,790,909	$4,230,000	$4,230,000	$8,460,000	$4,207,329	$17,369,413
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$8,460,000		
Selkirk	Sewer Separation	62%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x	x	x	$6,770,000	$1,830,000		$8,600,000	$220,643	$2,650,291	$ 65,695,324	$8,600,000	$8,600,000	$17,200,000	$7,866,678	$38,492,717
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$17,200,000		
Hart	Sewer Separation	62%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x		x	$5,280,000			$5,280,000	$110,577	$1,481,066	$ 33,660,962	$5,280,000	$5,280,000	$10,560,000	$5,251,701	$21,680,969
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$10,560,000		
St John's	Sewer Separation	67%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x	x	x	$7,140,000	$3,140,000		$10,280,000	$236,001	$2,834,766	$ 70,268,084	$10,280,000	$10,280,000	$20,560,000	$9,403,425	$46,012,225
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$20,560,000		
Polson	Sewer Separation	73%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x			$3,830,000			$3,830,000	$81,909	$1,020,528	$ 24,575,457	$3,830,000	$3,830,000	$7,660,000	$3,584,436	$16,744,755
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$7,660,000		
Munroe	Sewer Separation	69%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x		x	$7,290,000			$7,290,000	$151,532	$1,957,777	$ 45,801,193	$7,290,000	$7,290,000	$14,580,000	$7,045,713	$30,832,555
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$14,580,000		
Jefferson	Sewer Separation	90%						$145,510,000	$145,510,000	$95,219	$1,630,356	$ 30,265,089	$145,510,000	$145,510,000	$291,020,000	$195,055,208	$441,532,696
	In-Line/Latent Storage		x		x	$7,300,000			$7,300,000	$122,352	$1,698,464	$ 37,501,471	$7,300,000	$7,300,000	$14,600,000	$7,472,356	$29,102,507
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$305,620,000		
Linden	Sewer Separation	15%						$10,900,000	$10,900,000	$7,167	$114,526	$ 2,252,515	$10,900,000	$10,900,000	$21,800,000	$12,673,215	$38,121,773
	In-Line/Latent Storage								$0				$0	$0	$0	$0	$0
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$21,800,000		
Newton	Sewer Separation	99%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x		x	$5,670,000			$5,670,000	$115,697	$1,606,076	$ 35,461,583	$5,670,000	$5,670,000	$11,340,000	$5,803,871	$22,604,276
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$11,340,000		
Armstrong	Sewer Separation	92%						$61,080,000	$61,080,000	$62,456	$1,309,804	$ 20,444,648	$61,080,000	$61,080,000	$122,160,000	$94,773,679	$159,124,302
	In-Line/Latent Storage								$0				$0	$0	$0	$0	$0
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$122,160,000		
Hawthorne	Sewer Separation	95%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x		x	$4,640,000			$4,640,000	$103,410	$1,435,519	$ 31,695,751	$4,640,000	$4,640,000	$9,280,000	$4,749,552	$18,498,032
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$9,280,000		
SUBTOTAL						**$134,350,000**	**$26,820,000**	**$869,880,001**	**$1,045,810,002**	**$4,489,645**	**$61,351,428**	**$1,366,881,752**	**$1,045,810,002**	**$1,045,810,002**	**$2,091,620,004**	**$1,414,877,542**	**$3,285,600,743**
Green Infrastructure Allowance (10%)													$104,581,000	$104,581,000	$209,162,000	$118,958,961	$381,743,051
TOTAL													**$1,150,391,002**	**$1,150,391,002**	**$2,300,782,004**	**$1,533,836,503**	**$3,667,343,795**

District	Control Option	2019 (0)	2020 (1)	2021 (2)	2022 (3)	2023 (4)	2024 (5)	2025 (6)	2026 (7)	2027 (8)	2028 (9)	2029 (10)	2030 (11)	2031 (12)	2032 (13)	2033 (14)	2034 (15)	2035 (16)	2036 (17)	2037 (18)	2038 (19)	2039 (20)	2040 (21)	2041 (22)	2042 (23)	2043 (24)	2044 (25)	2045 (26)	2046 (27)	2047 (28)
Woodhaven	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$11,588,084	$5,967,863	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Strathmillan	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$12,413,596	$6,393,002	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Moorgate	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$14,070,188	$7,246,147	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Douglas Park	Sewer Separation	$2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Ferry Road	Sewer Separation	$16,026,903	$16,507,710	$17,002,941	$17,513,029	$30,923,006	$31,850,696	$30,072,366	$33,790,404	$31,903,773	$32,860,886	$33,846,712	$15,846,415	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Tuxedo	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$22,446,580	$7,706,659	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Doncaster	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$38,881,074	$40,047,506	$41,248,932	$42,486,400	$21,880,496	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Parkside	Sewer Separation	$2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Riverbend	Sewer Separation	$0	$0	$0	$0	$35,860,331	$34,094,900	$29,264,789	$37,678,416	$31,047,015	$15,989,213	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Tylehurst	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$42,793,818	$44,077,632	$45,399,961	$46,761,960	$48,164,819	$49,609,763	$25,549,028	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Clifton	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$34,285,596	$11,771,388
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Ash	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$22,199,015	$21,776,177	$22,429,462	$23,102,346	$11,897,708	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$34,096,733	$17,559,818	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Aubrey	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$32,020,844	$16,490,735	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Cornish	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,128,185	$10,366,015	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Colony	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$25,217,741	$12,987,136	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
River	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$8,235,527	$4,241,296	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Assiniboine	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$15,509,184	$13,312,050	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Cockburn	Sewer Separation	$13,823,158	$14,237,853	$14,664,988	$15,104,938	$26,671,005	$27,471,135	$11,789,695	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$14,089,730	$7,256,211	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Baltimore	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$17,757,041	$11,431,095	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Metcalfe	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$19,084,390	$32,761,536	$16,872,191	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Mager	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$11,654,686	$6,002,163	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Jessie	Sewer Separation	$0	$0	$0	$0	$7,287,670	$10,842,433	$17,181,086	$17,696,518	$9,113,707	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$6,884,396	$3,545,464	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Marion	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$13,280,921	$6,839,675	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Despins	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,983,616	$40,683,529	$62,856,053	$26,975,723	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Dumoulin	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$12,350,367	$6,360,439
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
La Verendrye	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,473,413	$2,818,808	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$3,139,422	$1,616,802
	TOTAL																													
Bannatyne	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$15,124,893	$7,789,320	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Alexander	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$11,386,802	$5,864,203	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Mission	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$15,511,387	$25,106,288	$51,718,953	$46,006,360	$49,880,580	$51,376,997	$52,918,307	$54,505,856	$28,070,516	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Roland	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$19,262,204	$9,920,035	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Syndicate	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$11,464,959	$5,904,454	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Selkirk	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$28,654,628	$9,838,089
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Hart	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$14,310,871	$7,370,098	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
St John's	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$34,252,276	$11,759,948
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Polson	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$9,010,630	$7,734,124	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Munroe	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,351,521	$10,481,034	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Jefferson	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$18,926,609	$9,747,204	$35,138,669	$45,241,036	$61,243,437	$63,080,740	$64,973,163	$52,374,019	$59,939,155	$30,868,665	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$19,209,575	$9,892,931	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Linden	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$11,133,912	$19,113,216	$7,874,645	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Newton	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$14,920,314	$7,683,962	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Armstrong	Sewer Separation	$0	$0	$0	$0	$0	$0	$19,448,724	$21,284,197	$25,791,439	$23,908,664	$25,994,031	$28,183,002	$14,514,246	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
Hawthorne	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$12,209,922	$6,288,110	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																													
SUBTOTAL																														
Green Infrastructure Allowance (10%)		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$17,542,059	$18,068,321	$18,610,370	$19,168,681	$19,743,742	$20,336,054	$20,946,136	$21,574,520	$22,221,755	$22,888,408	$23,575,060	$24,282,312	$25,010,781	$25,761,105	$26,533,938	$27,329,956	$28,149,855
TOTAL																														
Annual Capital Costs		$29,850,065	$30,745,562	$31,667,929	$32,617,967	$100,742,011	$104,259,163	$107,756,659	$110,449,535	$113,367,320	$116,791,659	$121,306,900	$125,174,446	$127,177,920	$130,688,755	$134,609,417	$138,647,700	$142,982,094	$146,551,856	$152,571,430	$156,466,891	$162,394,688	$166,328,340	$173,550,930	$176,975,495	$182,592,980	$189,691,227	$192,846,134	$199,042,198	$69,496,521
Cumulative Capital Costs		$29,850,065	$60,595,627	$92,263,556	$124,881,523	$225,623,535	$329,882,698	$437,639,358	$548,088,892	$661,456,212	$778,247,872	$899,554,771	$1,024,729,217	$1,151,907,138	$1,282,595,892	$1,417,205,310	$1,555,853,009	$1,698,835,103	$1,845,386,959	$1,997,958,390	$2,154,425,280	$2,316,819,968	$2,483,148,308	$2,656,699,239	$2,833,674,734	$3,016,267,715	$3,205,958,942	$3,398,805,076	$3,597,847,274	$3,667,343,795

City of Winnipeg - CSO Master Plan

Figure S1-C - Scenario 1 Annual Additional Operations And Maintenance (O&M) Costs

Inflation	3.0%	Discount Rate	3.0%	NPV	6.0%	Allowance	100.0%

Project Identification		a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p
		1) Project Details								2) Additional O&M Cost Budget			3) Capital Cost Budget			4) Program Budget Summary	
						Project Capital Cost (2019)											
District	Control Option	Balance of Area Separation %	Control Gate	Latent	Screens	In-line Storage Via Control Gate Construction	Latent Storage	Sewer Separation (Complete Or Partial)	Total	Annual (2019)	NPV (2019)	Total to 2100	2019 Capital Cost	100% Estimating Allowance	2019 Estimate	Additional O&M NPV	Additional O&M Budget Sum
Woodhaven	Sewer Separation	95%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x		x	$4,030,000			$4,030,000	$96,243	$1,199,121	$28,876,163	$4,030,000	$4,030,000	$8,060,000	$1,199,121	$28,876,163
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$8,060,000		
Strathmillan	Sewer Separation	40%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x		x	$4,580,000			$4,580,000	$95,219	$1,275,362	$28,985,828	$4,580,000	$4,580,000	$9,160,000	$1,275,362	$28,985,828
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$9,160,000		
Moorgate	Sewer Separation	70%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x		x	$5,040,000			$5,040,000	$104,434	$1,349,279	$31,565,687	$5,040,000	$5,040,000	$10,080,000	$1,349,279	$31,565,687
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL																
Douglas Park	Sewer Separation	0%							$1	$0	$0	$0	$1	$1	$2	$0	$0
	In-Line/Latent Storage								$0				$0	$0	$0	$0	$0
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$2		
Ferry Road	Sewer Separation	70%						$129,360,000	$129,360,000	$84,469	$1,831,307	$27,770,981	$129,360,000	$129,360,000	$258,720,000	$1,831,307	$27,770,981
	In-Line/Latent Storage								$0				$0	$0	$0	$0	$0
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$258,720,000		
Tuxedo	Sewer Separation	34%						$8,790,000	$8,790,000	$5,631	$93,156	$1,780,004	$8,790,000	$8,790,000	$17,580,000	$93,156	$1,780,004
	In-Line/Latent Storage								$0				$0	$0	$0	$0	$0
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$17,580,000		
Doncaster	Sewer Separation	92%						$49,890,000	$49,890,000	$32,764	$471,267	$10,108,820	$49,890,000	$49,890,000	$99,780,000	$471,267	$10,108,820
	In-Line/Latent Storage								$0				$0	$0	$0	$0	$0
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$99,780,000		
Parkside	Sewer Separation	0%						$1	$1	$0	$0	$0	$1	$1	$2	$0	$0
	In-Line/Latent Storage								$0				$0	$0	$0	$0	$0
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$2		
Riverbend	Sewer Separation	79%						$76,590,000	$76,590,000	$50,169	$1,161,918	$16,631,149	$76,590,000	$76,590,000	$153,180,000	$1,161,918	$16,631,149
	In-Line/Latent Storage								$0				$0	$0	$0	$0	$0
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$153,180,000		
Tylehurst	Sewer Separation	85%						$86,670,000	$86,670,000	$56,824	$846,714	$17,644,633	$86,670,000	$86,670,000	$173,340,000	$846,714	$17,644,633
	In-Line/Latent Storage								$0				$0	$0	$0	$0	$0
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$173,340,000		
Clifton	Sewer Separation	68%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x	x	x	$7,880,000	$2,410,000		$10,290,000	$240,608	$2,890,109	$71,639,912	$10,290,000	$10,290,000	$20,580,000	$2,890,109	$71,639,912
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$20,580,000		
Ash	Sewer Separation	83%						$29,100,000	$29,100,000	$18,942	$292,318	$5,917,997	$29,100,000	$29,100,000	$58,200,000	$292,318	$5,917,997
	In-Line/Latent Storage		x	x	x	$9,980,000	$2,600,000		$12,580,000	$244,191	$3,270,679	$74,334,423	$12,580,000	$12,580,000	$25,160,000	$3,270,679	$74,334,423
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$83,360,000		
Aubrey	Sewer Separation	69%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x	x	x	$11,140,000	$330,000		$11,470,000	$296,921	$3,836,184	$89,745,580	$11,470,000	$11,470,000	$22,940,000	$3,836,184	$89,745,580
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$22,940,000		
Cornish	Sewer Separation	74%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x	x	x	$4,810,000	$2,400,000		$7,210,000	$185,319	$2,394,308	$56,013,621	$7,210,000	$7,210,000	$14,420,000	$2,394,308	$56,013,621
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$14,420,000		
Colony	Sewer Separation	47%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x	x	x	$6,420,000	$2,350,000		$8,770,000	$229,858	$2,863,858	$68,964,877	$8,770,000	$8,770,000	$17,540,000	$2,863,858	$68,964,877
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$17,540,000		
River	Sewer Separation	46%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage				x				$2,950,000	$48,634	$628,341	$14,699,707	$2,950,000	$2,950,000	$5,900,000	$628,341	$14,699,707
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$5,900,000		
Assiniboine	Sewer Separation	56%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage				x				$6,790,000	$157,675	$2,037,146	$47,657,998	$6,790,000	$6,790,000	$13,580,000	$2,037,146	$47,657,998
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$13,580,000		
Cockburn	Sewer Separation	80%						$56,280,000	$56,280,000	$36,859	$941,560	$12,358,880	$56,280,000	$56,280,000	$112,560,000	$941,560	$12,358,880
	In-Line/Latent Storage		x		x	$4,900,000			$4,900,000	$82,933	$1,033,285	$24,882,645	$4,900,000	$4,900,000	$9,800,000	$1,033,285	$24,882,645
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$122,360,000		
Baltimore	Sewer Separation	63%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x	x	x	$5,190,000	$1,500,000		$6,690,000	$164,330	$2,047,435	$49,304,512	$6,690,000	$6,690,000	$13,380,000	$2,047,435	$49,304,512
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$13,380,000		
Metcalfe	Sewer Separation	88%						$17,430,000	$17,430,000	$17,918	$248,729	$5,491,838	$17,430,000	$17,430,000	$34,860,000	$248,729	$5,491,838
	In-Line/Latent Storage								$0				$0	$0	$0	$0	$0
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$34,860,000		
Mager	Sewer Separation	26%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x		x	$4,300,000			$4,300,000	$77,814	$1,042,232	$23,687,344	$4,300,000	$4,300,000	$8,600,000	$1,042,232	$23,687,344
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$8,600,000		
Jessie	Sewer Separation	85%						$25,900,000	$25,900,000	$16,894	$404,311	$5,622,406	$25,900,000	$25,900,000	$51,800,000	$404,311	$5,622,406
	In-Line/Latent Storage		x			$2,540,000			$2,540,000	$49,146	$658,258	$14,960,582	$2,540,000	$2,540,000	$5,080,000	$658,258	$14,960,582
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$56,880,000		
Marion	Sewer Separation	69%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x	x		$2,700,000	$2,200,000		$4,900,000	$133,614	$1,789,621	$40,673,662	$4,900,000	$4,900,000	$9,800,000	$1,789,621	$40,673,662
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$9,800,000		
Despins	Sewer Separation	36%						$39,980,000	$39,980,000	$26,109	$375,541	$8,055,466	$39,980,000	$39,980,000	$79,960,000	$375,541	$8,055,466
	In-Line/Latent Storage								$0				$0	$0	$0	$0	$0
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$79,960,000		
Dumoulin	Sewer Separation	58%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x		x	$4,170,000			$4,170,000	$94,707	$1,137,596	$28,198,689	$4,170,000	$4,170,000	$8,340,000	$1,137,596	$28,198,689
	Off-line Storage								$0			$0	$0	$0	$0	$0	$0
	TOTAL											$0			$8,340,000		
La Verendrye	Sewer Separation	8%						$2,080,000	$2,080,000	$1,536	$21,322	$470,791	$2,080,000	$2,080,000	$4,160,000	$21,322	$470,791
	In-Line/Latent Storage								$0				$0	$0	$0	$0	$0
	Off-line Storage								$1,060,000	$10,750	$129,126	$3,200,761	$1,060,000	$1,060,000	$2,120,000	$129,126	$3,200,761
	TOTAL														$6,280,000		
Bannatyne	Sewer Separation	56%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage			x	x		$5,260,000		$5,260,000	$93,172	$1,160,851	$27,954,583	$5,260,000	$5,260,000	$10,520,000	$1,160,851	$27,954,583
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$10,520,000		
Alexander	Sewer Separation	80%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage				x				$3,960,000	$71,159	$886,584	$21,349,929	$3,960,000	$3,960,000	$7,920,000	$886,584	$21,349,929
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$7,920,000		
Mission	Sewer Separation	79%						$130,320,000	$130,320,000	$84,981	$1,557,903	$27,296,023	$130,320,000	$130,320,000	$260,640,000	$1,557,903	$27,296,023
	In-Line/Latent Storage								$0				$0	$0	$0	$0	$0
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$260,640,000		
Roland	Sewer Separation	72%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x	x	x	$4,520,000	$2,800,000		$7,320,000	$168,426	$2,338,049	$51,623,278	$7,320,000	$7,320,000	$14,640,000	$2,338,049	$51,623,278
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$14,640,000		
Syndicate	Sewer Separation	58%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x		x	$4,230,000			$4,230,000	$104,434	$1,398,785	$31,790,909	$4,230,000	$4,230,000	$8,460,000	$1,398,785	$31,790,909
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$8,460,000		
Selkirk	Sewer Separation	62%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x	x	x	$6,770,000	$1,830,000		$8,600,000	$220,643	$2,650,291	$65,695,324	$8,600,000	$8,600,000	$17,200,000	$2,650,291	$65,695,324
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$17,200,000		
Hart	Sewer Separation	62%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x		x	$5,280,000			$5,280,000	$110,577	$1,481,066	$33,660,962	$5,280,000	$5,280,000	$10,560,000	$1,481,066	$33,660,962
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$10,560,000		
St John's	Sewer Separation	67%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x	x	x	$7,140,000	$3,140,000		$10,280,000	$236,001	$2,834,766	$70,268,084	$10,280,000	$10,280,000	$20,560,000	$2,834,766	$70,268,084
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$20,560,000		
Polson	Sewer Separation	73%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x			$3,830,000			$3,830,000	$81,909	$1,020,528	$24,575,457	$3,830,000	$3,830,000	$7,660,000	$1,020,528	$24,575,457
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$7,660,000		
Munroe	Sewer Separation	69%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x		x	$7,290,000			$7,290,000	$151,532	$1,957,777	$45,801,193	$7,290,000	$7,290,000	$14,580,000	$1,957,777	$45,801,193
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$14,580,000		
Jefferson	Sewer Separation	90%						$145,510,000	$145,510,000	$95,219	$1,630,356	$30,265,089	$145,510,000	$145,510,000	$291,020,000	$1,630,356	$30,265,089
	In-Line/Latent Storage		x		x	$7,300,000			$7,300,000	$122,352	$1,698,464	$37,501,471	$7,300,000	$7,300,000	$14,600,000	$1,698,464	$37,501,471
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$305,620,000		
Linden	Sewer Separation	15%						$10,900,000	$10,900,000	$7,167	$114,526	$2,252,515	$10,900,000	$10,900,000	$21,800,000	$114,526	$2,252,515
	In-Line/Latent Storage								$0				$0	$0	$0	$0	$0
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$21,800,000		
Newton	Sewer Separation	99%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x		x	$5,670,000			$5,670,000	$115,697	$1,606,076	$35,461,583	$5,670,000	$5,670,000	$11,340,000	$1,606,076	$35,461,583
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$11,340,000		
Armstrong	Sewer Separation	92%						$61,080,000	$61,080,000	$62,456	$1,309,804	$20,444,648	$61,080,000	$61,080,000	$122,160,000	$1,309,804	$20,444,648
	In-Line/Latent Storage								$0				$0	$0	$0	$0	$0
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$122,160,000		
Hawthorne	Sewer Separation	95%							$0				$0	$0	$0	$0	$0
	In-Line/Latent Storage		x		x	$4,640,000			$4,640,000	$103,410	$1,435,519	$31,695,751	$4,640,000	$4,640,000	$9,280,000	$1,435,519	$31,695,751
	Off-line Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$9,280,000		
SUBTOTAL						**$134,350,000**	**$26,820,000**	**$869,880,001**	**$1,045,810,002**	**$4,489,645**	**$61,351,428**	**$1,366,881,752**	**$1,045,810,002**	**$1,045,810,002**	**$2,081,540,004**	**$61,351,428**	**$1,366,881,752**
Green Infrastructure Allowance (10%)													$104,581,000	$104,581,000	$209,162,000		
GRAND TOTAL													**$1,150,391,002**	**$1,150,391,002**	**$2,290,702,004**		

District	Control Option	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Woodhaven	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$220,198	$226,804
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Strathmillan	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$205,349	$211,510	$217,855	$224,391
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Moorgate	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$231,978	$238,938	$246,106
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Douglas Park	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Ferry Road	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$120,432	$124,045	$127,767	$131,600	$135,548	$139,614	$143,803	$148,117	$152,560	$157,137	$161,851	$166,707	$171,708	$176,859	$182,165	$187,630	$193,259	$199,056
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Tuxedo	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$10,171	$10,476	$10,790	$11,114	$11,447	$11,791	$12,144	$12,509	$12,884	$13,270
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Doncaster	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$66,602	$68,600	$70,658	$72,778	$74,961	$77,210
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Parkside	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Riverbend	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$67,423	$69,446	$71,530	$73,675	$75,886	$78,162	$80,507	$82,922	$85,410	$87,972	$90,611	$93,330	$96,130	$99,014	$101,984	$105,043	$108,195	$111,441	$114,784	$118,227
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Tylehurst	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$112,148	$115,512	$118,978	$122,547	$126,224	$130,010	$133,911
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Clifton	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$567,009
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Ash	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$36,295	$37,384	$38,505	$39,660	$40,850	$42,076	$43,338	$44,638
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$526,620	$542,419	$558,691	$575,452
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Aubrey	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$659,547	$679,333	$699,713
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Cornish	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$411,648	$423,998	$436,717
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Colony	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$525,897	$541,674
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
River	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$108,029	$111,270	$114,608
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Assiniboine	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$350,242	$360,749	$371,572
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Cockburn	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$45,332	$46,692	$48,093	$49,535	$51,021	$52,552	$54,129	$55,753	$57,425	$59,148	$60,922	$62,750	$64,632	$66,571	$68,569	$70,626	$72,744	$74,927	$77,175	$79,490	$81,874	$84,331	$86,861
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$189,745	$195,437
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Baltimore	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$375,976	$387,255
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Metcalfe	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$37,516	$38,641	$39,800	$40,994	$42,224
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Mager	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$167,812	$172,847	$178,032	$183,373
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Jessie	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$22,043	$22,704	$23,385	$24,087	$24,809	$25,554	$26,320	$27,110	$27,923	$28,761	$29,624	$30,512	$31,428	$32,371	$33,342	$34,342	$35,372	$36,433	$37,526	$38,652	$39,812
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$105,988	$109,167	$112,442	$115,816
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Marion	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$288,151	$296,796	$305,700	$314,871
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Despins	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$53,073	$54,665	$56,305	$57,995	$59,734	$61,526
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Dumoulin	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$223,184
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
La Verendrye	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$3,216	$3,313	$3,412	$3,514	$3,620
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$25,333
	TOTAL																														
Bannatyne	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$213,170	$219,565
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Alexander	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$162,806	$167,690
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Mission	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$140,460	$144,674	$149,014	$153,485	$158,089	$162,832	$167,717	$172,748	$177,931	$183,269	$188,767	$194,430	$200,263
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Roland	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$352,646	$363,225	$374,122	$385,346	$396,906
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Syndicate	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$225,222	$231,978	$238,938	$246,106
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Selkirk	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$519,959
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Hart	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$238,470	$245,624	$252,993	$260,583
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
St John's	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$556,151
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Polson	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$187,402	$193,024
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Munroe	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$336,596	$346,694	$357,095
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Jefferson	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$166,967	$171,976	$177,135	$182,449	$187,923	$193,561	$199,367	$205,348	$211,509	$217,854	$224,390
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$256,178	$263,863	$271,779	$279,933	$288,331
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Linden	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$13,333	$13,733	$14,145	$14,569	$15,006	$15,456	$15,920	$16,398	$16,890
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Newton	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$242,243	$249,510	$256,996	$264,706	$272,647
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Armstrong	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$91,718	$94,470	$97,304	$100,223	$103,230	$106,327	$109,516	$112,802	$116,186	$119,672	$123,262	$126,960	$130,768	$134,691	$138,732	$142,894	$147,181
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
Hawthorne	Sewer Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$216,518	$223,014	$229,704	$236,595	$243,693
	Off-line Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																														
	Annual O&M Total	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$45,332**	**$46,692**	**$70,135**	**$139,663**	**$143,853**	**$268,601**	**$368,377**	**$379,428**	**$390,811**	**$402,536**	**$555,072**	**$571,724**	**$755,843**	**$788,689**	**$825,682**	**$886,748**	**$1,025,498**	**$1,175,938**	**$2,319,533**	**$4,146,732**	**$6,369,175**	**$8,435,443**	**$10,580,143**
	Annual O&M Total - 2019 PV	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$36,859**	**$36,859**	**$53,753**	**$103,922**	**$103,922**	**$188,391**	**$250,847**	**$250,847**	**$250,847**	**$250,847**	**$335,828**	**$335,828**	**$431,047**	**$436,678**	**$443,845**	**$462,787**	**$519,611**	**$578,484**	**$1,107,822**	**$1,922,818**	**$2,867,333**	**$3,686,936**	**$4,489,645**
	Cumulative O&M Total	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$45,332**	**$92,024**	**$162,159**	**$301,822**	**$445,675**	**$714,276**	**$1,082,653**	**$1,462,081**	**$1,852,893**	**$2,255,428**	**$2,810,500**	**$3,382,224**	**$4,138,067**	**$4,926,756**	**$5,752,438**	**$6,639,186**	**$7,664,684**	**$8,840,622**	**$11,160,155**	**$15,306,888**	**$21,676,062**	**$30,111,506**	**$40,691,649**

City of Winnipeg - CSO Master Plan

Figure S1 - D: Scenario 1 Annual Modelled Project Performance

Winnipeg

JACOBS

Project Identification		a	b	c	d	e	f	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
		1) Project Details				2) Performance																														
District	Control Option	Balance of Area Separation %	Control Gate	Latent	Screens	2018 Revised Baseline Total CSO Volume (m3/year)	Control Option Performance (CSO Volume Reduction)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Woodhaven	Sewer Separation	95%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent Storage		x		x		220	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	220	220
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					12,120																														
Strathmillan	Sewer Separation	40%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent Storage		x		x		20,748	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20,748	20,748	20,748	20,748
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					39,684																														
Moorgate	Sewer Separation	70%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent Storage		x		x		7,518	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7,518	7,518	7,518
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					64,937																														
Douglas Park	Sewer Separation	0%					739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739
	In-Line/Latent Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Off-line Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					739																														
Ferry Road	Sewer Separation	70%					136,599	0	0	0	0	0	0	0	0	0	0	0	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599
	In-Line/Latent Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Off-line Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					136,599																														
Tuxedo	Sewer Separation	34%					13,843	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843
	In-Line/Latent Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Off-line Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					13,843																														
Doncaster	Sewer Separation	92%					30,644	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30,644	30,644	30,644	30,644	30,644	30,644
	In-Line/Latent Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Off-line Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					30,644																														
Parkside	Sewer Separation	0%					2,979	2979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979
	In-Line/Latent Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Off-line Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					2,979																														
Riverbend	Sewer Separation	79%					87,057	0	0	0	0	0	0	0	0	0	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057
	In-Line/Latent Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Off-line Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					87,057																														
Tylehurst	Sewer Separation	85%					206,812	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	206,812	206,812	206,812	206,812	206,812	206,812	206,812
	In-Line/Latent Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Off-line Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					206,812																														
Clifton	Sewer Separation	68%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent Storage		x	x	x		26,483	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26,483
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					114,875																														
Ash	Sewer Separation	83%					54,678	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	54,678	54,678	54,678	54,678	54,678	54,678	54,678	54,678
	In-Line/Latent Storage		x	x	x		28,542	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28,542	28,542	28,542	28,542
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					341,484																														
Aubrey	Sewer Separation	69%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent Storage		x	x	x		59,934	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	59,934	59,934	59,934
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					141,643																														
Cornish	Sewer Separation	74%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent Storage		x	x	x		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					60,293																														
Colony	Sewer Separation	47%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent Storage		x	x	x		49,680	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	49,680	49,680
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					163,833																														
River	Sewer Separation	46%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent Storage				x		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					15,904																														
Assiniboine	Sewer Separation	56%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent Storage				x		708	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	708	708	708
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					13,005																														
Cockburn	Sewer Separation	80%					178,416	0	0	0	0	0	0	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416
	In-Line/Latent Storage		x		x		8,358	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8,358	8,358
	Off-line Storage						Part Sep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					188,459																														
Baltimore	Sewer Separation	63%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent Storage		x	x	x		5,976	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5,976	5,976
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					72,575																														
Metcalfe	Sewer Separation	88%					12,191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12,191	12,191	12,191	12,191	12,191
	In-Line/Latent Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Off-line Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					12,191																														
Mager	Sewer Separation	26%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent Storage		x		x		20,856	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20,856	20,856	20,856	20,856
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					21,912																														
Jessie	Sewer Separation	85%					23,202	0	0	0	0	0	0	0	0	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202
	In-Line/Latent Storage		x				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					187,594																														
Marion	Sewer Separation	69%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent Storage		x	x			14,225	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14,225	14,225	14,225	14,225
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					51,773																														
Despins	Sewer Separation	36%					43,955	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43,955	43,955	43,955	43,955	43,955	43,955
	In-Line/Latent Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Off-line Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					43,955																														
Dumoulin	Sewer Separation	58%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent Storage		x		x		6,985	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6,985
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					49,524																														
La Verendrye	Sewer Separation	8%					12,469	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12,469	12,469	12,469	12,469	12,469
	In-Line/Latent Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Off-line Storage						722	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	722
	TOTAL					13,191																														
Bannatyne	Sewer Separation	56%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent Storage			x	x		32,598	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32,598	32,598
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					148,170																														
Alexander	Sewer Separation	80%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent Storage				x		708	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	708	708
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					26,851																														
Mission	Sewer Separation	79%					12,809	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809
	In-Line/Latent Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Off-line Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					12,809																														
Roland	Sewer Separation	72%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent Storage		x	x	x		118,287	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	118,287	118,287	118,287	118,287	118,287
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					299,396																														
Syndicate	Sewer Separation	58%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent Storage		x		x		5,786	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5,786	5,786	5,786	5,786
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					57,357																														
Selkirk	Sewer Separation	62%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent Storage		x	x	x		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					172,507																														
Hart	Sewer Separation	62%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent Storage		x		x		37,171	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37,171	37,171	37,171	37,171
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					202,745																														
St John's	Sewer Separation	67%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent Storage		x	x	x		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					181,444																														
Polson	Sewer Separation	73%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent Storage		x				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					455,282																														
Munroe	Sewer Separation	69%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent Storage		x		x		18,388	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18,388	18,388	18,388
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					432,465																														
Jefferson	Sewer Separation	90%					119,247	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247
	In-Line/Latent Storage		x		x		53,965	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	53,965	53,965	53,965	53,965	53,965
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					287,466																														
Linden	Sewer Separation	15%					14,033	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033
	In-Line/Latent Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Off-line Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					14,033																														
Newton	Sewer Separation	99%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent Storage		x		x		5,620	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5,620	5,620	5,620	5,620	5,620
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					8,614																														
Armstrong	Sewer Separation	92%					749,622	0	0	0	0	0	0	0	0	0	0	0	0	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622
	In-Line/Latent Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Off-line Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					749,622																														
Hawthorne	Sewer Separation	95%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent Storage		x		x		2,753	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,753	2,753	2,753	2,753	2,753
	Off-line Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					33,245																														
SUBTOTAL						**5,169,631**	**2,225,526**	**3,718**	**3,718**	**3,718**	**3,718**	**3,718**	**3,718**	**182,134**	**182,134**	**205,336**	**292,393**	**292,393**	**428,992**	**1,178,614**	**1,178,614**	**1,178,614**	**1,178,614**	**1,191,423**	**1,191,423**	**1,310,670**	**1,324,513**	**1,338,546**	**1,393,224**	**1,600,036**	**1,674,635**	**1,879,920**	**2,007,248**	**2,093,796**	**2,191,336**	**2,225,526**
Total CSO Volume As Control Options Are Implemented								5,170,000	5,166,282	5,166,282	5,166,282	5,166,282	5,166,282	4,987,866	4,987,866	4,964,664	4,877,607	4,877,607	4,741,008	3,991,386	3,991,386	3,991,386	3,991,386	3,978,577	3,978,577	3,859,330	3,845,487	3,831,454	3,776,776	3,569,964	3,495,365	3,290,080	3,162,752	3,076,204	2,978,664	2,944,474

City of Winnipeg - CSO Master Plan

Figure S2-A: Scenario 2 Project Schedule

Winnipeg

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Project Identification		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
District	**Control Option**	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059
Woodhaven	Separation																																									
	In-Line/Latent																																					1	0.5			
	Storage																																									
Strathmillan	Separation																																									
	In-Line/Latent																																			1	0.5					
	Storage																																									
Moorgate	Separation																																									
	In-Line/Latent																																					1	0.5			
	Storage																																									
Douglas Park	Separation	0.5																																								
	In-Line/Latent																																									
	Storage																																									
Ferry Road	Separation	0.7	0.7	0.7	0.7	1.2	1.2	1.1	1.2	1.1	1.1	1.1	0.5																													
	In-Line/Latent																																									
	Storage																																									
Tuxedo	Separation																															0.7	0.5									
	In-Line/Latent																																									
	Storage																																									
Doncaster	Separation																																0.975	1.8	1	0.5						
	In-Line/Latent																																									
	Storage																																									
Parkside	Separation	0.5																																								
	In-Line/Latent																																									
	Storage																																									
Riverbend	Separation									1	1	1	1	1	1	1	1	1	1	1	0.5																					
	In-Line/Latent																																									
	Storage																																									
Tylehurst	Separation																									0.95	1	1	1	1	1	1	0.5									
	In-Line/Latent																																									
	Storage																																									
Clifton	Separation																																									
	In-Line/Latent																																							1.7	1	0.5
	Storage																																									
Ash	Separation																													1	1	1	1	1	0.5							
	In-Line/Latent																																						1	0.5		
	Storage																																									
Aubrey	Separation																																									
	In-Line/Latent																																								0.8	0.5
	Storage																																									
Cornish	Separation																																									
	In-Line/Latent																																							1	0.5	
	Storage																																									
Colony	Separation																																									
	In-Line/Latent																																							1	0.5	
	Storage																																									
River	Separation																																									
	In-Line/Latent																																					1	0.5			
	Storage																																									
Assiniboine	Separation																																									
	In-Line/Latent																																					1.25	0.5			
	Storage																																									
Cockburn	Separation	0.7	0.7	0.7	0.7	1.2	1.2	0.5																																		
	In-Line/Latent																																						1.2	0.5		
	Storage																																									
Baltimore	Separation																																									
	In-Line/Latent																																				1	0.5				
	Storage																																									
Metcalfe	Separation																										1	1	0.5													
	In-Line/Latent																																									
	Storage																																									
Mager	Separation																																									
	In-Line/Latent																																				1	0.5				
	Storage																																									
Jessie	Separation					0.7	0.7	1	1.2	0.5																																
	In-Line/Latent																																				1	0.5				
	Storage																																									
Marion	Separation																																									
	In-Line/Latent																																								0.8	0.5
	Storage																																									
Despins	Separation																											1	1.45	1.2	1	0.5										
	In-Line/Latent																																									
	Storage																																									
Dumoulin	Separation																																									
	In-Line/Latent																																				1	0.5				
	Storage																																									
La Verendrye	Separation																														1.75	0.5										
	In-Line/Latent																																									
	Storage																																								0.8	0.5
Bannatyne	Separation																																									
	In-Line/Latent																																			1	0.5					
	Storage																																									
Alexander	Separation																																									
	In-Line/Latent																																			1	0.5					
	Storage																																									
Mission	Separation														0.4	0.4	0.4	0.4	0.4	0.4	0.675	0.975	1.625	2.275	1.85	0.975	0.5															
	In-Line/Latent																																									
	Storage																																									
Roland	Separation																																									
	In-Line/Latent																																				1	0.5				
	Storage																																									
Syndicate	Separation																																									
	In-Line/Latent																																				1	0.5				
	Storage																																									
Selkirk	Separation																																									
	In-Line/Latent																																						1.75	0.5		
	Storage																																									
Hart	Separation																																									
	In-Line/Latent																																					1	0.5			
	Storage																																									
St John's	Separation																																									
	In-Line/Latent																																								0.8	0.5
	Storage																																									
Polson	Separation																																									
	In-Line/Latent																																							1	0.5	
	Storage																																									
Munroe	Separation																																									
	In-Line/Latent																																			1.2	0.5					
	Storage																																									
Jefferson	Separation											0.125	0.225	1	1	1	1	1	1	1	1	1	0.5																			
	In-Line/Latent																																		1	0.5						
	Storage																																									
Linden	Separation																								1.2	1	0.5															
	In-Line/Latent																																									
	Storage																																									
Newton	Separation																																									
	In-Line/Latent																																		1	0.5						
	Storage																																									
Armstrong	Separation							0.625	0.875	0.775	1.1	0.9	1.45	0.5																												
	In-Line/Latent																																									
	Storage																																									
Hawthorne	Separation																																									
	In-Line/Latent																																		1.1	0.5						
	Storage																																									

Figure S2-B: Scenario 2 Annual Budgeted Project Costs (With 100% Estimating Allowance)

Winnipeg

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Project Identification		a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p
										Inflation	3.0%	Discount Rate	3.0%	NPV	6.0%	Allowance	100.0%
		1) Project Details								2) Additional O&M Cost Budget			3) Capital Cost Budget			4) Program Budget Summary	
		Project Capital Cost (2019)															
District	Control Option	Balance of Area Separation %	Control Gate	Latent	Screens	In-line Storage Via Control Gate Construction	Latent Storage	Sewer Separation (Complete Or Partial)	Total	Annual (2019)	NPV (2019)	Total to 2100	2019 Capital Cost	100% Estimating Allowance	2019 Estimate	Capital NPV	Budget Sum
Woodhaven	Separation	95%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$4,030,000			$4,030,000	$96,243	$819,268	$26,351,844	$4,030,000	$4,030,000	$8,060,000	$2,840,190	$23,593,725
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$8,060,000		
Strathmillan	Separation	40%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$4,580,000			$4,580,000	$95,219	$877,340	$26,631,729	$4,580,000	$4,580,000	$9,160,000	$3,418,575	$25,274,495
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$9,160,000		
Moorgate	Separation	70%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$5,040,000			$5,040,000	$104,434	$888,993	$28,594,554	$5,040,000	$5,040,000	$10,080,000	$3,552,000	$29,506,792
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$10,080,000		
Douglas Park	Separation	0%							$1	$0	$0	$0	$1	$1	$2	$2	$2
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$2		
Ferry Road	Separation	70%						$129,360,000	$129,360,000	$84,469	$1,831,307	$27,770,981	$129,360,000	$129,360,000	$258,720,000	$220,118,688	$308,144,840
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$258,720,000		
Tuxedo	Separation	34%						$8,790,000	$8,790,000	$5,631	$60,499	$1,635,661	$8,790,000	$8,790,000	$17,580,000	$7,341,889	$43,204,665
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$17,580,000		
Doncaster	Separation	92%						$49,890,000	$49,890,000	$32,764	$313,875	$9,255,798	$49,890,000	$49,890,000	$99,780,000	$39,556,063	$258,868,186
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$99,780,000		
Parkside	Separation	0%						$1	$1	$0	$0	$0	$1	$1	$2	$2	$2
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$2		
Riverbend	Separation	79%						$76,590,000	$76,590,000	$50,169	$829,932	$15,858,215	$76,590,000	$76,590,000	$153,180,000	$105,156,003	$227,789,122
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$153,180,000		
Tylehurst	Separation	85%						$86,670,000	$86,670,000	$56,824	$610,494	$16,505,309	$86,670,000	$86,670,000	$173,340,000	$79,338,752	$389,133,373
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$173,340,000		
Clifton	Separation	68%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$7,880,000	$2,410,000		$10,290,000	$240,608	$1,812,517	$63,592,906	$10,290,000	$10,290,000	$20,580,000	$6,791,122	$64,474,425
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$20,580,000		
Ash	Separation	83%						$29,100,000	$29,100,000	$18,942	$188,601	$5,402,900	$29,100,000	$29,100,000	$58,200,000	$24,429,868	$142,569,750
	In-Line/Latent		x	x	x	$9,980,000	$2,600,000		$12,580,000	$244,191	$1,996,649	$66,109,779	$12,580,000	$12,580,000	$25,160,000	$8,614,982	$75,859,386
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$83,360,000		
Aubrey	Separation	69%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$11,140,000	$330,000		$11,470,000	$296,921	$2,236,723	$78,476,352	$11,470,000	$11,470,000	$22,940,000	$7,405,648	$73,489,887
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$22,940,000		
Cornish	Separation	74%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$4,810,000	$2,400,000		$7,210,000	$185,319	$1,454,796	$49,584,587	$7,210,000	$7,210,000	$14,420,000	$4,797,780	$44,781,762
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$14,420,000		
Colony	Separation	47%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$6,420,000	$2,350,000		$8,770,000	$229,858	$1,804,430	$61,501,325	$8,770,000	$8,770,000	$17,540,000	$5,835,858	$54,471,019
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$17,540,000		
River	Separation	46%							$0				$0	$0	$0	$0	$0
	In-Line/Latent				x				$2,950,000	$48,634	$413,992	$13,316,091	$2,950,000	$2,950,000	$5,900,000	$2,079,847	$17,270,841
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$5,900,000		
Assiniboine	Separation	56%							$0				$0	$0	$0	$0	$0
	In-Line/Latent				x				$6,790,000	$157,675	$1,342,205	$43,172,170	$6,790,000	$6,790,000	$13,580,000	$4,791,843	$39,695,979
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$13,580,000		
Cockburn	Separation	80%						$56,280,000	$56,280,000	$36,859	$941,560	$12,358,880	$56,280,000	$56,280,000	$112,560,000	$102,954,512	$123,762,771
	In-Line/Latent		x		x	$4,900,000			$4,900,000	$82,933	$678,109	$22,452,434	$4,900,000	$4,900,000	$9,800,000	$3,359,357	$29,513,356
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$122,360,000		
Baltimore	Separation	63%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$5,190,000	$1,500,000		$6,690,000	$164,330	$1,455,661	$45,484,934	$6,690,000	$6,690,000	$13,380,000	$4,852,183	$38,025,974
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$13,380,000		
Metcalfe	Separation	88%						$17,430,000	$17,430,000	$17,918	$223,241	$5,375,881	$17,430,000	$17,430,000	$34,860,000	$16,624,035	$74,753,975
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$34,860,000		
Mager	Separation	26%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$4,300,000			$4,300,000	$77,814	$689,285	$21,538,038	$4,300,000	$4,300,000	$8,600,000	$3,118,742	$24,441,209
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$8,600,000		
Jessie	Separation	85%						$25,900,000	$25,900,000	$16,894	$404,311	$5,622,406	$25,900,000	$25,900,000	$51,800,000	$43,602,041	$61,940,595
	In-Line/Latent		x			$2,540,000			$2,540,000	$49,146	$435,342	$13,603,112	$2,540,000	$2,540,000	$5,080,000	$1,842,234	$14,437,365
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$56,880,000		
Marion	Separation	69%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x		$2,700,000	$2,200,000		$4,900,000	$133,614	$1,006,525	$35,314,358	$4,900,000	$4,900,000	$9,800,000	$3,163,703	$31,394,982
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$9,800,000		
Despins	Separation	36%						$39,980,000	$39,980,000	$26,109	$291,219	$7,648,794	$39,980,000	$39,980,000	$79,960,000	$36,102,733	$181,550,659
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$79,960,000		
Dumoulin	Separation	58%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$4,170,000			$4,170,000	$94,707	$838,932	$26,214,059	$4,170,000	$4,170,000	$8,340,000	$3,024,455	$23,702,289
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$8,340,000		
La Verendrye	Separation	8%						$2,080,000	$2,080,000	$1,536	$17,133	$449,989	$2,080,000	$2,080,000	$4,160,000	$1,797,888	$9,868,668
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Storage								$1,060,000	$10,750	$80,980	$2,841,233	$1,060,000	$1,060,000	$2,120,000	$684,393	$6,791,568
	TOTAL														$6,280,000		
Bannatyne	Separation	56%							$0				$0	$0	$0	$0	$0
	In-Line/Latent			x	x		$5,260,000		$5,260,000	$93,172	$858,473	$26,059,003	$5,260,000	$5,260,000	$10,520,000	$3,926,136	$29,027,040
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$10,520,000		
Alexander	Separation	80%							$0				$0	$0	$0	$0	$0
	In-Line/Latent				x				$3,960,000	$71,159	$655,647	$19,902,206	$3,960,000	$3,960,000	$7,920,000	$2,955,799	$21,853,057
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$7,920,000		
Mission	Separation	79%						$130,320,000	$130,320,000	$84,981	$1,138,227	$25,869,073	$130,320,000	$130,320,000	$260,640,000	$144,901,670	$480,971,959
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$260,640,000		
Roland	Separation	72%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$4,520,000	$2,800,000		$7,320,000	$168,426	$1,491,939	$46,618,515	$7,320,000	$7,320,000	$14,640,000	$5,309,114	$41,606,896
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$14,640,000		
Syndicate	Separation	58%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$4,230,000			$4,230,000	$104,434	$925,093	$28,906,314	$4,230,000	$4,230,000	$8,460,000	$3,067,972	$24,043,329
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$8,460,000		
Selkirk	Separation	62%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$6,770,000	$1,830,000		$8,600,000	$220,643	$1,804,105	$59,734,575	$8,600,000	$8,600,000	$17,200,000	$5,908,112	$51,688,205
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$17,200,000		
Hart	Separation	62%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$5,280,000			$5,280,000	$110,577	$941,287	$30,276,586	$5,280,000	$5,280,000	$10,560,000	$3,721,142	$30,911,877
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$10,560,000		
St John's	Separation	67%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$7,140,000	$3,140,000		$10,280,000	$236,001	$1,777,809	$62,375,170	$10,280,000	$10,280,000	$20,560,000	$6,624,039	$66,001,994
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$20,560,000		
Polson	Separation	73%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x			$3,830,000			$3,830,000	$81,909	$643,004	$21,915,840	$3,830,000	$3,830,000	$7,660,000	$2,548,613	$23,788,370
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$7,660,000		
Munroe	Separation	69%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$7,290,000			$7,290,000	$151,532	$1,396,197	$42,381,676	$7,290,000	$7,290,000	$14,580,000	$5,447,453	$40,182,631
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$14,580,000		
Jefferson	Separation	90%						$145,510,000	$145,510,000	$95,219	$1,469,443	$29,749,010	$145,510,000	$145,510,000	$291,020,000	$184,134,272	$469,592,402
	In-Line/Latent		x		x	$7,300,000			$7,300,000	$122,352	$1,172,130	$34,564,678	$7,300,000	$7,300,000	$14,600,000	$5,607,524	$39,111,335
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$305,620,000		
Linden	Separation	15%						$10,900,000	$10,900,000	$7,167	$95,995	$2,181,729	$10,900,000	$10,900,000	$21,800,000	$11,029,150	$43,987,450
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$21,800,000		
Newton	Separation	99%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$5,670,000			$5,670,000	$115,697	$1,108,372	$32,684,537	$5,670,000	$5,670,000	$11,340,000	$4,355,433	$30,378,256
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$11,340,000		
Armstrong	Separation	92%						$61,080,000	$61,080,000	$62,456	$1,309,804	$20,444,648	$61,080,000	$61,080,000	$122,160,000	$94,083,505	$160,308,536
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$122,160,000		
Hawthorne	Separation	95%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$4,640,000			$4,640,000	$103,410	$990,668	$29,213,612	$4,640,000	$4,640,000	$9,280,000	$3,566,356	$24,844,424
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$9,280,000		
SUBTOTAL						$134,350,000	$26,820,000	$869,880,001	$1,045,810,002	$4,489,645	$42,322,114	$1,245,541,489	$1,045,810,002	$1,045,810,002	$2,091,620,004	$1,234,380,879	$4,016,609,422
Green Infrastructure Allowance (10%)													$104,581,000	$104,581,000	$209,162,000	$102,036,514	$464,997,910
TOTAL													$1,150,391,002	$1,150,391,002	$2,300,782,004		

District	Control Option	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
Woodhaven	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Strathmillan	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Moorgate	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Douglas Park	Separation	$2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Ferry Road	Separation	$16,026,903	$16,507,710	$17,002,941	$17,513,029	$30,923,006	$31,850,696	$30,072,366	$33,790,404	$31,903,773	$32,860,886	$33,846,712	$15,846,415	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Tuxedo	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Doncaster	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Parkside	Separation	$2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Riverbend	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$16,873,377	$17,379,579	$17,900,966	$18,437,995	$18,991,135	$19,560,869	$20,147,695	$20,752,126	$21,374,690	$22,015,930	$22,676,408	$11,678,350	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Tylehurst	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Clifton	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Ash	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Aubrey	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Cornish	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Colony	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
River	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Assiniboine	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Cockburn	Separation	$13,823,158	$14,237,853	$14,664,988	$15,104,938	$26,671,005	$27,471,135	$11,789,695	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Baltimore	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Metcalfe	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Mager	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Jessie	Separation	$0	$0	$0	$0	$9,953,890	$10,252,507	$15,085,831	$18,646,088	$8,002,279	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Marion	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Despins	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Dumoulin	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
La Verendrye	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Bannatyne	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Alexander	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Mission	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$13,579,020	$13,986,391	$14,405,982	$14,838,162	$15,283,307	$15,741,806	$27,361,226	$40,707,425	$69,881,079	$100,768,516
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Roland	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Syndicate	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Selkirk	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Hart	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
St John's	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Polson	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Munroe	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Jefferson	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$4,963,281	$9,201,923	$42,124,359	$43,388,089	$44,689,732	$46,030,424	$47,411,337	$48,833,677	$50,298,687	$51,807,648	$53,361,877	$27,481,367	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Linden	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Newton	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Armstrong	Separation	$0	$0	$0	$0	$0	$0	$14,645,123	$21,118,268	$19,265,894	$28,165,494	$23,735,830	$39,388,291	$13,989,635	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
Hawthorne	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																							
SUBTOTAL																								
Green Infrastructure Allowance (10%)		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$10,283,276	$10,591,774	$10,909,527	$11,236,813	$11,573,918	$11,921,135	$12,278,769	$12,647,132	$13,026,546	$13,417,343	$13,819,863
TOTAL																								
	Annual	$29,850,065	$30,745,562	$31,667,929	$32,617,967	$67,547,901	$69,574,338	$71,593,016	$73,554,759	$76,045,324	$78,405,959	$80,446,790	$82,874,625	$85,388,404	$87,119,753	$89,733,345	$92,425,346	$95,198,106	$98,054,049	$100,995,671	$103,494,357	$107,095,848	$110,779,788	$114,588,378
	Cumulative	$29,850,065	$60,595,627	$92,263,556	$124,881,523	$192,429,424	$262,003,762	$333,596,777	$407,151,536	$483,196,860	$561,602,819	$642,049,608	$724,924,233	$810,312,637	$897,432,390	$987,165,735	$1,079,591,081	$1,174,789,187	$1,272,843,236	$1,373,838,907	$1,477,333,263	$1,584,429,111	$1,695,208,900	$1,809,797,278

Figure S2-B: Scenario 2 Annual Budgeted Project Costs (With 100% Estimating Allowance)

Winnipeg

JACOBS

Project Identification		23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
District	Control Option	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060
Woodhaven	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$15,573,416	$8,020,309	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Strathmillan	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$16,682,835	$8,591,660	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Moorgate	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$19,476,430	$10,030,362	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Douglas Park	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Ferry Road	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Tuxedo	Separation	$0	$0	$0	$0	$0	$0	$0	$24,891,577	$18,313,089	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Doncaster	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$56,893,934	$108,186,003	$61,906,435	$31,881,814	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Parkside	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Riverbend	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Tylehurst	Separation	$0	$44,932,390	$48,716,170	$50,177,655	$51,682,985	$53,233,474	$54,830,478	$56,475,393	$29,084,827	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Clifton	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$33,616,992	$20,367,942	$10,489,490	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Ash	Separation	$0	$0	$0	$0	$0	$24,210,435	$24,936,748	$25,684,850	$26,455,396	$27,249,058	$14,033,265	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$50,072,202	$25,787,184	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Aubrey	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$44,708,676	$28,781,210	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Cornish	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$29,558,919	$15,222,843	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Colony	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$35,954,468	$18,516,551	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
River	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$11,399,895	$5,870,946	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Assiniboine	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$28,113,300	$11,582,680	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Cockburn	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,650,745	$8,862,611	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Baltimore	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$25,099,653	$12,926,321	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Metcalfe	Separation	$0	$0	$29,195,639	$30,071,509	$15,486,827	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Mager	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$16,132,811	$8,308,398	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Jessie	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$9,529,614	$4,907,751	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Marion	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$19,099,609	$12,295,373	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Despins	Separation	$0	$0	$0	$33,483,697	$50,007,901	$42,627,425	$36,588,539	$18,843,098	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Dumoulin	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$15,645,075	$8,057,214	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
La Verendrye	Separation	$0	$0	$0	$0	$0	$0	$7,624,799	$2,243,869	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$4,131,752	$2,659,815	$0
	TOTAL																			
Bannatyne	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$19,159,762	$9,867,278	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Alexander	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$14,424,460	$7,428,597	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Mission	Separation	$84,401,937	$45,816,565	$24,200,545	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Roland	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$27,463,298	$14,143,598	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Syndicate	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$15,870,184	$8,173,145	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Selkirk	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$39,935,699	$11,752,506	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Hart	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,403,879	$10,507,998	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
St John's	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$35,516,768	$30,485,226	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Polson	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$15,701,894	$8,086,476	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Munroe	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$28,116,127	$12,066,504	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Jefferson	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$25,816,063	$13,295,272	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Linden	Separation	$19,121,860	$16,412,930	$8,452,659	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Newton	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,051,654	$10,326,602	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Armstrong	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
Hawthorne	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$16,921,899	$7,922,525	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																			
SUBTOTAL								$123,980,564	$128,138,787	$130,747,245	$135,435,061	$138,729,316	$141,809,398	$147,694,675	$151,483,347	$156,670,940	$161,234,574	$165,650,617	$84,711,115	$0
Green Infrastructure Allowance (10%)		$14,234,459	$14,661,492	$15,101,337	$15,554,377	$16,021,009	$16,501,639	$16,996,688	$17,506,589	$18,031,786	$18,572,740	$19,129,922	$19,703,820	$20,294,934	$20,903,783	$21,530,896	$22,176,823	$22,842,128	$23,527,391	$0
TOTAL																				
		$117,758,256	$121,823,377	$125,666,350	$129,287,238	$133,198,721	$136,572,972													
		$1,927,555,534	$2,049,378,911	$2,175,045,262	$2,304,332,499	$2,437,531,221	$2,574,104,193													

Inflation	3.0%	Discount Rate	3.0%	NPV	6.0%	Allowance	100.0%

Project Identification		1) Project Details								2) Additional O&M Cost Budget			3) Capital Cost Budget			4) Program Budget Summary	
		a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p
						Project Capital Cost (2019)											
District	Control Option	Balance of Area Separation %	Control Gate	Latent	Screens	In-line Storage Via Control Gate Construction	Latent Storage	Sewer Separation (Complete Or Partial)	Total	Annual (2019)	NPV (2019)	Total to 2100	2019 Capital Cost	100% Estimating Allowance	2019 Estimate	Additional O&M NPV	Additional O&M Budget Sum
Woodhaven	Separation	95%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$4,030,000			$4,030,000	$96,243	$819,268	$26,351,844	$4,030,000	$4,030,000	$8,060,000	$819,268	$26,351,844
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$8,060,000		
Strathmillan	Separation	40%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$4,580,000			$4,580,000	$95,219	$877,340	$26,631,729	$4,580,000	$4,580,000	$9,160,000	$877,340	$26,631,729
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$9,160,000		
Moorgate	Separation	70%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$5,040,000			$5,040,000	$104,434	$888,993	$28,594,554	$5,040,000	$5,040,000	$10,080,000	$888,993	$28,594,554
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$10,080,000		
Douglas Park	Separation	0%							$1	$0	$0	$0	$1	$1	$2	$0	$0
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$2		
Ferry Road	Separation	70%						$129,360,000	$129,360,000	$84,469	$1,831,307	$27,770,981	$129,360,000	$129,360,000	$258,720,000	$1,831,307	$27,770,981
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$258,720,000		
Tuxedo	Separation	34%						$8,790,000	$8,790,000	$5,631	$60,499	$1,635,661	$8,790,000	$8,790,000	$17,580,000	$60,499	$1,635,661
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$17,580,000		
Doncaster	Separation	92%						$49,890,000	$49,890,000	$32,764	$313,875	$9,255,798	$49,890,000	$49,890,000	$99,780,000	$313,875	$9,255,798
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$99,780,000		
Parkside	Separation	0%						$1	$1	$0	$0	$0	$1	$1	$2	$0	$0
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$2		
Riverbend	Separation	79%						$76,590,000	$76,590,000	$50,169	$829,932	$15,858,215	$76,590,000	$76,590,000	$153,180,000	$829,932	$15,858,215
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$153,180,000		
Tylehurst	Separation	85%						$86,670,000	$86,670,000	$56,824	$610,494	$16,505,309	$86,670,000	$86,670,000	$173,340,000	$610,494	$16,505,309
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$173,340,000		
Clifton	Separation	68%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$7,880,000	$2,410,000		$10,290,000	$240,608	$1,812,517	$63,592,906	$10,290,000	$10,290,000	$20,580,000	$1,812,517	$63,592,906
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$20,580,000		
Ash	Separation	83%						$29,100,000	$29,100,000	$18,942	$188,601	$5,402,900	$29,100,000	$29,100,000	$58,200,000	$188,601	$5,402,900
	In-Line/Latent		x	x	x	$9,980,000	$2,600,000		$12,580,000	$244,191	$1,996,649	$66,109,779	$12,580,000	$12,580,000	$25,160,000	$1,996,649	$66,109,779
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$83,360,000		
Aubrey	Separation	69%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$11,140,000	$330,000		$11,470,000	$296,921	$2,236,723	$78,476,352	$11,470,000	$11,470,000	$22,940,000	$2,236,723	$78,476,352
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$22,940,000		
Cornish	Separation	74%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$4,810,000	$2,400,000		$7,210,000	$185,319	$1,454,796	$49,584,587	$7,210,000	$7,210,000	$14,420,000	$1,454,796	$49,584,587
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$14,420,000		
Colony	Separation	47%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$6,420,000	$2,350,000		$8,770,000	$229,858	$1,804,430	$61,501,325	$8,770,000	$8,770,000	$17,540,000	$1,804,430	$61,501,325
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$17,540,000		
River	Separation	46%							$0				$0	$0	$0	$0	$0
	In-Line/Latent				x				$2,950,000	$48,634	$413,992	$13,316,091	$2,950,000	$2,950,000	$5,900,000	$413,992	$13,316,091
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$5,900,000		
Assiniboine	Separation	56%							$0				$0	$0	$0	$0	$0
	In-Line/Latent				x				$6,790,000	$157,675	$1,342,205	$43,172,170	$6,790,000	$6,790,000	$13,580,000	$1,342,205	$43,172,170
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$13,580,000		
Cockburn	Separation	80%						$56,280,000	$56,280,000	$36,859	$941,560	$12,358,880	$56,280,000	$56,280,000	$112,560,000	$941,560	$12,358,880
	In-Line/Latent		x		x	$4,900,000			$4,900,000	$82,933	$678,109	$22,452,434	$4,900,000	$4,900,000	$9,800,000	$678,109	$22,452,434
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$122,360,000		
Baltimore	Separation	63%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$5,190,000	$1,500,000		$6,690,000	$164,330	$1,455,661	$45,484,934	$6,690,000	$6,690,000	$13,380,000	$1,455,661	$45,484,934
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$13,380,000		
Metcalfe	Separation	88%						$17,430,000	$17,430,000	$17,918	$223,241	$5,375,881	$17,430,000	$17,430,000	$34,860,000	$223,241	$5,375,881
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$34,860,000		
Mager	Separation	26%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$4,300,000			$4,300,000	$77,814	$689,285	$21,538,038	$4,300,000	$4,300,000	$8,600,000	$689,285	$21,538,038
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$8,600,000		
Jessie	Separation	85%						$25,900,000	$25,900,000	$16,894	$404,311	$5,622,406	$25,900,000	$25,900,000	$51,800,000	$404,311	$5,622,406
	In-Line/Latent		x			$2,540,000			$2,540,000	$49,146	$435,342	$13,603,112	$2,540,000	$2,540,000	$5,080,000	$435,342	$13,603,112
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$56,880,000		
Marion	Separation	69%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x		$2,700,000	$2,200,000		$4,900,000	$133,614	$1,006,525	$35,314,358	$4,900,000	$4,900,000	$9,800,000	$1,006,525	$35,314,358
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$9,800,000		
Despins	Separation	36%						$39,980,000	$39,980,000	$26,109	$291,219	$7,648,794	$39,980,000	$39,980,000	$79,960,000	$291,219	$7,648,794
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$79,960,000		
Dumoulin	Separation	58%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$4,170,000			$4,170,000	$94,707	$838,932	$26,214,059	$4,170,000	$4,170,000	$8,340,000	$838,932	$26,214,059
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$8,340,000		
La Verendrye	Separation	8%						$2,080,000	$2,080,000	$1,536	$17,133	$449,989	$2,080,000	$2,080,000	$4,160,000	$17,133	$449,989
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Additional Storage								$1,060,000	$10,750	$80,980	$2,841,233	$1,060,000	$1,060,000	$2,120,000	$80,980	$2,841,233
	TOTAL														$6,280,000		
Bannatyne	Separation	56%							$0				$0	$0	$0	$0	$0
	In-Line/Latent			x	x		$5,260,000		$5,260,000	$93,172	$858,473	$26,059,003	$5,260,000	$5,260,000	$10,520,000	$858,473	$26,059,003
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$10,520,000		
Alexander	Separation	80%							$0				$0	$0	$0	$0	$0
	In-Line/Latent				x				$3,960,000	$71,159	$655,647	$19,902,206	$3,960,000	$3,960,000	$7,920,000	$655,647	$19,902,206
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$7,920,000		
Mission	Separation	79%						$130,320,000	$130,320,000	$84,981	$1,138,227	$25,869,073	$130,320,000	$130,320,000	$260,640,000	$1,138,227	$25,869,073
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$260,640,000		
Roland	Separation	72%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$4,520,000	$2,800,000		$7,320,000	$168,426	$1,491,939	$46,618,515	$7,320,000	$7,320,000	$14,640,000	$1,491,939	$46,618,515
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$14,640,000		
Syndicate	Separation	58%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$4,230,000			$4,230,000	$104,434	$925,093	$28,906,314	$4,230,000	$4,230,000	$8,460,000	$925,093	$28,906,314
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$8,460,000		
Selkirk	Separation	62%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$6,770,000	$1,830,000		$8,600,000	$220,643	$1,804,105	$59,734,575	$8,600,000	$8,600,000	$17,200,000	$1,804,105	$59,734,575
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$17,200,000		
Hart	Separation	62%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$5,280,000			$5,280,000	$110,577	$941,287	$30,276,586	$5,280,000	$5,280,000	$10,560,000	$941,287	$30,276,586
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$10,560,000		
St John's	Separation	67%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$7,140,000	$3,140,000		$10,280,000	$236,001	$1,777,809	$62,375,170	$10,280,000	$10,280,000	$20,560,000	$1,777,809	$62,375,170
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$20,560,000		
Polson	Separation	73%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x			$3,830,000			$3,830,000	$81,909	$643,004	$21,915,840	$3,830,000	$3,830,000	$7,660,000	$643,004	$21,915,840
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$7,660,000		
Munroe	Separation	69%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$7,290,000			$7,290,000	$151,532	$1,396,197	$42,381,676	$7,290,000	$7,290,000	$14,580,000	$1,396,197	$42,381,676
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$14,580,000		
Jefferson	Separation	90%						$145,510,000	$145,510,000	$95,219	$1,469,443	$29,749,010	$145,510,000	$145,510,000	$291,020,000	$1,469,443	$29,749,010
	In-Line/Latent		x		x	$7,300,000			$7,300,000	$122,352	$1,172,130	$34,564,678	$7,300,000	$7,300,000	$14,600,000	$1,172,130	$34,564,678
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$305,620,000		
Linden	Separation	15%						$10,900,000	$10,900,000	$7,167	$95,995	$2,181,729	$10,900,000	$10,900,000	$21,800,000	$95,995	$2,181,729
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$21,800,000		
Newton	Separation	99%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$5,670,000			$5,670,000	$115,697	$1,108,372	$32,684,537	$5,670,000	$5,670,000	$11,340,000	$1,108,372	$32,684,537
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$11,340,000		
Armstrong	Separation	92%						$61,080,000	$61,080,000	$62,456	$1,309,804	$20,444,648	$61,080,000	$61,080,000	$122,160,000	$1,309,804	$20,444,648
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$122,160,000		
Hawthorne	Separation	95%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$4,640,000			$4,640,000	$103,410	$990,668	$29,213,612	$4,640,000	$4,640,000	$9,280,000	$990,668	$29,213,612
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$9,280,000		
SUBTOTAL						$134,350,000	$26,820,000		$1,045,810,002	$4,489,645	$42,322,114	$1,245,541,489	$1,045,810,002	$1,045,810,002	$2,081,540,004	$42,322,114	$1,245,541,489
Green Infrastructure Allowance (10%)													$104,581,000	$104,581,000	$209,162,000		
GRAND TOTAL													$1,150,391,002	$1,150,391,002	$2,290,702,004		

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
District	Control Option	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043
Woodhaven	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Strathmillan	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Moorgate	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Douglas Park	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Ferry Road	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$120,432	$124,045	$127,767	$131,600	$135,548	$139,614	$143,803	$148,117	$152,560	$157,137	$161,851	$166,707	$171,708
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Tuxedo	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Doncaster	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Parkside	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Riverbend	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$90,611	$93,330	$96,130	$99,014	$101,984
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Tylehurst	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Clifton	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Ash	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Aubrey	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Cornish	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Colony	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
River	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Assiniboine	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Cockburn	Separation	$0	$0	$0	$0	$0	$0	$0	$45,332	$46,692	$48,093	$49,535	$51,021	$52,552	$54,129	$55,753	$57,425	$59,148	$60,922	$62,750	$64,632	$66,571	$68,569	$70,626	$72,744	$74,927
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Baltimore	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Metcalfe	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Mager	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Jessie	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$22,043	$22,704	$23,385	$24,087	$24,809	$25,554	$26,320	$27,110	$27,923	$28,761	$29,624	$30,512	$31,428	$32,371	$33,342	$34,342
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Marion	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Despins	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Dumoulin	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
La Verendrye	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Bannatyne	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Alexander	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Mission	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Roland	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Syndicate	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Selkirk	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Hart	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
St John's	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Polson	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Munroe	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Jefferson	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$182,449	$187,923	$193,561
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Linden	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Newton	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Armstrong	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$91,718	$94,470	$97,304	$100,223	$103,230	$106,327	$109,516	$112,802	$116,186	$119,672	$123,262	$126,960
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Hawthorne	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Annual		$0	$0	$0	$0	$0	$0	$0	$45,332	$46,692	$70,135	$72,240	$74,407	$197,071	$294,702	$303,543	$312,649	$322,029	$331,689	$341,640	$351,889	$453,057	$466,649	$663,098	$682,991	$703,481
Annual 2019 PV		$0	$0	$0	$0	$0	$0	$0	$36,859	$36,859	$53,753	$53,753	$53,753	$138,222	$200,678	$200,678	$200,678	$200,678	$200,678	$200,678	$200,678	$250,847	$250,847	$346,066	$346,066	$346,066
Cumulative		$0	$0	$0	$0	$0	$0	$0	$45,332	$92,024	$162,159	$234,399	$308,806	$505,877	$800,579	$1,104,121	$1,416,770	$1,738,799	$2,070,488	$2,412,128	$2,764,018	$3,217,075	$3,683,724	$4,346,822	$5,029,813	$5,733,294

Figure S2-C - Scenario 2 Annual Additional Operations And Maintenance (O&M) Costs

Project Identification		25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
District	Control Option	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060
Woodhaven	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$295,927	$304,805	$313,949	$323,368
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Strathmillan	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$275,972	$284,251	$292,779	$301,562	$310,609	$319,928
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Moorgate	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$321,112	$330,746	$340,668	$350,888
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Douglas Park	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Ferry Road	Separation	$176,859	$182,165	$187,630	$193,259	$199,056	$205,028	$211,179	$217,514	$224,040	$230,761	$237,684	$244,814	$252,159	$259,723	$267,515	$275,540	$283,807
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Tuxedo	Separation	$0	$0	$0	$0	$0	$0	$0	$14,501	$14,936	$15,384	$15,846	$16,321	$16,811	$17,315	$17,834	$18,369	$18,920
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Doncaster	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$92,192	$94,958	$97,807	$100,741	$103,763	$106,876	$110,083
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Parkside	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Riverbend	Separation	$105,043	$108,195	$111,441	$114,784	$118,227	$121,774	$125,427	$129,190	$133,066	$137,058	$141,170	$145,405	$149,767	$154,260	$158,888	$163,654	$168,564
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Tylehurst	Separation	$0	$0	$0	$0	$0	$0	$0	$146,328	$150,718	$155,239	$159,896	$164,693	$169,634	$174,723	$179,965	$185,364	$190,924
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Clifton	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$808,419
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Ash	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$51,748	$53,300	$54,899	$56,546	$58,243	$59,990	$61,790	$63,643
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$773,359	$796,560	$820,457
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Aubrey	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$997,623
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Cornish	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$604,519	$622,655
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Colony	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$749,804	$772,298
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
River	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$149,538	$154,024	$158,645	$163,404
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Assiniboine	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$484,817	$499,361	$514,342	$529,772
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Cockburn	Separation	$77,175	$79,490	$81,874	$84,331	$86,861	$89,466	$92,150	$94,915	$97,762	$100,695	$103,716	$106,828	$110,032	$113,333	$116,733	$120,235	$123,843
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$262,651	$270,531	$278,646
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Baltimore	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$490,563	$505,280	$520,438	$536,051	$552,133
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Metcalfe	Separation	$0	$0	$0	$40,994	$42,224	$43,491	$44,796	$46,139	$47,524	$48,949	$50,418	$51,930	$53,488	$55,093	$56,746	$58,448	$60,201
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Mager	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$232,292	$239,260	$246,438	$253,831	$261,446
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Jessie	Separation	$35,372	$36,433	$37,526	$38,652	$39,812	$41,006	$42,236	$43,503	$44,809	$46,153	$47,537	$48,964	$50,432	$51,945	$53,504	$55,109	$56,762
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$146,712	$151,113	$155,647	$160,316	$165,126
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Marion	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$448,931
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Despins	Separation	$0	$0	$0	$0	$0	$0	$65,273	$67,232	$69,249	$71,326	$73,466	$75,670	$77,940	$80,278	$82,686	$85,167	$87,722
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Dumoulin	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$282,723	$291,205	$299,941	$308,939	$318,207
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
La Verendrye	Separation	$0	$0	$0	$0	$0	$0	$3,840	$3,955	$4,074	$4,196	$4,322	$4,452	$4,585	$4,723	$4,865	$5,010	$5,161
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$36,119
	TOTAL																	
Bannatyne	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$270,037	$278,139	$286,483	$295,077	$303,929	$313,047
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Alexander	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$206,237	$212,424	$218,797	$225,361	$232,122	$239,086
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Mission	Separation	$0	$183,269	$188,767	$194,430	$200,263	$206,271	$212,459	$218,832	$225,397	$232,159	$239,124	$246,298	$253,687	$261,297	$269,136	$277,210	$285,527
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Roland	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$502,789	$517,873	$533,409	$549,411	$565,893
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Syndicate	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$311,760	$321,112	$330,746	$340,668	$350,888
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Selkirk	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$698,782	$719,745	$741,337
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Hart	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$340,001	$350,201	$360,708	$371,529
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
St John's	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$792,939
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Polson	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$267,191	$275,206
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Munroe	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$439,182	$452,357	$465,928	$479,906	$494,303	$509,132
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Jefferson	Separation	$199,367	$205,348	$211,509	$217,854	$224,390	$231,122	$238,055	$245,197	$252,553	$260,129	$267,933	$275,971	$284,250	$292,778	$301,561	$310,608	$319,926
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$344,282	$354,610	$365,248	$376,206	$387,492	$399,117	$411,090
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Linden	Separation	$0	$15,456	$15,920	$16,398	$16,890	$17,396	$17,918	$18,456	$19,009	$19,580	$20,167	$20,772	$21,395	$22,037	$22,698	$23,379	$24,081
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Newton	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$325,555	$335,321	$345,381	$355,742	$366,415	$377,407	$388,729
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Armstrong	Separation	$130,768	$134,691	$138,732	$142,894	$147,181	$151,596	$156,144	$160,829	$165,654	$170,623	$175,742	$181,014	$186,445	$192,038	$197,799	$203,733	$209,845
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
Hawthorne	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$290,982	$299,712	$308,703	$317,964	$327,503	$337,328	$347,448
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																	
SUBTOTAL																		
Green Infrastructure Allowance (10%)																		
GRAND TOTAL		**$724,585**	**$945,048**	**$973,399**	**$1,043,595**	**$1,074,903**	**$1,107,150**	**$1,209,479**	**$1,406,592**	**$1,448,789**	**$1,544,001**	**$2,643,332**	**$3,914,061**	**$5,998,321**	**$7,769,666**	**$9,737,548**	**$11,651,188**	**$15,084,755**
		$346,066	**$438,214**	**$438,214**	**$456,131**	**$456,131**	**$456,131**	**$483,776**	**$546,232**	**$546,232**	**$565,174**	**$939,396**	**$1,350,478**	**$2,009,335**	**$2,526,899**	**$3,074,665**	**$3,571,751**	**$4,489,645**
		$6,457,879	**$7,402,927**	**$8,376,326**	**$9,419,922**	**$10,494,825**	**$11,601,976**	**$12,811,454**	**$14,218,046**	**$15,666,835**	**$17,210,836**	**$19,854,167**	**$23,768,228**	**$29,766,549**	**$37,536,215**	**$47,273,763**	**$58,924,951**	**$74,009,705**

City of Winnipeg - CSO Master Plan

Figure S2 - D: Scenario 2 Annual Modelled Project Performance

Winnipeg

JACOBS

Project Identification		a (1) Project Details)	b	c	d	e (2) Performance)	f	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
District	Control Option	Balance of Area Separation %	Control Gate	Latent	Screens	2018 Revised Baseline Total CSO Volume (m3/year)	Control Option Performance (CSO Volume Reduction)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060
Woodhaven	Separation	95%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x		x		220	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	220	220	220	220	220
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					12,120																																											
Strathmillan	Separation	40%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x		x		20,748	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20,748	20,748	20,748	20,748	20,748	20,748	20,748
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					39,684																																											
Moorgate	Separation	70%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x		x		7,518	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7,518	7,518	7,518	7,518	7,518
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					64,937																																											
Douglas Park	Separation	0%					739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739
	In-Line/Latent						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					739																																											
Ferry Road	Separation	70%					136,599	0	0	0	0	0	0	0	0	0	0	0	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599
	In-Line/Latent						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					136,599																																											
Tuxedo	Separation	34%					13,843	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843
	In-Line/Latent						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					13,843																																											
Doncaster	Separation	92%					30,644	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30,644	30,644	30,644	30,644	30,644	30,644	30,644	30,644
	In-Line/Latent						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					30,644																																											
Parkside	Separation	0%					2,979	2979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979
	In-Line/Latent						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					2,979																																											
Riverbend	Separation	79%					87,057	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057
	In-Line/Latent						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					87,057																																											
Tylehurst	Separation	85%					206,812	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	206,812	206,812	206,812	206,812	206,812	206,812	206,812	206,812	206,812	206,812	206,812
	In-Line/Latent						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					206,812																																											
Clifton	Separation	68%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x	x	x		26,483	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26,483	26,483
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					114,875																																											
Ash	Separation	83%					54,678	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	54,678	54,678	54,678	54,678	54,678	54,678	54,678	54,678	54,678
	In-Line/Latent		x	x	x		28,542	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28,542	28,542	28,542	28,542
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					341,484																																											
Aubrey	Separation	69%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x	x	x		59,934	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	59,934	59,934
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					141,643																																											
Cornish	Separation	74%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x	x	x		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					60,293																																											
Colony	Separation	47%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x	x	x		49,680	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	49,680	49,680	49,680
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					163,833																																											
River	Separation	46%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent				x		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					15,904																																											
Assiniboine	Separation	56%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent				x		708	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	708	708	708	708	708
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					13,005																																											
Cockburn	Separation	80%					178,416	0	0	0	0	0	0	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416
	In-Line/Latent		x		x		8,358	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8,358	8,358	8,358	8,358
	Storage						Part Sep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					188,459																																											
Baltimore	Separation	63%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x	x	x		5,976	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5,976	5,976	5,976	5,976	5,976	5,976
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					72,575																																											
Metcalfe	Separation	88%					12,191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12,191	12,191	12,191	12,191	12,191	12,191	12,191	12,191	12,191	12,191	12,191	12,191	12,191	12,191	12,191
	In-Line/Latent						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					12,191																																											
Mager	Separation	26%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x		x		20,856	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20,856	20,856	20,856	20,856	20,856	20,856
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					21,912																																											
Jessie	Separation	85%					23,202	0	0	0	0	0	0	0	0	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202
	In-Line/Latent		x				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					187,594																																											
Marion	Separation	69%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x	x			14,225	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14,225	14,225
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					51,773																																											
Despins	Separation	36%					43,955	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43,955	43,955	43,955	43,955	43,955	43,955	43,955	43,955	43,955	43,955	43,955	43,955
	In-Line/Latent						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					43,955																																											
Dumoulin	Separation	58%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x		x		6,985	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6,985	6,985	6,985	6,985	6,985	6,985
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					49,524																																											
La Verendrye	Separation	8%					12,469	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12,469	12,469	12,469	12,469	12,469	12,469	12,469	12,469	12,469	12,469	12,469	12,469
	In-Line/Latent						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						722	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	722	722
	TOTAL					13,191																																											
Bannatyne	Separation	56%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent			x	x		32,598	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32,598	32,598	32,598	32,598	32,598	32,598	32,598
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					148,170																																											
Alexander	Separation	80%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent				x		708	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	708	708	708	708	708	708	708
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					26,851																																											
Mission	Separation	79%					12,809	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809
	In-Line/Latent						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					12,809																																											
Roland	Separation	72%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x	x	x		118,287	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	118,287	118,287	118,287	118,287	118,287	118,287
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					299,396																																											
Syndicate	Separation	58%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x		x		5,786	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5,786	5,786	5,786	5,786	5,786	5,786
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					57,357																																											
Selkirk	Separation	62%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x	x	x		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					172,507																																											
Hart	Separation	62%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x		x		37,171	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37,171	37,171	37,171	37,171	37,171
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					202,745																																											
St John's	Separation	67%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x	x	x		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					181,444																																											
Polson	Separation	73%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					455,282																																											
Munroe	Separation	69%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x		x		18,388	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18,388	18,388	18,388	18,388	18,388	18,388	18,388
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					432,465																																											
Jefferson	Separation	90%					119,247	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247
	In-Line/Latent		x		x		53,965	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	53,965	53,965	53,965	53,965	53,965	53,965	53,965	53,965
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					287,466																																											
Linden	Separation	15%					14,033	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033
	In-Line/Latent						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					14,033																																											
Newton	Separation	99%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x		x		5,620	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5,620	5,620	5,620	5,620	5,620	5,620	5,620	5,620
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					8,614																																											
Armstrong	Separation	92%					749,622	0	0	0	0	0	0	0	0	0	0	0	0	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622
	In-Line/Latent						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					749,622																																											
Hawthorne	Separation	95%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x		x		2,753	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,753	2,753	2,753	2,753	2,753	2,753	2,753	2,753
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					33,245																																											
SUBTOTAL						**5,169,631**	**2,225,526**	**3,718**	**3,718**	**3,718**	**3,718**	**3,718**	**3,718**	**182,134**	**182,134**	**205,336**	**205,336**	**205,336**	**341,935**	**1,091,557**	**1,091,557**	**1,091,557**	**1,091,557**	**1,091,557**	**1,091,557**	**1,091,557**	**1,178,614**	**1,178,614**	**1,297,861**	**1,297,861**	**1,297,861**	**1,297,861**	**1,324,703**	**1,324,703**	**1,336,894**	**1,336,894**	**1,336,894**	**1,393,318**	**1,613,973**	**1,613,973**	**1,668,651**	**1,761,633**	**1,834,075**	**1,991,965**	**2,037,582**	**2,074,482**	**2,124,162**	**2,225,526**	**2,225,526**
							Total CSO Volume As Control Options Are Implemented	5,170,000	5,166,282	5,166,282	5,166,282	5,166,282	5,166,282	4,987,866	4,987,866	4,964,664	4,964,664	4,964,664	4,828,065	4,078,443	4,078,443	4,078,443	4,078,443	4,078,443	4,078,443	4,078,443	3,991,386	3,991,386	3,872,139	3,872,139	3,872,139	3,872,139	3,845,297	3,845,297	3,833,106	3,833,106	3,833,106	3,776,682	3,556,027	3,556,027	3,501,349	3,408,367	3,335,925	3,178,035	3,132,418	3,095,518	3,045,838	2,944,474	2,944,474

City of Winnipeg - CSO Master Plan

Figure S3-A: Scenario 3 Project Schedule

Project Identification		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76
District	Control Option	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095
Woodhaven	Separation																																																																												
	In-Line/Latent																																																																					0.85	0.5							
	Storage																																																																												
Strathmillan	Separation																																																																												
	In-Line/Latent																																																																	1	0.5											
	Storage																																																																												
Moorgate	Separation																																																																												
	In-Line/Latent																																																																			1	0.5									
	Storage																																																																												
Douglas Park	Separation	0.5																																																																											
	In-Line/Latent																																																																												
	Storage																																																																												
Ferry Road	Separation	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1	1	1	1	1	1	1	0.5																																																														
	In-Line/Latent																																																																												
	Storage																																																																												
Tuxedo	Separation																																																	1	1	0.5																								
	In-Line/Latent																																																																												
	Storage																																																																												
Doncaster	Separation																																																							0.625	1.2	1.2	1.2	1.05	1	0.5														
	In-Line/Latent																																																																												
	Storage																																																																												
Parkside	Separation	0.5																																																																											
	In-Line/Latent																																																																												
	Storage																																																																												
Riverbend	Separation																0.525	0.475	1	1	1	1	1	1	1	1	1	0.5																																																		
	In-Line/Latent																																																																												
	Storage																																																																												
Tylehurst	Separation																																												0.49	0.775	1.05	1.35	1.35	1	1	1.175	0.5																							
	In-Line/Latent																																																																												
	Storage																																																																												
Clifton	Separation																																																																												
	In-Line/Latent																																																																							1	1	0.5			
	Storage																																																																												
Ash	Separation																																																					1	1	1	1	1	1	0.5																		
	In-Line/Latent																																																																			1.5	0.5								
	Storage																																																																												
Aubrey	Separation																																																																												
	In-Line/Latent																																																																										1.25	0.5	
	Storage																																																																												
Cornish	Separation																																																																												
	In-Line/Latent																																																																							1	0.5				
	Storage																																																																												
Colony	Separation																																																																												
	In-Line/Latent																																																																									1.15	0.5		
	Storage																																																																												
River	Separation																																																																												
	In-Line/Latent																																																																					1	0.5						
	Storage																																																																												
Assiniboine	Separation																																																																												
	In-Line/Latent																																																																				1	0.5							
	Storage																																																																												
Cockburn	Separation	1	1	1	1	1	1	1	1	1	0.5																																																																			
	In-Line/Latent																																																																				1	0.5							
	Storage																																																																												
Baltimore	Separation																																																																												
	In-Line/Latent																																																																	1	0.5											
	Storage																																																																												
Metcalfe	Separation																																																				0.825	1	1	0.5																				
	In-Line/Latent																																																																												
	Storage																																																																												
Mager	Separation																																																																												
	In-Line/Latent																																																																			1	0.5									
	Storage																																																																												
Jessie	Separation																																										1	1	1	1	0.5																													
	In-Line/Latent																																																																			1	0.5									
	Storage																																																																												
Marion	Separation																																																																												
	In-Line/Latent																																																																		1	0.5										
	Storage																																																																												
Despins	Separation																																																											0.35	0.625	1	1.4	0.275	0.5											
	In-Line/Latent																																																																												
	Storage																																																																												
Dumoulin	Separation																																																																												
	In-Line/Latent																																																																						1	0.5					
	Storage																																																																												
La Verendrye	Separation																																																				1	1	0.5																					
	In-Line/Latent																																																																												
	Storage																																																																											1	0.5
Bannatyne	Separation																																																																												
	In-Line/Latent																																																																			1.2	0.5									
	Storage																																																																												
Alexander	Separation																																																																												
	In-Line/Latent																																																																					1	0.5						
	Storage																																																																												
Mission	Separation																	1	1	1	1	1	1	1	1	1	1	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.3	0.5																																									
	In-Line/Latent																																																																												
	Storage																																																																												
Roland	Separation																																																																												
	In-Line/Latent																																																																				1	0.5								
	Storage																																																																												
Syndicate	Separation																																																																												
	In-Line/Latent																																																																				1	0.5								
	Storage																																																																												
Selkirk	Separation																																																																												
	In-Line/Latent																																																																											0.4	0.5
	Storage																																																																												
Hart	Separation																																																																												
	In-Line/Latent																																																																						1	0.5					
	Storage																																																																												
St John's	Separation																																																																												
	In-Line/Latent																																																																											0.6	0.5
	Storage																																																																												
Polson	Separation																																																																												
	In-Line/Latent																																																																						1	0.5					
	Storage																																																																												
Munroe	Separation																																																																												
	In-Line/Latent																																																																								1	0.5			
	Storage																																																																												
Jefferson	Separation																											0.275	0.95	0.95	0.95	0.95	0.95	0.95	1	1.9	2.475	2.475	2.475	2.475	2.475	2.475	1.4	1.4	0.5																															
	In-Line/Latent																																																																								0.425	0.55	0.5	
	Storage																																																																												
Linden	Separation																																																				1	0.9	1	0.5																				
	In-Line/Latent																																																																												
	Storage																																																																												
Newton	Separation																																																																												
	In-Line/Latent																																																																					0.75	0.5						
	Storage																																																																												
Armstrong	Separation									0.2	0.6	1	1	0.8	0.8	0.8	1.3	1.3	0.5																																																											
	In-Line/Latent																																																																												
	Storage																																																																												
Hawthorne	Separation																																																																												
	In-Line/Latent																																																																	1	0.5											
	Storage																																																																												

City of Winnipeg - CSO Master Plan

Figure S3-B: Scenario 3 Annual Budgeted Project Costs (With 100% Estimating Allowance)

Winnipeg

JACOBS

Inflation	3.0%	Discount Rate	3.0%	NPV	6.0%	Allowance	100.0%

Project Identification		a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p
		1) Project Details								2) O&M Cost Budget			3) Capital Cost Budget			4) Program Budget Summary	
						Project Capital Cost (2019)											
District	Control Option	Balance of Area Separation %	Control Gate	Latent	Screens	In-line Storage Via Control Gate Construction	Latent Storage	Sewer Separation (Complete Or Partial)	Total	Annual (2019)	NPV (2019)	Total to 2100	2019 Capital Cost	Estimating Allowance	2019 Estimate	Capital NPV	Budget Sum
Woodhaven	Separation	95%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$4,030,000			$4,030,000	$96,243	$132,831	$10,814,851	$4,030,000	$4,030,000	$8,060,000	$1,132,116	$60,822,631
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$8,060,000		
Strathmillan	Separation	40%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$4,580,000			$4,580,000	$95,219	$201,025	$14,152,579	$4,580,000	$4,580,000	$9,160,000	$1,486,807	$59,561,003
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$9,160,000		
Moorgate	Separation	70%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$5,040,000			$5,040,000	$104,434	$188,621	$14,074,218	$5,040,000	$5,040,000	$10,080,000	$1,544,836	$69,534,688
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$10,080,000		
Douglas Park	Separation	0%							$1	$0	$0	$0	$1	$1	$2	$2	$2
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$2		
Ferry Road	Separation	70%						$129,360,000	$129,360,000	$84,469	$1,601,876	$27,267,137	$129,360,000	$129,360,000	$258,720,000	$213,918,521	$320,092,088
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$258,720,000		
Tuxedo	Separation	34%						$8,790,000	$8,790,000	$5,631	$25,816	$1,246,015	$8,790,000	$8,790,000	$17,580,000	$4,209,016	$76,633,590
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$17,580,000		
Doncaster	Separation	92%						$49,890,000	$49,890,000	$32,764	$85,280	$5,502,678	$49,890,000	$49,890,000	$99,780,000	$18,972,291	$552,637,212
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$99,780,000		
Parkside	Separation	0%						$1	$1	$0	$0	$0	$1	$1	$2	$2	$2
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$2		
Riverbend	Separation	79%						$76,590,000	$76,590,000	$50,169	$625,074	$15,052,468	$76,590,000	$76,590,000	$153,180,000	$82,457,848	$292,258,923
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$153,180,000		
Tylehurst	Separation	85%						$86,670,000	$86,670,000	$56,824	$247,738	$12,309,144	$86,670,000	$86,670,000	$173,340,000	$43,669,076	$719,796,510
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$173,340,000		
Clifton	Separation	68%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$7,880,000	$2,410,000		$10,290,000	$240,608	$208,459	$19,066,931	$10,290,000	$10,290,000	$20,580,000	$2,619,974	$171,595,543
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$20,580,000		
Ash	Separation	83%						$29,100,000	$29,100,000	$18,942	$55,974	$3,407,866	$29,100,000	$29,100,000	$58,200,000	$11,754,203	$303,055,037
	In-Line/Latent		x	x	x	$9,980,000	$2,600,000		$12,580,000	$244,191	$370,705	$29,316,880	$12,580,000	$12,580,000	$25,160,000	$3,649,455	$183,674,872
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$83,360,000		
Aubrey	Separation	69%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$11,140,000	$330,000		$11,470,000	$296,921	$187,295	$18,157,960	$11,470,000	$11,470,000	$22,940,000	$2,718,887	$208,183,878
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$22,940,000		
Cornish	Separation	74%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$4,810,000	$2,400,000		$7,210,000	$185,319	$183,346	$16,288,981	$7,210,000	$7,210,000	$14,420,000	$1,860,267	$118,776,244
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$14,420,000		
Colony	Separation	47%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$6,420,000	$2,350,000		$8,770,000	$229,858	$171,680	$16,166,611	$8,770,000	$8,770,000	$17,540,000	$2,138,347	$153,135,996
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$17,540,000		
River	Separation	46%							$0				$0	$0	$0	$0	$0
	In-Line/Latent				x				$2,950,000	$48,634	$60,604	$5,079,879	$2,950,000	$2,950,000	$5,900,000	$806,119	$45,808,059
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$5,900,000		
Assiniboine	Separation	56%							$0				$0	$0	$0	$0	$0
	In-Line/Latent				x				$6,790,000	$157,875	$217,617	$17,717,947	$6,790,000	$6,790,000	$13,580,000	$1,909,482	$102,365,220
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$13,580,000		
Cockburn	Separation	80%						$56,280,000	$56,280,000	$36,959	$853,651	$12,218,764	$56,280,000	$56,280,000	$112,560,000	$99,903,343	$128,099,118
	In-Line/Latent		x		x	$4,900,000			$4,900,000	$82,933	$114,461	$9,319,178	$4,900,000	$4,900,000	$9,800,000	$1,377,977	$73,871,808
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$122,360,000		
Baltimore	Separation	63%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$5,190,000	$1,500,000		$6,690,000	$164,330	$346,931	$24,424,612	$6,690,000	$6,690,000	$13,380,000	$2,171,777	$87,000,679
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$13,380,000		
Metcalfe	Separation	88%						$17,430,000	$17,430,000	$17,916	$88,707	$3,615,961	$17,430,000	$17,430,000	$34,860,000	$7,538,181	$168,822,970
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$34,860,000		
Mager	Separation	26%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$4,300,000			$4,300,000	$77,814	$140,541	$10,486,672	$4,300,000	$4,300,000	$8,600,000	$1,318,015	$59,325,230
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$8,600,000		
Jessie	Separation	85%						$25,900,000	$25,900,000	$16,894	$98,155	$4,097,936	$25,900,000	$25,900,000	$51,800,000	$14,749,905	$189,079,009
	In-Line/Latent		x			$2,540,000			$2,540,000	$49,146	$88,764	$6,623,230	$2,540,000	$2,540,000	$5,080,000	$778,548	$35,043,275
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$56,880,000		
Marion	Separation	69%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x		$2,700,000	$2,200,000		$4,900,000	$133,614	$261,411	$18,946,680	$4,900,000	$4,900,000	$9,800,000	$1,545,869	$65,634,145
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$9,800,000		
Despins	Separation	36%						$39,980,000	$39,980,000	$26,109	$55,120	$3,880,546	$39,980,000	$39,980,000	$79,960,000	$13,664,946	$493,037,570
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$79,960,000		
Dumoulin	Separation	58%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$4,170,000			$4,170,000	$94,707	$105,684	$9,120,024	$4,170,000	$4,170,000	$8,340,000	$1,107,247	$66,694,981
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$8,340,000		
La Verendrye	Separation	8%						$2,080,000	$2,080,000	$1,536	$6,035	$317,787	$2,080,000	$2,080,000	$4,160,000	$913,796	$19,815,512
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Storage								$1,060,000	$10,750	$5,568	$555,774	$1,060,000	$1,060,000	$2,120,000	$243,821	$19,653,916
	TOTAL														$6,280,000		
Bannatyne	Separation	56%							$0				$0	$0	$0	$0	$0
	In-Line/Latent			x	x		$5,260,000		$5,260,000	$93,172	$168,280	$12,556,410	$5,260,000	$5,260,000	$10,520,000	$1,614,076	$72,485,401
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$10,520,000		
Alexander	Separation	80%							$0				$0	$0	$0	$0	$0
	In-Line/Latent				x				$3,960,000	$71,159	$88,673	$7,432,666	$3,960,000	$3,960,000	$7,920,000	$1,082,113	$61,491,496
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$7,920,000		
Mission	Separation	79%						$130,320,000	$130,320,000	$84,961	$793,002	$23,768,102	$130,320,000	$130,320,000	$260,640,000	$123,704,327	$575,053,858
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$260,640,000		
Roland	Separation	72%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$4,520,000	$2,800,000		$7,320,000	$168,426	$279,594	$21,477,725	$7,320,000	$7,320,000	$14,640,000	$2,180,189	$104,020,582
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$14,640,000		
Syndicate	Separation	58%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$4,230,000			$4,230,000	$104,434	$173,365	$13,317,495	$4,230,000	$4,230,000	$8,460,000	$1,259,884	$60,110,255
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$8,460,000		
Selkirk	Separation	62%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$6,770,000	$1,830,000		$8,600,000	$220,843	$114,287	$11,407,221	$8,600,000	$8,600,000	$17,200,000	$1,965,611	$160,108,814
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$17,200,000		
Hart	Separation	62%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$5,280,000			$5,280,000	$110,577	$123,393	$10,648,244	$5,280,000	$5,280,000	$10,560,000	$1,401,982	$84,448,321
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$10,560,000		
St John's	Separation	67%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$7,140,000	$3,140,000		$10,280,000	$236,001	$122,242	$12,201,227	$10,280,000	$10,280,000	$20,560,000	$2,356,415	$191,292,149
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$20,560,000		
Polson	Separation	73%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x			$3,830,000			$3,830,000	$61,909	$91,402	$7,887,588	$3,830,000	$3,830,000	$7,660,000	$1,016,968	$61,257,021
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$7,660,000		
Munroe	Separation	69%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$7,290,000			$7,290,000	$151,532	$131,285	$12,008,110	$7,290,000	$7,290,000	$14,580,000	$1,827,674	$123,696,974
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$14,580,000		
Jefferson	Separation	90%						$145,510,000	$145,510,000	$95,219	$604,807	$23,827,999	$145,510,000	$145,510,000	$291,020,000	$101,946,919	$870,301,774
	In-Line/Latent		x		x	$7,300,000			$7,300,000	$122,352	$91,384	$8,605,404	$7,300,000	$7,300,000	$14,600,000	$1,793,164	$126,543,954
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$305,620,000		
Linden	Separation	15%						$10,900,000	$10,900,000	$7,167	$26,683	$1,446,384	$10,900,000	$10,900,000	$21,800,000	$4,722,218	$105,393,102
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$21,800,000		
Newton	Separation	99%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$5,670,000			$5,670,000	$115,697	$144,173	$12,084,766	$5,670,000	$5,670,000	$11,340,000	$1,546,437	$88,218,988
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$11,340,000		
Armstrong	Separation	92%						$61,080,000	$61,080,000	$62,456	$1,106,629	$19,957,703	$61,080,000	$61,080,000	$122,160,000	$84,305,747	$179,969,283
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$122,160,000		
Hawthorne	Separation	95%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$4,640,000			$4,640,000	$103,410	$218,318	$15,370,005	$4,640,000	$4,640,000	$9,280,000	$1,506,285	$60,341,278
	Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$9,280,000		
SUBTOTAL						$134,300,000	$26,620,000	$869,890,001	$1,045,810,002	$4,489,645	$10,974,485	$543,226,355	$1,045,810,002	$1,045,810,002	$2,091,620,004	$874,410,446	$7,767,442,961
Green Infrastructure													$104,581,000	$104,581,000	$209,162,000	$61,388,657	$517,503,349
GRAND TOTAL													$1,150,391,002	$1,150,391,002	$2,300,782,004		

District	Control Option	2019 (0)	2020 (1)	2021 (2)	2022 (3)	2023 (4)	2024 (5)	2025 (6)	2026 (7)	2027 (8)	2028 (9)	2029 (10)	2030 (11)	2031 (12)	2032 (13)	2033 (14)	2034 (15)	2035 (15)	2036 (15)	2037 (15)	2038 (15)	2039 (15)	2040 (15)	2041 (15)	2042 (15)	2043 (15)	2044 (15)	2045 (15)	2046 (15)	2047 (15)	2048 (15)	2049 (15)	2050 (15)	2051 (15)	2052 (15)
Douglas Park	Separation	$2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Ferry Road	Separation	$18,155,789	$18,700,463	$19,261,477	$19,839,321	$20,434,501	$21,047,536	$21,678,962	$22,329,331	$19,166,009	$19,740,989	$20,333,219	$20,943,216	$21,571,512	$22,218,657	$22,885,217	$11,785,887	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Parkside	Separation	$2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Riverbend	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$12,290,447	$11,453,526	$24,836,066	$25,581,148	$26,348,583	$27,139,040	$27,953,211	$28,791,808	$29,655,562	$30,545,229	$31,461,586	$16,202,717	$0	$0	$0	$0	$0	$0
Cockburn	Separation	$11,848,421	$12,203,874	$12,569,990	$12,947,090	$13,335,502	$13,735,567	$14,147,634	$14,572,063	$15,009,225	$7,729,751	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Mission	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,272,857	$20,881,042	$21,507,474	$22,152,698	$22,817,279	$23,501,797	$24,206,851	$24,933,057	$25,681,048	$26,451,480	$36,780,783	$37,884,206	$39,020,732	$40,191,354	$41,397,095	$42,639,008	$43,918,178
Jefferson	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$6,578,016	$23,405,775	$24,107,949	$24,831,187	$25,576,123	$26,343,406	$27,133,708
Armstrong	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$3,728,883	$11,522,248	$19,779,858	$20,373,254	$16,787,561	$17,291,188	$17,809,924	$29,809,360	$30,703,641	$12,163,365	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Green Infrastructure		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$4,587,923	$4,725,561	$4,867,328	$5,013,347	$5,163,748	$5,318,660	$5,478,220	$5,642,567	$5,811,844	$5,986,199	$6,165,785	$6,350,759	$6,541,281	$6,737,520	$6,939,645	$7,147,835	$7,362,270	$7,583,138	$7,810,632	$8,044,951	$8,286,299	$8,534,888
Annual		$30,004,215	$30,904,337	$31,831,467	$32,786,411	$33,770,003	$34,783,103	$35,826,596	$36,901,394	$37,904,117	$38,992,988	$40,113,077	$41,316,470	$42,946,997	$44,235,406	$45,562,469	$46,608,594	$48,157,835	$49,208,408	$51,195,329	$52,731,189	$54,313,124	$55,942,518	$57,620,794	$59,349,418	$61,129,900	$62,963,797	$64,852,711	$66,709,350	$68,652,251	$70,711,819	$72,833,173	$75,018,169	$77,268,714	$79,586,775
Cumulative		$30,004,215	$60,908,551	$92,740,018	$125,526,429	$159,296,433	$194,079,536	$229,906,132	$266,807,527	$304,711,644	$343,704,632	$383,817,709	$425,134,179	$468,081,176	$512,316,582	$557,879,051	$604,487,645	$652,645,481	$701,853,889	$753,049,218	$805,780,407	$860,093,531	$916,036,049	$973,656,843	$1,033,006,260	$1,094,136,160	$1,157,099,958	$1,221,952,668	$1,288,662,018	$1,357,314,269	$1,428,026,088	$1,500,859,261	$1,575,877,430	$1,653,146,144	$1,732,732,919

8/19/2019

Figure S3-B: Scenario 3 Annual Budgeted Project Costs (With 100% Estimating Allowance)

Project Identification		15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
District	Control Option	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096
Woodhaven	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$37,874,899	$22,947,733	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Strathmillan	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$39,314,194	$20,246,810	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Moorgate	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$45,897,484	$23,637,204	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Douglas Park	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Ferry Road	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Tuxedo	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$29,929,735	$30,827,627	$15,876,228	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Doncaster	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$46,780,146	$92,512,417	$95,287,790	$98,146,424	$88,454,464	$86,769,617	$44,686,353	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Parkside	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Riverbend	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Tylehurst	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$35,885,003	$58,459,599	$81,579,427	$108,034,470	$111,275,504	$84,899,088	$87,446,061	$105,831,595	$46,385,763	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Clifton	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$67,134,895	$69,148,942	$35,611,705	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Ash	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$42,892,616	$44,179,395	$45,504,777	$46,869,920	$48,276,018	$49,724,298	$25,608,013	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$136,730,674	$46,944,198	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Aubrey	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$146,022,576	$60,161,301	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Cornish	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$78,400,161	$40,376,083	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Colony	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$105,769,607	$47,366,389	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
River	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$30,236,343	$15,571,716	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Assiniboine	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$67,567,802	$34,797,418	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Cockburn	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$48,760,269	$25,111,539	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Baltimore	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$57,426,191	$29,574,488	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Metcalfe	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$40,227,715	$50,223,693	$51,730,404	$26,641,158	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Mager	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$39,158,568	$20,166,662	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Jesse	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$39,836,455	$41,031,549	$42,262,495	$43,530,370	$22,418,141	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$23,130,875	$11,912,401	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Marion	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$43,322,868	$22,311,277	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Despins	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$38,573,495	$70,947,678	$116,921,774	$168,601,198	$34,111,635	$63,881,790	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Dumoulin	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$44,023,090	$22,671,891	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
La Verendrye	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$7,739,074	$7,971,246	$4,105,192	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$12,972,882	$6,681,034	$0
	TOTAL																																												
Bannatyne	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$50,718,648	$21,766,753	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Alexander	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$40,588,446	$20,903,050	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Mission	Separation	$43,560,326	$17,256,591	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Roland	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$68,660,450	$35,360,132	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Syndicate	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$39,676,736	$20,433,519	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Selkirk	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$70,167,787	$90,341,026	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Hart	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$55,741,466	$28,706,855	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
St John's	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$102,937,479	$88,354,670	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Polson	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$40,433,677	$20,823,344	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Munroe	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$81,648,168	$42,048,806	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Jefferson	Separation	$29,418,652	$57,572,303	$77,245,364	$79,562,725	$81,949,607	$84,408,095	$86,940,338	$89,548,548	$52,173,336	$53,738,536	$19,768,104	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$35,337,022	$47,102,171	$44,104,760	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Linden	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$29,820,386	$27,643,498	$31,636,448	$16,292,770	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Newton	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$52,303,748	$35,915,240	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Armstrong	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
Hawthorne	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$39,829,227	$20,512,052	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																																												
SUBTOTAL																																													
Green Infrastructure		$8,790,935	$9,054,663	$9,326,303	$9,606,092	$9,894,275	$10,191,103	$10,496,836	$10,811,741	$11,136,093	$11,470,176	$11,814,282	$12,168,710	$12,533,771	$12,909,784	$13,297,078	$13,695,990	$14,106,870	$14,530,076	$14,965,978	$15,414,958	$15,877,407	$16,353,729	$16,844,341	$17,349,671	$17,870,161	$18,406,266	$18,958,454	$19,527,207	$20,113,024	$20,716,414	$21,337,907	$21,978,044	$22,637,385	$23,316,507	$24,016,002	$24,736,482	$25,478,576	$26,242,934	$27,030,222	$27,841,128	$28,676,362	$29,536,653	$30,422,753	$0
GRAND TOTAL																																													
		$81,769,914	$83,883,557	$86,571,667	$89,168,817	$91,843,882	$94,599,198	$97,437,174	$100,360,290	$103,145,884	$106,240,261	$109,729,884	$114,158,679	$116,531,339	$120,944,254	$124,572,582	$128,524,814	$132,380,558	$136,237,899	$139,138,917	$144,146,011	$147,528,844	$151,572,580	$156,226,678	$160,913,478	$165,740,883	$171,042,239	$176,675,749	$181,135,334	$188,714,222	$191,397,661	$198,875,914	$203,194,896	$208,457,592	$215,840,832	$225,163,170	$230,721,708	$238,066,816	$243,980,080	$253,540,437	$258,373,418	$266,170,088	$275,776,103	$215,799,483	$0
		$1,814,502,832	$1,898,386,389	$1,984,958,056	$2,074,126,874	$2,165,970,756	$2,260,569,954	$2,358,007,128	$2,458,367,418	$2,561,513,302	$2,667,753,563	$2,777,483,447	$2,891,642,126	$3,008,173,465	$3,129,117,719	$3,253,690,301	$3,382,215,115	$3,514,595,673	$3,650,833,572	$3,789,972,489	$3,934,118,500	$4,081,647,344	$4,233,219,924	$4,389,446,602	$4,550,360,080	$4,716,100,963	$4,887,143,202	$5,063,818,951	$5,244,954,285	$5,433,668,507	$5,625,066,167	$5,823,942,081	$6,027,136,977	$6,235,594,568	$6,451,435,400	$6,676,598,570	$6,907,320,278	$7,145,387,095	$7,389,367,175	$7,642,907,612	$7,901,281,030	$8,167,451,117	$8,443,227,220	$8,659,026,703	$8,659,026,703

City of Winnipeg - CSO Master Plan

Figure S3-C - Scenario 3 Annual Additional Operations And Maintenance (O&M) Costs

Winnipeg

JACOBS

						Inflation	3.0%	Discount Rate	3.0%	NPV	6.0%	Allowance	100.0%				
		a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p
Project Identification		1) Project Details				Project Capital Cost (2019)				2) Additional O&M Cost Budget			3) Capital Cost Budget			4) Program Budget Summary	
District	Control Option	Balance of Area Separation %	Control Gate	Latent	Screens	In-line Storage Via Control Gate Construction	Latent Storage	Sewer Separation (Complete Or Partial)	Total	Annual (2019)	NPV (2019)	Total to 2100	2019 Capital Cost	100% Estimating Allowance	2019 Estimate	Additional O&M NPV	Additional O&M Budget Sum
Woodhaven	Separation	95%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$4,030,000			$4,030,000	$96,243	$132,831	$10,814,851	$4,030,000	$4,030,000	$8,060,000	$132,831	$10,814,851
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$8,060,000		
Strathmillan	Separation	40%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$4,580,000			$4,580,000	$95,219	$201,025	$14,152,579	$4,580,000	$4,580,000	$9,160,000	$201,025	$14,152,579
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$9,160,000		
Moorgate	Separation	70%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$5,040,000			$5,040,000	$104,434	$188,621	$14,074,218	$5,040,000	$5,040,000	$10,080,000	$188,621	$14,074,218
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL																
Douglas Park	Separation	0%							$1	$0	$0	$0	$1	$1	$2	$0	$0
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$2		
Ferry Road	Separation	70%						$129,360,000	$129,360,000	$84,469	$1,601,876	$27,267,137	$129,360,000	$129,360,000	$258,720,000	$1,601,876	$27,267,137
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$258,720,000		
Tuxedo	Separation	34%						$8,790,000	$8,790,000	$5,631	$25,816	$1,246,015	$8,790,000	$8,790,000	$17,580,000	$25,816	$1,246,015
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$17,580,000		
Doncaster	Separation	92%						$49,890,000	$49,890,000	$32,764	$85,280	$5,502,678	$49,890,000	$49,890,000	$99,780,000	$85,280	$5,502,678
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$99,780,000		
Parkside	Separation	0%						$1	$1	$0	$0	$0	$1	$1	$2	$0	$0
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$2		
Riverbend	Separation	79%						$76,590,000	$76,590,000	$50,169	$625,074	$15,052,468	$76,590,000	$76,590,000	$153,180,000	$625,074	$15,052,468
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$153,180,000		
Tylehurst	Separation	85%						$86,670,000	$86,670,000	$56,824	$247,738	$12,309,144	$86,670,000	$86,670,000	$173,340,000	$247,738	$12,309,144
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$173,340,000		
Clifton	Separation	68%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$7,880,000	$2,410,000		$10,290,000	$240,608	$208,459	$19,066,931	$10,290,000	$10,290,000	$20,580,000	$208,459	$19,066,931
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$20,580,000		
Ash	Separation	83%						$29,100,000	$29,100,000	$18,942	$55,974	$3,407,866	$29,100,000	$29,100,000	$58,200,000	$55,974	$3,407,866
	In-Line/Latent		x	x	x	$9,980,000	$2,600,000		$12,580,000	$244,191	$370,705	$29,316,880	$12,580,000	$12,580,000	$25,160,000	$370,705	$29,316,880
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$83,360,000		
Aubrey	Separation	69%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$11,140,000	$330,000		$11,470,000	$296,921	$187,295	$18,157,960	$11,470,000	$11,470,000	$22,940,000	$187,295	$18,157,960
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$22,940,000		
Cornish	Separation	74%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$4,810,000	$2,400,000		$7,210,000	$185,319	$183,346	$16,288,981	$7,210,000	$7,210,000	$14,420,000	$183,346	$16,288,981
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$14,420,000		
Colony	Separation	47%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$6,420,000	$2,350,000		$8,770,000	$229,858	$171,680	$16,166,611	$8,770,000	$8,770,000	$17,540,000	$171,680	$16,166,611
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$17,540,000		
River	Separation	46%							$0				$0	$0	$0	$0	$0
	In-Line/Latent				x				$2,950,000	$48,634	$60,604	$5,079,879	$2,950,000	$2,950,000	$5,900,000	$60,604	$5,079,879
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$5,900,000		
Assiniboine	Separation	56%							$0				$0	$0	$0	$0	$0
	In-Line/Latent				x				$6,790,000	$157,675	$217,617	$17,717,947	$6,790,000	$6,790,000	$13,580,000	$217,617	$17,717,947
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$13,580,000		
Cockburn	Separation	80%						$56,280,000	$56,280,000	$36,859	$853,651	$12,218,764	$56,280,000	$56,280,000	$112,560,000	$853,651	$12,218,764
	In-Line/Latent		x		x	$4,900,000			$4,900,000	$82,933	$114,461	$9,319,178	$4,900,000	$4,900,000	$9,800,000	$114,461	$9,319,178
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$122,360,000		
Baltimore	Separation	63%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$5,190,000	$1,500,000		$6,690,000	$164,330	$346,931	$24,424,612	$6,690,000	$6,690,000	$13,380,000	$346,931	$24,424,612
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$13,380,000		
Metcalfe	Separation	88%						$17,430,000	$17,430,000	$17,918	$66,707	$3,615,961	$17,430,000	$17,430,000	$34,860,000	$66,707	$3,615,961
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$34,860,000		
Mager	Separation	26%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$4,300,000			$4,300,000	$77,814	$140,541	$10,486,672	$4,300,000	$4,300,000	$8,600,000	$140,541	$10,486,672
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$8,600,000		
Jessie	Separation	85%						$25,900,000	$25,900,000	$16,894	$98,155	$4,097,936	$25,900,000	$25,900,000	$51,800,000	$98,155	$4,097,936
	In-Line/Latent		x			$2,540,000			$2,540,000	$49,146	$88,764	$6,623,230	$2,540,000	$2,540,000	$5,080,000	$88,764	$6,623,230
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$56,880,000		
Marion	Separation	69%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x		$2,700,000	$2,200,000		$4,900,000	$133,614	$261,411	$18,946,680	$4,900,000	$4,900,000	$9,800,000	$261,411	$18,946,680
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$9,800,000		
Despins	Separation	36%						$39,980,000	$39,980,000	$26,109	$55,120	$3,880,546	$39,980,000	$39,980,000	$79,960,000	$55,120	$3,880,546
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$79,960,000		
Dumoulin	Separation	58%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$4,170,000			$4,170,000	$94,707	$105,684	$9,120,024	$4,170,000	$4,170,000	$8,340,000	$105,684	$9,120,024
	Additional Storage								$0			$0	$0	$0	$0	$0	$0
	TOTAL											$0			$8,340,000		
La Verendrye	Separation	8%						$2,080,000	$2,080,000	$1,536	$6,035	$317,787	$2,080,000	$2,080,000	$4,160,000	$6,035	$317,787
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Additional Storage								$1,060,000	$10,750	$5,568	$555,774	$1,060,000	$1,060,000	$2,120,000	$5,568	$555,774
	TOTAL														$6,280,000		
Bannatyne	Separation	56%							$0				$0	$0	$0	$0	$0
	In-Line/Latent			x	x		$5,260,000		$5,260,000	$93,172	$168,280	$12,556,410	$5,260,000	$5,260,000	$10,520,000	$168,280	$12,556,410
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$10,520,000		
Alexander	Separation	80%							$0				$0	$0	$0	$0	$0
	In-Line/Latent				x				$3,960,000	$71,159	$88,673	$7,432,666	$3,960,000	$3,960,000	$7,920,000	$88,673	$7,432,666
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$7,920,000		
Mission	Separation	79%						$130,320,000	$130,320,000	$84,981	$783,002	$23,768,102	$130,320,000	$130,320,000	$260,640,000	$783,002	$23,768,102
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$260,640,000		
Roland	Separation	72%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$4,520,000	$2,800,000		$7,320,000	$168,426	$279,594	$21,477,725	$7,320,000	$7,320,000	$14,640,000	$279,594	$21,477,725
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$14,640,000		
Syndicate	Separation	58%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$4,230,000			$4,230,000	$104,434	$173,365	$13,317,495	$4,230,000	$4,230,000	$8,460,000	$173,365	$13,317,495
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$8,460,000		
Selkirk	Separation	62%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$6,770,000	$1,830,000		$8,600,000	$220,643	$114,287	$11,407,221	$8,600,000	$8,600,000	$17,200,000	$114,287	$11,407,221
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$17,200,000		
Hart	Separation	62%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$5,280,000			$5,280,000	$110,577	$123,393	$10,648,244	$5,280,000	$5,280,000	$10,560,000	$123,393	$10,648,244
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$10,560,000		
St John's	Separation	67%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x	x	x	$7,140,000	$3,140,000		$10,280,000	$236,001	$122,242	$12,201,227	$10,280,000	$10,280,000	$20,560,000	$122,242	$12,201,227
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$20,560,000		
Polson	Separation	73%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x			$3,830,000			$3,830,000	$81,909	$91,402	$7,887,588	$3,830,000	$3,830,000	$7,660,000	$91,402	$7,887,588
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$7,660,000		
Munroe	Separation	69%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$7,290,000			$7,290,000	$151,532	$131,285	$12,008,110	$7,290,000	$7,290,000	$14,580,000	$131,285	$12,008,110
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$14,580,000		
Jefferson	Separation	90%						$145,510,000	$145,510,000	$95,219	$604,807	$23,827,999	$145,510,000	$145,510,000	$291,020,000	$604,807	$23,827,999
	In-Line/Latent		x		x	$7,300,000			$7,300,000	$122,352	$91,384	$8,605,404	$7,300,000	$7,300,000	$14,600,000	$91,384	$8,605,404
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$305,620,000		
Linden	Separation	15%						$10,900,000	$10,900,000	$7,167	$26,683	$1,446,384	$10,900,000	$10,900,000	$21,800,000	$26,683	$1,446,384
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$21,800,000		
Newton	Separation	99%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$5,670,000			$5,670,000	$115,697	$144,173	$12,084,766	$5,670,000	$5,670,000	$11,340,000	$144,173	$12,084,766
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$11,340,000		
Armstrong	Separation	92%						$61,080,000	$61,080,000	$62,456	$1,106,629	$19,957,703	$61,080,000	$61,080,000	$122,160,000	$1,106,629	$19,957,703
	In-Line/Latent								$0				$0	$0	$0	$0	$0
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$122,160,000		
Hawthorne	Separation	95%							$0				$0	$0	$0	$0	$0
	In-Line/Latent		x		x	$4,640,000			$4,640,000	$103,410	$218,318	$15,370,005	$4,640,000	$4,640,000	$9,280,000	$218,318	$15,370,005
	Additional Storage								$0				$0	$0	$0	$0	$0
	TOTAL														$9,280,000		
SUBTOTAL						$134,350,000	$26,820,000		$1,045,810,002	$4,489,645	$10,974,485	$543,226,358	$1,045,810,002	$1,045,810,002	$2,081,540,004	$10,974,485	$543,226,358
Green Infrastructure Allowance (10%)													$104,581,000	$104,581,000	$209,162,000		
GRAND TOTAL													$1,150,391,002	$1,150,391,002	$2,290,702,004		

District	Control Option	0 2019	1 2020	2 2021	3 2022	4 2023	5 2024	6 2025	7 2026	8 2027	9 2028	10 2029	11 2030	12 2031	13 2032	14 2033	15 2034	16 2035	17 2036	18 2037	19 2038	20 2039	21 2040	22 2041	23 2042	24 2043	25 2044	26 2045	27 2046	28 2047	29 2048	30 2049	31 2050
Woodhaven	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Strathmillan	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Moorgate	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Douglas Park	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Ferry Road	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$135,548	$139,614	$143,803	$148,117	$152,560	$157,137	$161,851	$166,707	$171,708	$176,859	$182,165	$187,630	$193,259	$199,056	$205,028	$211,179
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Tuxedo	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Doncaster	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Parkside	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Riverbend	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$114,784	$118,227	$121,774	$125,427
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Tylehurst	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Clifton	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Ash	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Aubrey	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Cornish	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Colony	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
River	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Assiniboine	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Cockburn	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$49,535	$51,021	$52,552	$54,129	$55,753	$57,425	$59,148	$60,922	$62,750	$64,632	$66,571	$68,569	$70,626	$72,744	$74,927	$77,175	$79,490	$81,874	$84,331	$86,861	$89,466	$92,150
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Baltimore	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Metcalfe	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Mager	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Jessie	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Marion	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Despins	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Dumoulin	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
La Verendrye	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Bannatyne	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Alexander	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Mission	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Roland	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Syndicate	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Selkirk	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Hart	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
St John's	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Polson	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Munroe	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Jefferson	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Linden	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Newton	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Armstrong	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$106,327	$109,516	$112,802	$116,186	$119,672	$123,262	$126,960	$130,768	$134,691	$138,732	$142,894	$147,181	$151,596	$156,144
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Hawthorne	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Annual	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$49,535	$51,021	$52,552	$54,129	$55,753	$57,425	$194,696	$200,536	$312,879	$322,266	$331,934	$341,892	$352,148	$362,713	$373,594	$384,802	$396,346	$408,236	$535,267	$551,325	$567,865	$584,901
	Annual 2019 PV	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$36,859	$36,859	$36,859	$36,859	$36,859	$36,859	$121,328	$121,328	$183,784	$183,784	$183,784	$183,784	$183,784	$183,784	$183,784	$183,784	$183,784	$183,784	$233,953	$233,953	$233,953	$233,953
	Cumulative	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$49,535	$100,557	$153,109	$207,238	$262,990	$320,415	$515,111	$715,647	$1,028,526	$1,350,792	$1,682,726	$2,024,617	$2,376,765	$2,739,478	$3,113,072	$3,497,874	$3,894,220	$4,302,456	$4,837,724	$5,389,049	$5,956,914	$6,541,815

8/19/2019

City of Winnipeg - CSO Master Plan

Figure S3-C - Scenario 3 Annual Additional Operations And Maintenance (O&M) Costs

Winnipeg

JACOBS

Project Identification		32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
District	Control Option	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071
Woodhaven	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Strathmillan	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Moorgate	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Douglas Park	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Ferry Road	Separation	$217,514	$224,040	$230,761	$237,684	$244,814	$252,159	$259,723	$267,515	$275,540	$283,807	$292,321	$301,091	$310,123	$319,427	$329,010	$338,880	$349,046	$359,518	$370,303	$381,412	$392,855
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Tuxedo	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$26,190
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Doncaster	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Parkside	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Riverbend	Separation	$129,190	$133,066	$137,058	$141,170	$145,405	$149,767	$154,260	$158,888	$163,654	$168,564	$173,621	$178,830	$184,194	$189,720	$195,412	$201,274	$207,312	$213,532	$219,938	$226,536	$233,332
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Tylehurst	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Clifton	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Ash	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Aubrey	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Cornish	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Colony	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
River	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Assiniboine	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Cockburn	Separation	$94,915	$97,762	$100,695	$103,716	$106,828	$110,032	$113,333	$116,733	$120,235	$123,843	$127,558	$131,385	$135,326	$139,386	$143,567	$147,874	$152,311	$156,880	$161,586	$166,434	$171,427
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Baltimore	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Metcalfe	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Mager	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Jessie	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$67,777	$69,810	$71,905	$74,062	$76,284	$78,572
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Marion	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Despins	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Dumoulin	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
La Verendrye	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Bannatyne	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Alexander	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Mission	Separation	$0	$0	$0	$0	$246,298	$253,687	$261,297	$269,136	$277,210	$285,527	$294,093	$302,915	$312,003	$321,363	$331,004	$340,934	$351,162	$361,697	$372,548	$383,724	$395,236
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Roland	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Syndicate	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Selkirk	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Hart	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
St John's	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Polson	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Munroe	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Jefferson	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$360,080	$370,882	$382,009	$393,469	$405,273	$417,431	$429,954	$442,853
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Linden	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Newton	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Armstrong	Separation	$160,829	$165,654	$170,623	$175,742	$181,014	$186,445	$192,038	$197,799	$203,733	$209,845	$216,140	$222,624	$229,303	$236,182	$243,268	$250,566	$258,083	$265,825	$273,800	$282,014	$290,474
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
Hawthorne	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																					
SUBTOTAL																						
Green Infrastructure Allowance (10%)																						
GRAND TOTAL		**$602,448**	**$620,522**	**$639,137**	**$658,311**	**$924,358**	**$952,089**	**$980,652**	**$1,010,071**	**$1,040,374**	**$1,071,585**	**$1,103,732**	**$1,136,844**	**$1,170,950**	**$1,566,158**	**$1,613,143**	**$1,729,314**	**$1,781,193**	**$1,834,629**	**$1,889,668**	**$1,946,358**	**$2,030,939**
		$233,953	**$233,953**	**$233,953**	**$233,953**	**$318,934**	**$318,934**	**$318,934**	**$318,934**	**$318,934**	**$318,934**	**$318,934**	**$318,934**	**$318,934**	**$414,153**	**$414,153**	**$431,047**	**$431,047**	**$431,047**	**$431,047**	**$431,047**	**$436,678**
		$7,144,263	**$7,764,785**	**$8,403,922**	**$9,062,233**	**$9,986,592**	**$10,938,681**	**$11,919,333**	**$12,929,404**	**$13,969,778**	**$15,041,363**	**$16,145,095**	**$17,281,939**	**$18,452,889**	**$20,019,047**	**$21,632,190**	**$23,361,504**	**$25,142,697**	**$26,977,326**	**$28,866,994**	**$30,813,352**	**$32,844,291**

Project Identification		53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
District	Control Option	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096
Woodhaven	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$762,037	$784,898	$808,445	$832,698	$857,679	$883,410	$909,912	$937,209
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Strathmillan	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$650,347	$669,857	$689,953	$710,652	$731,971	$753,930	$776,548	$799,845	$823,840	$848,555	$874,012	$900,232	$927,239
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Moorgate	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$756,723	$779,424	$802,807	$826,891	$851,698	$877,249	$903,566	$930,673	$958,593	$987,351	$1,016,972
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Douglas Park	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Ferry Road	Separation	$404,640	$416,780	$429,283	$442,162	$455,426	$469,089	$483,162	$497,657	$512,586	$527,964	$543,803	$560,117	$576,921	$594,228	$612,055	$630,417	$649,329	$668,809	$688,873	$709,539	$730,826	$752,750	$775,333	$798,593	$822,551
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Tuxedo	Separation	$26,976	$27,785	$28,619	$29,477	$30,362	$31,273	$32,211	$33,177	$34,172	$35,198	$36,254	$37,341	$38,461	$39,615	$40,804	$42,028	$43,289	$44,587	$45,925	$47,303	$48,722	$50,183	$51,689	$53,240	$54,837
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Doncaster	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$204,786	$210,930	$217,258	$223,775	$230,488	$237,403	$244,525	$251,861	$259,417	$267,199	$275,215	$283,472	$291,976	$300,735	$309,757	$319,050
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Parkside	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Riverbend	Separation	$240,332	$247,542	$254,968	$262,617	$270,496	$278,611	$286,969	$295,578	$304,445	$313,579	$322,986	$332,676	$342,656	$352,936	$363,524	$374,429	$385,662	$397,232	$409,149	$421,423	$434,066	$447,088	$460,501	$474,316	$488,545
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Tylehurst	Separation	$272,213	$280,379	$288,790	$297,454	$306,378	$315,569	$325,036	$334,787	$344,831	$355,176	$365,831	$376,806	$388,110	$399,753	$411,746	$424,098	$436,821	$449,926	$463,424	$477,327	$491,646	$506,396	$521,588	$537,235	$553,352
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Clifton	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2,144,198	$2,208,524	$2,274,780	$2,343,023
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Ash	Separation	$0	$0	$0	$0	$0	$0	$0	$111,599	$114,947	$118,395	$121,947	$125,605	$129,374	$133,255	$137,252	$141,370	$145,611	$149,979	$154,479	$159,113	$163,887	$168,803	$173,867	$179,083	$184,456
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,877,146	$1,933,461	$1,991,465	$2,051,209	$2,112,745	$2,176,127	$2,241,411	$2,308,653	$2,377,913
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Aubrey	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2,807,175	$2,891,390
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Cornish	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,603,387	$1,651,489	$1,701,034	$1,752,065	$1,804,626
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Colony	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2,109,845	$2,173,141	$2,238,335
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
River	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$396,624	$408,523	$420,778	$433,402	$446,404	$459,796	$473,590
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Assiniboine	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,248,444	$1,285,897	$1,324,474	$1,364,208	$1,405,134	$1,447,288	$1,490,707	$1,535,428
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Cockburn	Separation	$176,570	$181,867	$187,323	$192,943	$198,731	$204,693	$210,834	$217,159	$223,673	$230,384	$237,295	$244,414	$251,746	$259,299	$267,078	$275,090	$283,343	$291,843	$300,598	$309,616	$318,905	$328,472	$338,326	$348,476	$358,930
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$656,649	$676,348	$696,639	$717,538	$739,064	$761,236	$784,073	$807,595
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Baltimore	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,122,373	$1,156,044	$1,190,725	$1,226,447	$1,263,240	$1,301,138	$1,340,172	$1,380,377	$1,421,788	$1,464,442	$1,508,375	$1,553,626	$1,600,235
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Metcalfe	Separation	$0	$0	$0	$93,792	$96,606	$99,504	$102,489	$105,564	$108,730	$111,992	$115,352	$118,813	$122,377	$126,048	$129,830	$133,725	$137,736	$141,869	$146,125	$150,508	$155,024	$159,674	$164,465	$169,399	$174,480
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Mager	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$563,832	$580,747	$598,170	$616,115	$634,598	$653,636	$673,245	$693,443	$714,246	$735,674	$757,744
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Jessie	Separation	$80,929	$83,357	$85,858	$88,434	$91,087	$93,819	$96,634	$99,533	$102,519	$105,594	$108,762	$112,025	$115,386	$118,847	$122,413	$126,085	$129,868	$133,764	$137,777	$141,910	$146,167	$150,552	$155,069	$159,721	$164,512
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$356,108	$366,792	$377,795	$389,129	$400,803	$412,827	$425,212	$437,968	$451,107	$464,641	$478,580
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Marion	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$939,961	$968,160	$997,205	$1,027,121	$1,057,934	$1,089,672	$1,122,362	$1,156,033	$1,190,714	$1,226,436	$1,263,229	$1,301,126
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Despins	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$178,321	$183,671	$189,181	$194,856	$200,702	$206,723	$212,924	$219,312	$225,892	$232,668	$239,648	$246,838	$254,243
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Dumoulin	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$795,544	$819,411	$843,993	$869,313	$895,392	$922,254
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
La Verendrye	Separation	$0	$0	$7,806	$8,040	$8,282	$8,530	$8,786	$9,050	$9,321	$9,601	$9,889	$10,185	$10,491	$10,806	$11,130	$11,464	$11,808	$12,162	$12,527	$12,902	$13,289	$13,688	$14,099	$14,522	$14,957
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$104,683
	TOTAL																									
Bannatyne	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$675,115	$695,369	$716,230	$737,717	$759,848	$782,644	$806,123	$830,307	$855,216	$880,872	$907,298
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Alexander	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$580,324	$597,733	$615,665	$634,135	$653,159	$672,754	$692,937
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Mission	Separation	$407,093	$419,306	$431,885	$444,841	$458,187	$471,932	$486,090	$500,673	$515,693	$531,164	$547,099	$563,512	$580,417	$597,830	$615,764	$634,237	$653,264	$672,862	$693,048	$713,840	$735,255	$757,313	$780,032	$803,433	$827,536
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Roland	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,257,013	$1,294,723	$1,333,565	$1,373,572	$1,414,779	$1,457,222	$1,500,939	$1,545,967	$1,592,346	$1,640,116
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Syndicate	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$779,424	$802,807	$826,891	$851,698	$877,249	$903,566	$930,673	$958,593	$987,351	$1,016,972
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Selkirk	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2,148,602
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Hart	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$928,852	$956,717	$985,419	$1,014,981	$1,045,431	$1,076,794
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
St John's	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2,298,157
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Polson	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$688,038	$708,679	$729,940	$751,838	$774,393	$797,625
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Munroe	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,350,389	$1,390,900	$1,432,627	$1,475,606
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Jefferson	Separation	$456,138	$469,822	$483,917	$498,435	$513,388	$528,789	$544,653	$560,993	$577,822	$595,157	$613,012	$631,402	$650,344	$669,854	$689,950	$710,649	$731,968	$753,927	$776,545	$799,841	$823,836	$848,552	$874,008	$900,228	$927,235
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,123,060	$1,156,752	$1,191,454
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Linden	Separation	$0	$0	$0	$37,517	$38,642	$39,802	$40,996	$42,225	$43,492	$44,797	$46,141	$47,525	$48,951	$50,419	$51,932	$53,490	$55,095	$56,747	$58,450	$60,203	$62,009	$63,870	$65,786	$67,759	$69,792
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Newton	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$943,548	$971,854	$1,001,010	$1,031,040	$1,061,971	$1,093,830	$1,126,645
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Armstrong	Separation	$299,189	$308,164	$317,409	$326,932	$336,740	$346,842	$357,247	$367,964	$379,003	$390,373	$402,085	$414,147	$426,572	$439,369	$452,550	$466,126	$480,110	$494,513	$509,349	$524,629	$540,368	$556,579	$573,276	$590,475	$608,189
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
Hawthorne	Separation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	In-Line/Latent	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$706,291	$727,479	$749,304	$771,783	$794,936	$818,784	$843,348	$868,648	$894,708	$921,549	$949,196	$977,671	$1,007,002
	Additional Storage	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	TOTAL																									
SUBTOTAL																										
Green Infrastructure Allowance (10%)																										
GRAND TOTAL		**$2,364,080**	**$2,435,002**	**$2,515,859**	**$2,722,643**	**$2,804,322**	**$2,888,452**	**$2,975,105**	**$3,175,957**	**$3,271,236**	**$3,574,159**	**$3,681,384**	**$3,791,825**	**$6,562,911**	**$7,699,759**	**$10,282,531**	**$12,627,444**	**$14,883,413**	**$17,997,045**	**$20,457,452**	**$23,483,609**	**$25,791,505**	**$30,059,837**	**$34,194,538**	**$38,027,549**	**$43,719,817**
		$493,502	**$493,502**	**$495,038**	**$520,123**	**$520,123**	**$520,123**	**$520,123**	**$539,065**	**$539,065**	**$571,829**	**$571,829**	**$571,829**	**$960,897**	**$1,094,511**	**$1,419,077**	**$1,691,937**	**$1,936,128**	**$2,272,979**	**$2,508,468**	**$2,795,662**	**$2,980,982**	**$3,373,122**	**$3,725,331**	**$4,022,252**	**$4,489,645**
		$35,208,371	**$37,643,373**	**$40,159,232**	**$42,881,875**	**$45,686,197**	**$48,574,649**	**$51,549,754**	**$54,725,712**	**$57,996,948**	**$61,571,107**	**$65,252,491**	**$69,044,316**	**$75,607,228**	**$83,306,987**	**$93,589,518**	**$106,216,962**	**$121,100,375**	**$139,097,420**	**$159,554,872**	**$183,038,481**	**$208,829,986**	**$238,889,824**	**$273,084,361**	**$311,111,910**	**$354,831,728**

City of Winnipeg - CSO Master Plan

Figure S3 - D: Scenario 3 Annual Modelled Project Performance

Winnipeg

JACOBS

Project Identification		a	b	c	d	e	f	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
		1) Project Details				2) Performance																																																	
District	Control Option	Balance of Area Separation %	Control Gate	Latent	Screens	2018 Revised Baseline Total CSO Volume (m3/year)	Control Option Performance (CSO Volume Reduction)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066
Woodhaven	Separation	95%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x		x		220	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					12,120																																																	
Strathmillan	Separation	40%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x		x		20,748	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					39,684																																																	
Moorgate	Separation	70%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x		x		7,518	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					64,937																																																	
Douglas Park	Separation	0%					739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739
	In-Line/Latent						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					739																																																	
Ferry Road	Separation	70%					136,599	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599
	In-Line/Latent						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					136,599																																																	
Tuxedo	Separation	34%					13,843	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					13,843																																																	
Doncaster	Separation	92%					30,644	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					30,644																																																	
Parkside	Separation	0%					2,979	2979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979
	In-Line/Latent						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					2,979																																																	
Riverbend	Separation	79%					87,057	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057
	In-Line/Latent						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					87,057																																																	
Tylehurst	Separation	85%					206,812	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					206,812																																																	
Clifton	Separation	68%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x	x	x		26,483	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					114,875																																																	
Ash	Separation	83%					54,678	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x	x	x		28,542	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					341,484																																																	
Aubrey	Separation	69%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x	x	x		59,934	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					141,643																																																	
Cornish	Separation	74%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x	x	x		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					60,293																																																	
Colony	Separation	47%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x	x	x		49,680	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					163,833																																																	
River	Separation	46%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent				x		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					15,904																																																	
Assiniboine	Separation	56%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent				x		708	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					13,005																																																	
Cockburn	Separation	80%					178,416	0	0	0	0	0	0	0	0	0	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416
	In-Line/Latent		x		x		8,358	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						Part Sep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					188,459																																																	
Baltimore	Separation	63%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x	x	x		5,976	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					72,575																																																	
Metcalfe	Separation	88%					12,191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					12,191																																																	
Mager	Separation	26%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x		x		20,856	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					21,912																																																	
Jessie	Separation	85%					23,202	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23,202	23,202
	In-Line/Latent		x				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					187,594																																																	
Marion	Separation	69%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x	x			14,225	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					51,773																																																	
Despins	Separation	36%					43,955	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					43,955																																																	
Dumoulin	Separation	58%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x		x		6,985	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					49,524																																																	
La Verendrye	Separation	8%					12,469	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						722	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					13,191																																																	
Bannatyne	Separation	56%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent			x	x		32,598	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					148,170																																																	
Alexander	Separation	80%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent				x		708	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					26,851																																																	
Mission	Separation	79%					12,809	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809
	In-Line/Latent						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					12,809																																																	
Roland	Separation	72%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x	x	x		118,287	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					299,396																																																	
Syndicate	Separation	58%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x		x		5,786	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					57,357																																																	
Selkirk	Separation	62%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x	x	x		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					172,507																																																	
Hart	Separation	62%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x		x		37,171	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					202,745																																																	
St John's	Separation	67%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x	x	x		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					181,444																																																	
Polson	Separation	73%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					455,282																																																	
Munroe	Separation	69%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x		x		18,388	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					432,465																																																	
Jefferson	Separation	90%					119,247	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	119,247	119,247	119,247	119,247
	In-Line/Latent		x		x		53,965	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					287,466																																																	
Linden	Separation	15%					14,033	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					14,033																																																	
Newton	Separation	99%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x		x		5,620	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					8,614																																																	
Armstrong	Separation	92%					749,622	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622
	In-Line/Latent						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						separated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					749,622																																																	
Hawthorne	Separation	95%					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent		x		x		2,753	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL					33,245																																																	
SUBTOTAL						**5,169,631**	**2,225,526**	**3,718**	**3,718**	**3,718**	**3,718**	**3,718**	**3,718**	**3,718**	**3,718**	**3,718**	**182,134**	**182,134**	**182,134**	**182,134**	**182,134**	**182,134**	**318,733**	**318,733**	**1,068,355**	**1,068,355**	**1,068,355**	**1,068,355**	**1,068,355**	**1,068,355**	**1,068,355**	**1,068,355**	**1,068,355**	**1,068,355**	**1,155,412**	**1,155,412**	**1,155,412**	**1,155,412**	**1,155,412**	**1,155,412**	**1,155,412**	**1,155,412**	**1,168,221**	**1,168,221**	**1,168,221**	**1,168,221**	**1,168,221**	**1,168,221**	**1,168,221**	**1,168,221**	**1,168,221**	**1,287,468**	**1,287,468**	**1,310,670**	**1,310,670**
		Total CSO Volume As Control Options Are Implemented						5,170,000	5,166,282	5,166,282	5,166,282	5,166,282	5,166,282	5,166,282	5,166,282	5,166,282	4,987,866	4,987,866	4,987,866	4,987,866	4,987,866	4,987,866	4,851,267	4,851,267	4,101,645	4,101,645	4,101,645	4,101,645	4,101,645	4,101,645	4,101,645	4,101,645	4,101,645	4,101,645	4,014,588	4,014,588	4,014,588	4,014,588	4,014,588	4,014,588	4,014,588	4,014,588	4,001,779	4,001,779	4,001,779	4,001,779	4,001,779	4,001,779	4,001,779	4,001,779	4,001,779	3,882,532	3,882,532	3,859,330	3,859,330

8/20/2019

City of Winnipeg - CSO Master Plan

Figure S3 - D: Scenario 3 Annual Modelled Project Performance

Project Identification		48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
District	Control Option	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096
Woodhaven	Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	220	220	220	220	220	220	220	220	220
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Strathmillan	Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20,748	20,748	20,748	20,748	20,748	20,748	20,748	20,748	20,748	20,748	20,748	20,748	20,748	20,748
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Moorgate	Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7,518	7,518	7,518	7,518	7,518	7,518	7,518	7,518	7,518	7,518	7,518	7,518
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Douglas Park	Separation	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739	739
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Ferry Road	Separation	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599	136,599
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Tuxedo	Separation	0	0	0	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843	13,843
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Doncaster	Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	30,644	30,644	30,644	30,644	30,644	30,644	30,644	30,644	30,644	30,644	30,644	30,644	30,644	30,644	30,644	30,644	30,644
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Parkside	Separation	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979	2,979
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Riverbend	Separation	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057	87,057
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Tylehurst	Separation	0	0	0	0	206,812	206,812	206,812	206,812	206,812	206,812	206,812	206,812	206,812	206,812	206,812	206,812	206,812	206,812	206,812	206,812	206,812	206,812	206,812	206,812	206,812	206,812	206,812	206,812	206,812	206,812
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Clifton	Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26,483	26,483	26,483	26,483	26,483
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Ash	Separation	0	0	0	0	0	0	0	0	0	0	0	54,678	54,678	54,678	54,678	54,678	54,678	54,678	54,678	54,678	54,678	54,678	54,678	54,678	54,678	54,678	54,678	54,678	54,678	54,678
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28,542	28,542	28,542	28,542	28,542	28,542	28,542	28,542	28,542	28,542
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Aubrey	Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	59,934	59,934	59,934
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Cornish	Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Colony	Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	49,680	49,680	49,680	49,680
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
River	Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Assiniboine	Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	708	708	708	708	708	708	708	708	708
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Cockburn	Separation	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416	178,416
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8,358	8,358	8,358	8,358	8,358	8,358	8,358	8,358	8,358
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Baltimore	Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5,976	5,976	5,976	5,976	5,976	5,976	5,976	5,976	5,976	5,976	5,976	5,976	5,976	5,976
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Metcalfe	Separation	0	0	0	0	0	0	0	12,191	12,191	12,191	12,191	12,191	12,191	12,191	12,191	12,191	12,191	12,191	12,191	12,191	12,191	12,191	12,191	12,191	12,191	12,191	12,191	12,191	12,191	12,191
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Mager	Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20,856	20,856	20,856	20,856	20,856	20,856	20,856	20,856	20,856	20,856	20,856	20,856
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Jessie	Separation	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202	23,202
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Marion	Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14,225	14,225	14,225	14,225	14,225	14,225	14,225	14,225	14,225	14,225	14,225	14,225	14,225
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Despins	Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43,955	43,955	43,955	43,955	43,955	43,955	43,955	43,955	43,955	43,955	43,955	43,955	43,955	43,955
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Dumoulin	Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6,985	6,985	6,985	6,985	6,985	6,985	6,985
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
La Verendrye	Separation	0	0	0	0	0	0	12,469	12,469	12,469	12,469	12,469	12,469	12,469	12,469	12,469	12,469	12,469	12,469	12,469	12,469	12,469	12,469	12,469	12,469	12,469	12,469	12,469	12,469	12,469	12,469
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	722	722
	TOTAL																														
Bannatyne	Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32,598	32,598	32,598	32,598	32,598	32,598	32,598	32,598	32,598	32,598	32,598	32,598
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Alexander	Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	708	708	708	708	708	708	708	708
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Mission	Separation	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809	12,809
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Roland	Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	118,287	118,287	118,287	118,287	118,287	118,287	118,287	118,287	118,287	118,287	118,287
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Syndicate	Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5,786	5,786	5,786	5,786	5,786	5,786	5,786	5,786	5,786	5,786	5,786
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Selkirk	Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Hart	Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37,171	37,171	37,171	37,171	37,171	37,171	37,171
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
St John's	Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Polson	Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Munroe	Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18,388	18,388	18,388	18,388	18,388
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Jefferson	Separation	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247	119,247
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	53,965	53,965	53,965	53,965
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Linden	Separation	0	0	0	0	0	0	0	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033	14,033
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Newton	Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5,620	5,620	5,620	5,620	5,620	5,620	5,620	5,620
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Armstrong	Separation	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622	749,622
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
Hawthorne	Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	In-Line/Latent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,753	2,753	2,753	2,753	2,753	2,753	2,753	2,753	2,753	2,753	2,753	2,753	2,753	2,753
	Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL																														
SUBTOTAL		**1,310,670**	**1,310,670**	**1,310,670**	**1,324,513**	**1,531,325**	**1,531,325**	**1,543,794**	**1,570,018**	**1,570,018**	**1,570,018**	**1,570,018**	**1,624,696**	**1,624,696**	**1,655,340**	**1,655,340**	**1,655,340**	**1,728,772**	**1,742,997**	**1,803,969**	**1,928,042**	**1,956,584**	**1,965,870**	**1,972,198**	**2,016,354**	**2,016,354**	**2,061,225**	**2,164,870**	**2,224,804**	**2,225,526**	**2,225,526**
		3,859,330	3,859,330	3,859,330	3,845,487	3,638,675	3,638,675	3,626,206	3,599,982	3,599,982	3,599,982	3,599,982	3,545,304	3,545,304	3,514,660	3,514,660	3,514,660	3,441,228	3,427,003	3,366,031	3,241,958	3,213,416	3,204,130	3,197,802	3,153,646	3,153,646	3,108,775	3,005,130	2,945,196	2,944,474	2,944,474

JACOBS

CSO Master Plan

Part 3A – CSO Master Plan Summary

Revision 03

August, 2019

City of Winnipeg

CSO Master Plan

Project No: 470010CH
Document Title: Part 3A – CSO Master Plan Summary
Revision: Revision 03
Date: August, 2019
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Project Manager: John Berry
File Name: CSO_Part3A_Summary_CO1MP_Final 08212019

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Document History and Status

Revision	Date	Description	By	Review	Approved
0	12/03/2018	DRAFT For City Review	ES	SG	ES
1	03/29/2019	1st DRAFT For City Review	JT	SG/MF	SG
2	08/09/2019	Final Draft Submission	SG	MF	JB / DJT
3	08/16/2019	Final Submission For CSO Master Plan	MF	SG	JB / DJT

Contents

Table(s)

Figure(s)

Acronyms and Abbreviations

AACE	American Association of Cost Engineers
BFR	basement flooding relief
CEC	Clean Environment Commission
City	City of Winnipeg
CS	combined sewer
CSO	Combined Sewer Overflow
DEP	district engineering plan
DWF	dry weather flow
EA	Environment Act Licence
GFC	gravity flow control
GI	green infrastructure
LDS	land drainage sewer
MSD	Manitoba Sustainable Development
NEWPCC	North End Sewage Treatment Plant
No.	Number
NPV	Net Present Value
O&M	operations and maintenance
RTC	real time control
SEWPCC	South End Sewage Treatment Plant
SRS	storm relief sewer
STP	sewage treatment plant
WEWPCC	West End Sewage Treatment Plant
WSTP	Winnipeg Sewage Treatment Program
WWF	wet weather flow
WWS	wastewater sewer

1. Introduction

1.1 Background

Development of the Combined Sewer Overflow (CSO) Master Plan has been structured in a three-phased approach. Development of potential plans for each of the five alternative control limits, were included in the first phase and was followed by a detailed evaluation in the second phase. The findings from the first two phases were documented in the CSO Master Plan Preliminary Proposal and submitted to Manitoba Sustainable Development (MSD) by the submission deadline of December 31, 2015. MSD then approved the Preliminary Proposal recommendation and provided notification to proceed with the with the development of the CSO Master Plan on November 24, 2017.

1.2 Purpose

The purpose of this document is to provide a summary of the proposed CSO Master Plan and highlight the technical approach used in its development. This includes the identification of CSO control projects proposed for each sewer district, the budget estimate cost summary and program implementation schedule.

The CSO Master Plan was developed by evaluating a series of control option solutions for each district, followed by evaluation of implementation scenarios using the selected control options. Only the final selection of control options and implementation scenarios are included in Part 3A of this report.

Each section included in this Part 3A report is described as follows:

- **Regulatory Background:** Provides background on the CSO Master Plan performance target selection and identifies applicable regulatory requirements.
- **Project Development:** Identifies the projects selected as part of the CSO Master Plan and provides details on the approach to project selection.
- **Program Development:** Describes the CSO Master Plan implementation and provides details on the approach to the program selection.
- **CSO Master Plan Details:** Describes the projects, costs and performance of the CSO Master Plan.
- **CSO Master Plan Monitoring and Reporting:** Describes current and future monitoring and reporting requirements.
- **Master Plan Update:** Describes how updates may apply to the CSO Master Plan and details the requirements of the 2030 CSO Master Plan update.

1.3 Supplemental Documentation

This summary report is supported by both the Part 3B – District Engineering Plans (DEPs) and Part 3C – Standard Details that all form part of Phase 3 of the CSO Master Plan. Part 3B of the CSO Master Plan includes all 43 of the combined sewer DEPs, which provide background on the specific sewer district, the control options recommended in the district, and the performance costs of these recommended control options. Part 3C describes the control option technologies selected as representative for use in development of the CSO Master Plan.

All Part 3 documents are identified as “living documents”, allowing for new information and modifications to be made as new information is received or CSO Master Plan projects are completed. Additionally, the Part 2 – Technical Report is referenced throughout this report and should be reviewed when additional detail on the overall program or individual projects is needed.

1.3.1 Part 2 – Technical Report

The Part 2 – Technical Report provides the background for the development of the CSO Master Plan. It includes details on the licensing process, technical development of the control options and the basis for the program. The Part 2 report provides a technical overview of the entire program / project and should be reviewed if more detail on items discussed in this report is needed.

1.3.2 Part 3B – District Engineering Plans

The Province of Manitoba's *Environment Act Licence No. 3042* (EA No. 3042) (Manitoba Conservation and Water Stewardship, 2013) requires the development of detailed engineering plans as part of the CSO Master Plan submission. Clause 11 includes this requirement as follows:

> *The Licencee shall, on or before December 31, 2017, file a final Master Plan, including the detailed engineering plans, proposed monitoring plan, and implementation schedule for the approved design identified in the preliminary plan above. The Master Plan is to be filed for approval by the Director. The Licencee shall implement the plan by December 31, 2030, unless otherwise approved by the Director.*

Although identified as "detailed" plans, the proposed control option solutions within each sewer district engineering plan (DEP) have been developed to a conceptual level of detail. This is considered suitable for the level of study completed during a master planning project of this nature. This approach was confirmed with MSD at the June 15, 2018 Regulatory Working Committee meeting.

The DEPs identify and describe the proposed projects for each district that will achieve the 85 percent CSO capture in a representative year target, but do not identify their order of implementation. The sequence of project implementation may be reordered at any time to accommodate potential changes to the CSO Master Plan in future conditions.

All 43 combined sewer districts have a DEP and these are included as Appendix A of Part 3B. Each DEP is laid out in the same manner and contains similar information relevant to the specific sewer district.

General information including a description of the existing sewer systems and a summary of current planning and investment work can be found in each DEP. The remainder of the DEP contains the CSO Master Plan information with a summary of the proposed projects and a description on how they have been applied conceptually. The performance of these solutions, using the 2019 updated hydraulic model simulated under the 1992 representative year conditions is included for each district. The capital costs for the recommended solutions and how they may have changed in comparison to the capital cost projections in the Preliminary Proposal is also included. The impacts resulting from a potential migration from 85 percent capture to the future performance target is commented on in the DEPs. This includes prioritization of districts where there may be potential "sunken" costs on solutions to address the 85 percent capture target, only to not be required to meet the future performance target. Finally, the DEPs include potential risks and opportunities for the solutions recommended for the district present in the future.

1.3.3 Part 3C – Standard Details

Part 3C is a supporting document to both the Part 3A – Master Plan Summary report and Part 3B – District Engineering Plans that all form part of Phase 3 of the Master Plan.

It provides background information on the CSO technologies recommended through the CSO Master Plan, including detailed descriptions of conceptual solutions, design rationale and considerations, and other rationale for their selection (such as operations and maintenance [O&M] considerations). Where appropriate, industry products with a history of use in these types of applications for each CSO technology are highlighted to demonstrate what type of products may be selected for this work. It includes further details for sewer separation, latent storage, in-line storage, screening, gravity flow control and off-line storage tank and off-line storage tunnel solutions.

2. Regulatory Requirements

The CSO Master Plan provides a roadmap for program implementation in conformance with the regulatory requirements. Therefore, it must adhere to a specific set of conditions as stipulated by EA No. 3042 and confirmed during the Preliminary Proposal development and review phase. EA No. 3042, with additional clarifications, is the basis for the CSO Master Plan. A summary of the relevant regulatory requirements is included here for reference. Further details and background on these regulatory requirements are described in detail in Section 2.2 and Section 2.7 of the Part 2 – Technical Report. Specific clarifications of the regulatory requirements were also developed by engaging with MSD. The results from these regulatory clarifications are included in Appendix B of the Part 2 - Technical Report.

The CSO Master Plan has been developed on a percent capture basis with a performance target of 85 percent capture. This is noted as Control Option No. 1 – 85 Percent Capture in a Representative Year as approved by MSD.

The control limit will be monitored on the basis of percent capture for the representative year. The representative year is 1992 based on a detailed review of the historical data. The 1992 rainfall trends are used to assess the performance of the system within the developed InfoWorks hydraulic model of the Winnipeg sewer system. The normal summer water level (NSWL) for the City of Winnipeg is used in this hydraulic model as a conservative alternative to the 1992 river levels. The output from this InfoWorks hydraulic model has then been assessed to calculate the percent capture of the overall system and determine the level of compliance. The 85 Percent Capture in a Representative Year control limit will be achieved upon completion of all the proposed projects based on this modeling work completed.

Table 2-1 lists the Preliminary Proposal (2013) and CSO Master Plan (2019) baseline and future performance for CSO volume, with the complete implementation program based on achieving 85 percent capture under the 1992 representative year.

Table 2-1. Percent Capture Calculation Summary

Condition	Total CSO Volume (m^3)	Total Dry Weather Flow Volume (m^3)	Total Wet Weather Flow Volume Captured (m^3)	Target Reduction in CSO Volume (m^3)	Percent Capture [a] (%)
PP Baseline (2013) CSO	5,260,000	7,749,000	7,317,000	-	74
CSO PP 85 Percent Capture in the 1992 Representative Year	2,980,000	7,749,000	9,593,000	2,300,000	85
MP Baseline (2019) CSO	5,170,000	7,749,000	6,660,000	-	74
CSO MP 85 Percent Capture in the 1992 Representative Year	2,900,000	7,749,000	8,8920,000	2,270,000	85

[a] Percent Capture = $\frac{\text{(Total Dry Weather Flow Volume + Total Wet Weather Flow Volume Captured)}}{\text{(Total CSO Volume+Total Dry Weather Flow Volume+Total Wet Weather Flow Volume Captured)}}$

Therefore, the total targeted CSO reduction for Control Option No. 1 is 2,270,000 m^3 and is used for performance tracking over the course of the program. Ultimately the CSO reduction target with the updated CSO Master Plan (2019) model is only a minor difference, as a result of model updates. Rounding the updated figure results in the same 2,300,000 m^3 reported during the Preliminary Proposal. This same 2,300,000 m^3 was therefore selected and referenced throughout this document as the target reduction in overflow volume to reach the 85 percent capture target in the latest hydraulic model.

Additional licence requirement dictated by MSD in EA No. 3042 include:

- no DWF overflows in the combined sewer system (Clause 7),
- no increase in CSOs as a result in-fill development (Clause 8),
- public notification of CSOs (Clause 10),
- incorporation of green infrastructure within the CSO Master Plan solutions where possible (Clause 11),
- reduction of floatable materials entering the river stream (Clause 12), and
- regulatory progress reporting (Clause 13).

The CSO Master Plan has been developed to incorporate each of these elements. Each requirement is discussed in detail in Section 2.2.6 of the Part 2 – Technical Report.

2.1 Migration to Future Control Targets

The Preliminary Proposal approval letter from MSD dated Nov 24, 2017, includes the condition that Control Option No. 1: 85 Percent Capture In A Representative Year be implemented in such a way that Control Option No. 2: No More Than Four Overflows In A Representative Year may eventually be phased in.

MSD and the City held multiple meetings during the development of the CSO Master Plan to discuss this migration requirement. An alternative approach has been presented to MSD, of migrating to Control Option No. 2 based on an equivalent percent volume capture target. This has been presented in order to main volume percent capture as the performance metric. This would avoid throw-away costs by allowing for contiguous projects and maintaining a percent volume capture evaluation framework.

MSD confirmed during the Regulatory Working Committee meeting of November 26, 2018 that the bacteriological water quality improvement identified for Control Option No. 2 is required to be met regardless of how the program is initiated, and ultimately any alternative approach would need to demonstrate equivalent or better bacteriological water quality improvement for approval. The agreed resolution was to work towards implementing Control Option No. 1 and at the same time further evaluate the water quality implications of maintaining a percent capture program. The results of the further evaluation will be part of the required 2030 Master Plan update submission.

3. Project Development

As described in Section 3.5 of Part 2 – Technical Report, the project selection completed for the Preliminary Proposal forms the basis for this phase of the evaluation. The control options were reevaluated through additional modelling refinements based on information gathered during the Phase 3 development.

Project development within each sewer district was carried out in two steps. Step One: Initial Control Option Selection was completed to identify committed projects, optimization of the use of existing infrastructure and addition of end-of-pipe screening at primary outfalls. Step Two: Control Option Refinements included a series of analyses to develop a system wide set of control options that could achieve the performance target. Refinements were made as part of Step Two where cost benefits were identified or where the conceptual practicality of the control option was not justifiable. A summary of the resulting projects selected as part of Step One and Step Two are detailed below. Specific details of the processes used part of Step One and Step Two can be found in Section 3.5 of the Part 2 – Technical Report.

3.1 Step One: Initial Control Option Selection

The first step of project development included the selection and evaluation of previously committed projects, followed by in-line and latent storage, off-line screening and gravity flow control (GFC) evaluations on a district-by-district basis. The applicability of a control option within a sewer district was evaluated based on a number of criteria including compatibility with existing sewer infrastructure, proximity to the primary CS outfall/interceptor sewers, and estimated hydraulic performance. The initial solution configurations were implemented within the InfoWorks model based on system hydraulics and then locations were verified with GIS in terms of constructability and feasibility.

These assessments led to the initial control option recommendations in each district listed in Table 3.1.

Table 3.1. Step One: Initial Control Option Selection Process – Recommended Projects

District	Complete Separation	Partial Separation	Latent Storage (River Control)	In-Line Storage Via Control Gate	Floatables Management Via Screens	Gravity Flow Control
Woodhaven				Yes	Yes	
Strathmillan				Yes	Yes	
Moorgate				Yes	Yes	
Douglas Park [a]	Yes					
Ferry Road [a]	Yes					
Tuxedo				Yes	Yes	
Doncaster				Yes	Yes	
Parkside [a]	Yes					
Riverbend [a]	Yes					
Tylehurst	Yes					
Clifton			Yes	Yes	Yes	
Ash		Yes	Yes	Yes	Yes	
Aubrey			Yes	Yes	Yes	
Cornish			Yes	Yes	Yes	
Colony			Yes	Yes	Yes	Yes
River					Yes	
Assiniboine			Yes		Yes	Yes
Cockburn [a]		Yes		Yes	Yes	
Baltimore			Yes	Yes	Yes	
Metcalfe				Yes	Yes	
Mager				Yes	Yes	
Jessie [a]		Yes		Yes		
Marion			Yes	Yes		
Despins				Yes		
Dumoulin				Yes	Yes	
La Verendrye				Yes	Yes	
Bannatyne			Yes		Yes	Yes
Alexander					Yes	Yes
Mission [a]	Yes					
Roland			Yes	Yes	Yes	
Syndicate				Yes	Yes	
Selkirk			Yes	Yes	Yes	Yes
Hart				Yes	Yes	
St John's				Yes	Yes	Yes
Polson				Yes		Yes
Munroe				Yes	Yes	Yes
Jefferson [a]		Yes		Yes	Yes	Yes
Linden				Yes	Yes	
Newton				Yes	Yes	Yes
Armstrong [a]	Yes					
Hawthorne				Yes	Yes	

[a] denotes a Committed Project to the CSO and BFR program

3.2 Step Two: Control Option Refinement Process

Refinements were completed for initial control option selection to respond to operational challenges and to achieve the 85 percent capture target. This included:

- a review and further evaluation of sewer districts with screening operational challenges,
- incorporation of additional complete or partial sewer separation where cost-effective,
- the addition of flap gate control and/or CS-SRS interconnection adjustments to accommodate additional latent storage,
- incorporation of additional off-line storage where required to provide volume capture remaining required to meet Control Option No. 1,
- These refinements resulted in the final control option selections for each district shown in Table 3.2. These control option selections form the projects recommended in this CSO Master Plan submission. Further details of each of these refinements included in Step Two of the project development process are defined in Section 3.5.4 of the Part 2 – Technical Report.

Table 3.2. Step Two: Control Option Refinements Process – Selected Projects

District	Complete Separation - District Specific Evaluation	Complete Separation – System-Wide Evaluation	Partial Separation	Latent Storage (River Control)	Latent Storage (Flap Gate Control Upgrades)	Latent Storage (Interconnection Upgrades)	In-Line Storage Via Control Gate	In-Line Storage Via Existing Weir	Floatables Management Via Screens	Alternative Floatables Management	Off-Line Storage Tanks	Off-line Tunnel Storage	Gravity Flow Control
Woodhaven [b]							Yes		Yes				
Strathmillan [b]							Yes		Yes				
Moorgate							Yes		Yes				
Douglas Park [a]	Yes												
Ferry Road [a]	Yes												
Tuxedo		Yes											
Doncaster		Yes											
Parkside [a]	Yes												
Riverbend [a]	Yes												
Tylehurst	Yes												
Clifton				Yes	Yes		Yes		Yes				
Ash			Yes	Yes	Yes		Yes		Yes				
Aubrey				Yes		Yes	Yes		Yes				
Cornish [b]				Yes			Yes		Yes				
Colony				Yes			Yes		Yes				Yes
River								Yes	Yes				
Assiniboine				Yes				Yes	Yes				Yes
Cockburn [a]			Yes				Yes		Yes				
Baltimore				Yes			Yes		Yes				
Metcalfe		Yes											
Mager							Yes		Yes				
Jessie			Yes					Yes		Yes			
Marion				Yes				Yes		Yes			
Despins		Yes											
Dumoulin							Yes		Yes				
La Verendrye		Yes										Yes	
Bannatyne				Yes				Yes	Yes				Yes
Alexander								Yes	Yes				Yes
Mission [a]	Yes												
Roland				Yes			Yes		Yes				
Syndicate							Yes		Yes				
Selkirk				Yes			Yes		Yes				Yes
Hart							Yes		Yes				
St John's				Yes			Yes		Yes				Yes
Polson								Yes		Yes			Yes
Munroe							Yes		Yes				Yes
Jefferson [a]			Yes				Yes		Yes				Yes
Linden		Yes											
Newton							Yes		Yes				Yes
Armstrong [a]	Yes												
Hawthorne							Yes		Yes				

[a] denotes a Committed Project to the CSO and BFR program

[b] In-Line Storage Control Gate recommended for this district primarily to provide hydraulic head for screen operation. This solution does not provide sufficient additional volume capture to be cost-effective based on performance alone. Should screens no longer be required for this district, In-Line Storage Control Gate recommendation should be reassessed.

3.3 Capital Cost Summary

A conceptual level Class 5 estimate was developed for the CSO Master Plan. A Class 5 estimate is defined by the *American Association of Cost Engineers International, (AACE) Cost Estimate Classification System - As Applied In Engineering, Procurement, and Construction for the Process Industries* (AACE, 1997) as having a project definition of zero to two percent to be used in a conceptual study with an expected range of accuracy from -50 percent to +100 percent .

The total capital cost to implement the CSO Master Plan including the 10 percent Green Infrastructure (GI) allowance is estimated as $1,150,400,000 in 2019 dollars. Applying the maximum +100 percent of the Class 5 estimating range, the total capital cost for budgeting purposes is estimated to be $2,300,800,000. The capital cost summary is shown in Table 3.3.

Table 3.3. CSO Master Plan Capital Cost Estimate (2019-dollars)

Item	2019 Capital Cost Estimate
Class 5 Estimated Capital Costs	$1,045,800,000
Green Infrastructure Allowance	$104,600,000
Subtotal – Capital Cost Estimate	**$1,150,400,000**
Class 5 Estimate Range of Accuracy: -50% to +100%	$575,200,000 to +$2,300,800,000
Total Capital Cost for Budgeting Purposes	**$2,300,800,000**

A capital cost for each of the proposed control options was developed and totaled to form a cost for the proposed work within each sewer district. The district capital costs were then totaled to calculate the total estimated capital costs of the CSO Master Plan. A 53 percent markup was then applied to these estimated construction costs to arrive at the Class 5 Estimated Capital Costs included in Table 3.3 above. A green infrastructure allowance of 10 percent of these costs was then added to result in the Subtotal – Capital Cost Estimates amount. Finally the maximum of the estimate accuracy range of +100 percent was applied to the capital cost sub-total to produce the capital cost total to be used by the City of Winnipeg for budgeting proposes.

This markup of 53 percent applied to the estimated construction costs included the following components:

- Engineering – 13 percent
- Project Design Contingencies – 30 percent
- Program Management – 2 percent
- Manitoba Retail Sales Tax – 8 percent (reduced to 7 percent in 2019, but not applied)

Exclusions specific to the capital cost values provided in Table 3.3 included the following:

- Finance and Administration – 3.25 percent
- Federal Goods and Services Tax (GST) –not included because of the municipal exemptions applicable to the work associated with the CSO Master Plan. Normally 5 percent for all private goods and services.
- Land Acquisition Costs (as applicable) – site specific based on the final locations selected for construction of the measures recommended in the CSO Master Plan and was therefore not included in the capital cost estimates.

Operations and maintenance (O&M) costs are identified separately from the capital costs and for the purposes of comparing solutions in the DEPs were considered over a 35 year lifecycle. Lifecycle costing allowed for comparative evaluations to be completed as control options in specific districts were refined. Additionally, this method aligns with the City's current business case evaluation process and will allow the long term O&M costs of the solutions recommended to be referenced for development of the future business cases for each project.

The CSO Master Plan estimates are focused on future budgeting, and do not report the following project costs which are attributable to the total cost of the program:

- Program Support Services:
  - Field services by internal resources, consulting services, and contracts for carrying out or supporting the engineering evaluations, pilot testing, and RTC works in support of program management have not been included in the capital costs for the CSO Master Plan.
  - These support services costs will be refined and better understood during the CSO Master Plan implementation phase.
- Combined Sewer Overflow and Basement Flooding Relief Program Committed Projects:
  - Projects as part of the CSO and BFR program which are underway at the time of writing were considered in the cost estimation. Anything completed prior to the completion of this report was not included in the estimate.
  - The value of these works either already constructed or currently underway as part of the CSO and BFR program is approximately $540,000,000.
- Sewage Treatment Plant Upgrades:
  - Combined sewage captured under the CSO program to achieve 85 percent capture (2 percent increased volume) will be routed to sewage treatment plants for wet weather flow (WWF) treatment.
  - WWF treatment upgrades are underway at the South End Sewage Treatment Plant (SEWPCC) and will be funded as part of the Winnipeg Sewage Treatment Program budget.
  - The future North End Sewage Treatment Plant (NEWPCC) project is to include an independent treatment facility for WWF, which will be used by the CSO program. The costs associated with these upgrades have been budgeted in the NEWPCC upgrade project estimates.
  - The capital and operating costs of all WWF treatment is included the STP upgrade budgets and has not been included in the CSO program capital cost estimates.

4. Program Development

Program development refers to the process of arranging the proposed projects as identified in Section 3 into a sequential plan that best meets the program criteria and constraints. Multiple program scenarios based on the anticipated level of funding from each level of government were evaluated in terms of overall program cost and timeline. Three funding scenarios were considered in the program development process. The assumptions used to develop the program and the comparative evaluation of the scenarios is described in Section 4 of the Part 2 – Technical Report. This section provides a summary of each of the three scenarios evaluated.

4.1 Funding Scenarios

Three funding scenarios were identified to align with the 2003 Clean Environment Commission (CEC) hearings recommendation for government cost sharing for upgrading the sewer collection and treatment systems. The program scenarios used in the program development are described as follows:

- **Scenario 1 – Shared Tri-Level Funding:** Tri-level funding agreement between the Government of Canada, Manitoba Government and the City of Winnipeg. The City has an expectation that the program will be equally funded through a cost-sharing arrangement with the provincial and federal governments, at one-third equal funding contributions from each level of government. This scenario places a cap of $30 million per year on funding from each of the three levels of government ($90 million per year maximum), with the program completion date being extended as necessary to complete the program.
- **Scenario 2 – Shared Bi-level Funding:** Bi-level funding agreement between the City of Winnipeg and either the Manitoba Government or the Government of Canada. As a compromise to three-way sharing, the second scenario assumes that one of two senior levels of government will not participate in the funding arrangement. This has the effect of maintaining the same $30 million per year level of funding per year from two of the three levels of government ($60 million per year maximum) and extending the program until its completion.
- **Scenario 3 –City-only Funding:** This scenario assumes the two senior levels of government will not participate in shared funding, with the program being fully funded by the City at a cap of $30 million per year. The schedule would be extended as necessary at the fixed rate of funding to complete the program.

4.2 Program Evaluation Summary

The three scenarios identified in Section 4.1 were compared to evaluate the overall timeline and total capital expenditure. A program work book was created for each funding scenario using the same implementation strategy with the only difference being the annual funding. A high level comparison of the funding scenarios expenditures and timeline is included in this section. More details on the evaluation of the scenarios are included in Section 4.4 of the Part 2 – Technical Report. The breakdown of the annual costs based on the project sequencing, resulting in the total expenditures and timeline shown below can be found in Appendix D and Appendix E of the Part 2 – Technical Report.

The implementation scenarios evaluated as part of the workbook include four main parts; the project details, O&M cost summary, capital cost summary, and a budget schedule. A comparison of the total capital expenditure and implementation timelines for each of the three scenarios is shown in Table 4-1.

Table 4-1. Program Scenario Implementation Comparison

Program Scenario	Description	Funding by	Annual Budget	Total Capital Expenditure	Timeline
Scenario 1	3 Levels of Funding 3 x $30 Million	Tri-level: Government of Canada, Manitoba Government and the City of Winnipeg	$90 Million	$3,667,000,000	27 years (2047)
Scenario 2	2 Levels of Funding 2 x $30 Million	Bi-Level: City of Winnipeg and either the Manitoba Government or the Government of Canada	$60 Million	$4,482,000,000	39 years (2059)
Scenario 3	City Only $30 Million	One Level: City of Winnipeg Only	$30 Million	$8,659,000,000	75 years (2095)

The results of the evaluations show that a shared, tri-level funding arrangement where all three levels of government contribute results in the shortest timeline and lowest capital expenditure. Under this scenario each level of government would contribute $30 Million per year for a total annual contribution of $90 Million per year. This is in line with the CEC recommendation for shared funding and has a completion date that is the closest to the 2045 date identified by MSD. Scenario 1 forms the basis of the recommended CSO Master Plan and is described in further detail in Section 5 of Part 3A.

5. CSO Master Plan Summary

The CSO Master Plan consists of a number of control option solutions that, when combined, will function to meet the Control Option No. 1: 85 Percent Capture In A Representative Year performance target. It predominately includes a combination of sewer separation, in-line storage, floatables management, latent storage, and gravity flow control throughout the CS districts to meet the target. This section summarizes the projects, performance and implementation schedule for the CSO Master Plan. It is intended to be a conceptual road map that will continue to evolve and be updated as the implementation of the program progresses.

5.1 Project Summary

The CSO Master Plan is developed from a detailed analysis of all CS districts to determine a suitable combination of proposed control option solutions that will meet the 85 percent capture in a representative year performance target. The details of the project selection are included in Section 3. The summary list of district-specific projects that are proposed as part of the CSO Master Plan is provided in Table 5-1. A more detailed breakdown of the components of the projects selected for each district can be found in Table 3.1 and Table 3.2.

Table 5-1. Control Option Selection for the CSO Master Plan

District	Latent Storage	In-line Storage	Screening	Gravity Flow Control	Off-line Storage	Complete District Sewer Separation	Partial District Sewer Separation
Woodhaven [a]		Yes	Yes				
Strathmillan [a]		Yes	Yes				
Moorgate		Yes	Yes				
Douglas Park						Yes	
Ferry Road						Yes	
Tuxedo						Yes	
Doncaster						Yes	
Parkside						Yes	
Riverbend						Yes	
Tylehurst						Yes	
Clifton	Yes	Yes	Yes				
Ash	Yes	Yes	Yes				Yes
Aubrey	Yes	Yes	Yes				
Cornish [a]	Yes	Yes	Yes				
Colony	Yes	Yes	Yes	Yes			
River			Yes				
Assiniboine	Yes		Yes	Yes			
Cockburn		Yes	Yes				Yes

Table 5-1. Control Option Selection for the CSO Master Plan

District	Latent Storage	In-line Storage	Screening	Gravity Flow Control	Off-line Storage	Complete District Sewer Separation	Partial District Sewer Separation
Baltimore	Yes	Yes	Yes				
Metcalfe						Yes	
Mager		Yes	Yes				
Jessie							Yes
Marion	Yes						
Despins						Yes	
Dumoulin		Yes	Yes				
La Verendrye					Yes	Yes	
Bannatyne			Yes	Yes			
Alexander			Yes	Yes			
Mission						Yes	
Roland	Yes	Yes	Yes				
Syndicate		Yes	Yes				
Selkirk	Yes	Yes	Yes	Yes			
Hart		Yes	Yes				
St John's	Yes	Yes	Yes	Yes			
Polson				Yes			
Munroe		Yes	Yes	Yes			
Jefferson E		Yes	Yes	Yes			Yes
Jefferson W							
Linden						Yes	
Newton		Yes	Yes	Yes			
Armstrong						Yes	
Hawthorne		Yes	Yes				

[a] In-Line Storage Control Gate recommended for this district primarily to provide hydraulic head for screen operation. This solution does not provide sufficient additional volume capture to be cost-effective based on performance alone. Should screens no longer be required for this district, In-Line Storage Control Gate recommendation should be reassessed.

Figure 5-1 provides an overview map of the location of the proposed control options in each district.

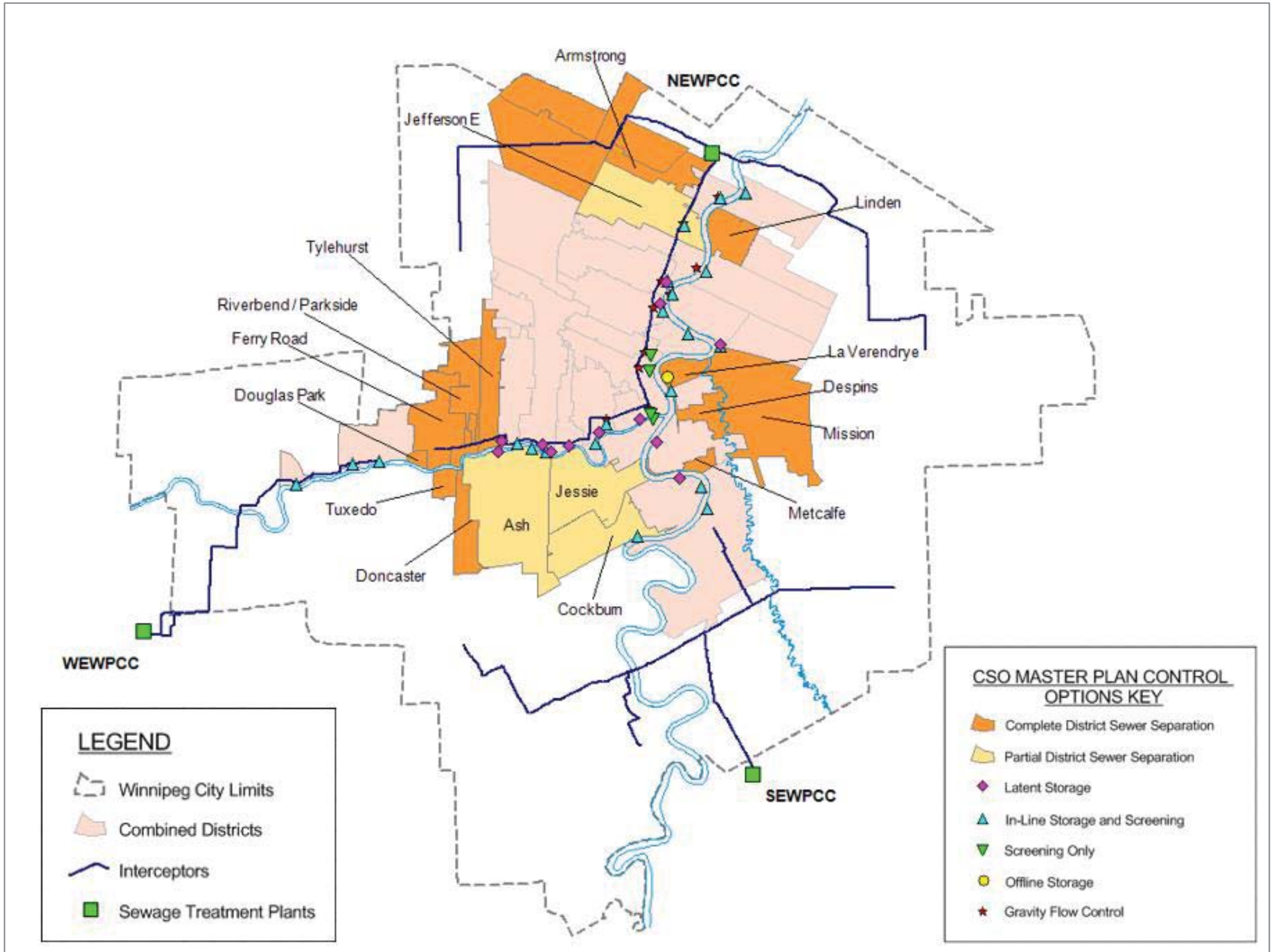

Figure 5-1. CSO Master Plan Project Overview Map

5.1.1 Project Costs

The costs were developed on a district basis and are summarized in terms of capital and O&M costs in Table 5-2.

Table 5-2. Sewer District Capital Cost Summary

District	Capital Cost (2019 Dollars)	2019 Total Operations and Maintenance Cost (Over 35-year period)	Total Lifecycle Cost
Woodhaven	$4,430,000	$2,070,000	$6,500,000
Strathmillan	$5,040,000	$2,050,000	$7,090,000
Moorgate	$5,540,000	$2,240,000	$7,780,000
Douglas Park	$0	$0	$0
Ferry Road	$142,300,000	$1,820,000	$144,120,000
Tuxedo	$9,670,000	$120,000	$9,790,000
Doncaster	$54,880,000	$700,000	$55,580,000
Parkside	$0	$0	$0
Riverbend	$84,250,000	$1,080,000	$85,330,000
Tylehurst	$95,340,000	$1,220,000	$96,560,000
Clifton	$11,320,000	$5,170,000	$16,490,000
Ash	$45,850,000	$5,650,000	$51,500,000
Aubrey	$12,620,000	$6,380,000	$19,000,000
Cornish	$7,930,000	$3,980,000	$11,910,000
Colony	$9,650,000	$4,940,000	$14,590,000
River	$3,250,000	$1,050,000	$4,300,000
Assiniboine	$7,470,000	$3,390,000	$10,860,000
Cockburn	$67,300,000	$2,570,000	$69,870,000
Baltimore	$7,360,000	$3,530,000	$10,890,000
Metcalfe	$19,170,000	$390,000	$19,560,000
Mager	$4,730,000	$1,670,000	$6,400,000
Jessie	$31,280,000	$1,420,000	$32,700,000
Marion	$5,390,000	$2,870,000	$8,260,000
Despins	$43,980,000	$560,000	$44,540,000
Dumoulin	$4,590,000	$2,040,000	$6,630,000
La Verendrye	$3,450,000	$260,000	$3,710,000
Bannatyne	$5,790,000	$2,000,000	$7,790,000
Alexander	$4,360,000	$1,530,000	$5,890,000
Mission	$143,350,000	$1,830,000	$145,180,000
Roland	$8,050,000	$3,620,000	$11,670,000

Table 5-2. Sewer District Capital Cost Summary

District	Capital Cost (2019 Dollars)	2019 Total Operations and Maintenance Cost (Over 35-year period)	Total Lifecycle Cost
Syndicate	$4,650,000	$2,240,000	$6,890,000
Selkirk	$9,460,000	$4,740,000	$14,200,000
Hart	$5,810,000	$2,380,000	$8,190,000
St John's	$11,310,000	$5,070,000	$16,380,000
Polson	$4,210,000	$1,760,000	$5,970,000
Munroe	$8,020,000	$3,260,000	$11,280,000
Munroe Annex	$15,000	$0	$0
Jefferson W	$0	$0	$0
Jefferson E	$168,090,000	$4,680,000	$172,770,000
Linden	$11,990,000	$150,000	$12,140,000
Newton	$6,240,000	$2,490,000	$8,730,000
Armstrong	$67,190,000	$1,340,000	$68,530,000
Hawthorne	$5,100,000	$2,220,000	$7,320,000
TOTAL	**$1,150,425,000**	**$96,480,000**	**$1,246,890,000**

The control option costs per district are identified in Figure 5-2. This provides perspective on the type of work and relative cost within each sewer district. Note that where *Additional* is noted in the figure, it corresponds with assorted pipe work relocation, such as removal and replacement of the existing off-take structure, construction of additional CS-SRS interconnections, or other miscellaneous construction work.

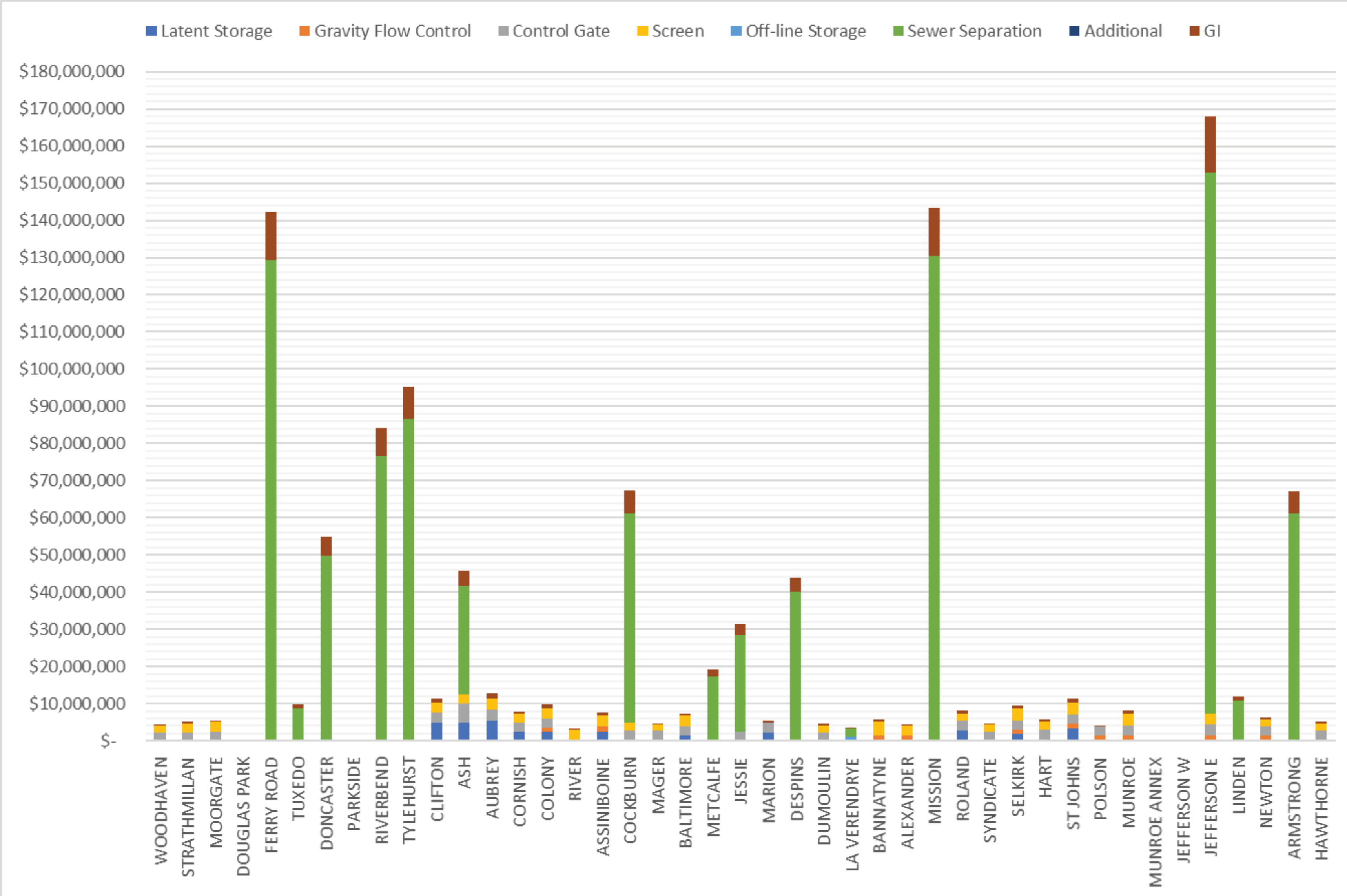

Figure 5-2. Sewer District Cost Summary

The costs associated with each type of control option are listed in Table 5-3. This illustrates the number of projects recommended related to each type of control option and the total cost impact of each control option technology. Sewer separation represents a significant portion of the planned work. Where *Additional* is noted in the table, it corresponds with assorted pipe work relocation, such as removal and replacement of the existing off-take structure, construction of additional CS-SRS interconnections, or other miscellaneous construction work.

Table 5-3. Control Option Cost Summary for the CSO Master Plan

Control Option	Master Plan 2019 Dollars	
	Number of Districts	Total Costs
Latent Storage	13	$29,300,000
Flap Gate Control	2	$4,800,000
Gravity Flow Control	10	$12,900,000
Control Gate	24	$64,200,000
Screen	25	$63,500,000
Off-line Storage Tank	0	N/A
Off-line Storage Tunnel	0	N/A
Sewer Separation	15	$869,900,000
Additional	3	$1,300,000
SUBTOTAL	**41**	**$1,045,800,000**
Green Infrastructure	41	$ 104,600,000
SUBTOTAL		**$1,150,400,000**

5.1.2 Performance

The purpose of the CSO Master Plan program is to capture 85 percent of the CSO that occur in the 1992 representative year. As described in Section 2 of Part 3A, this will be achieved when the reduction of the CSO volume reaches 2,300,000 m^3 as modelled against the 1992 representative year. The CSO volumes under the 1992 representative year conditions under each district are shown below in Table 5-4.

Each of the components in Table 5-4 are explained as follows:

- **2018 Baseline CSO Volume:** This represents the total overflow volume from each specific district, based on the updated 2018 hydraulic model utilized during the CSO Master Plan development.
- **Completed CSO Master Plan CSO Volume:** This represented the modelled overflow volume remaining in each specific district, after the control options recommended in each DEP have been implemented.
- **Reduction in CSO Volume:** This represents the reduction in CSO volume as a result of the control options recommended in each district, in comparison to 2018 Baseline CSO Volume.
- **Reduction In CSO Volume (%):** This shows the same CSO volume reduction as a result of the controls recommended in each district, as a percentage of the 2018 Baseline CSO Volume.

Table 5-4. Sewer District CSO Reduction

District	2018 Baseline CSO Volume (m^3)	Completed CSO Master Plan CSO Volume (m^3)	Reduction in CSO Volume (m^3)	Reduction in CSO Volume (%)
Woodhaven	12,120	11,900	220	0.0%
Strathmillan	39,684	18,936	20,748	0.8%
Moorgate	64,937	57,419	7,518	0.3%
Douglas Park	739	0	739	0.0%
Ferry Road	136,599	0	136,599	5.0%
Tuxedo	13,843	0	13,843	0.5%
Doncaster	30,644	0	30,644	1.1%
Parkside	2,979	0	2,979	0.1%
Riverbend	87,057	0	87,057	3.2%
Tylehurst	206,812	0	206,812	7.5%
Clifton	114,875	88,392	26,483	1.0%
Ash	341,484	258,264	83,220	3.0%
Aubrey	141,643	81,709	59,934	2.2%
Cornish [a]	64,659	63,724	935	0.0%
Colony	163,833	108,985	54,848	2.0%
River [a]	15,904	15,904	0	0.0%
Assiniboine	13,005	11,549	1,457	0.1%
Cockburn	188,459	6,183	182,276	6.6%
Baltimore	72,575	66,599	5,976	0.2%
Metcalfe	12,191	0	12,191	0.4%
Mager	21,912	1,056	20,856	0.8%
Jessie	187,594	164,392	23,202	0.8%
Marion	51,773	37,548	14,225	0.5%
Despins	43,955	0	43,955	1.6%
Dumoulin	49,524	42,539	6,985	0.3%
La Verendrye	13,191	0	13,191	0.5%
Bannatyne	148,170	115,571	32,598	1.2%
Alexander	26,851	26,142	708	0.0%
Mission	12,809	0	12,809	0.5%
Roland	299,396	181,108	118,287	4.3%
Syndicate	57,357	51,571	5,786	0.2%
Selkirk	172,507	150,161	22,346	0.8%
Hart	202,745	165,575	37,171	1.3%

Table 5-4. Sewer District CSO Reduction

District	2018 Baseline CSO Volume (m^3)	Completed CSO Master Plan CSO Volume (m^3)	Reduction in CSO Volume (m^3)	Reduction in CSO Volume (%)
St John's [a]	149,432	125,828	23,604	0.9%
Polson [a]	455,282	455,282	0	0.0%
Munroe	432,465	370,430	62,035	2.2%
Jefferson	287,466	47,252	240,215	8.7%
Linden	14,033	0	14,033	0.5%
Newton	8,614	2,994	5,620	0.2%
Armstrong	749,622	0	749,622	27.2%
Hawthorne	33,245	30,493	2,753	0.1%
TOTAL	**5,141,983** [b]	**2,757,506** [b]	**2,384,477** [b]	**100.0%**

[a] Influence from neighboring districts resulted in performance values in error for this district. Individual district model performance values utilized for evaluation purposes.

[b] Values provided are approximations using a combination of system-wide and individual district hydraulic model results. These values will differ from the results in Table 5-5.

The performance results from Table 5-4 have been developed using the sewer system hydraulic model results and indicates both complex district interactions and instabilities within some districts performance, as noted in the footnotes below. The City is committed to reducing the CSO volumes within the CS sewerage districts and will not allow negative impacts to be developed, where control option solutions transfer CSO volume to another district. Refer to the individual DEPs in Part 3B of the CSO Master Plan for further assessment of the control option proposals and commentary on model instability issues where they have been found to occur.

Overall the performance for CSO capture on a system wide basis can be summarized as illustrated in Table 5-5. Table 5-5 includes a comparison of the performance results to the performance modelled as part of the Preliminary Proposal development.

Each of the model conditions in Table 5-5 are explained as follows:

- **2013 PP Baseline:** This represents the model conditions for the 2013 Baseline hydraulic model used during the Preliminary Proposal, showing how the sewer system functions currently.
- **PP 85 Percent Capture in the 1992 Representative Year:** This represents the model conditions of the same 2013 Baseline model used during the Preliminary Proposal, showing the performance after each of the control options recommended in the Preliminary Proposal are implemented.
- **2018 MP Baseline:** This represents the model conditions for the updated 2018 Baseline hydraulic model used during the CSO Master Plan development, showing how the sewer system functions currently.
- **MP 85 Percent Capture in the 1992 Representative Year:** This represents the model conditions of the same 2018 Baseline model used during the CSO Master Plan, showing the performance after each of the control options recommended in the CSO Master Plan are implemented.

Table 5-5. System Wide CSO Reduction

Condition	Total CSO Volume (m^3)	Total Dry Weather Flow Volume (m^3)	Total Wet Weather Flow Volume Captured (m^3)	Target Reduction in CSO Volume (m^3)	Percent Capture [a] (%)
2013 PP Baseline	5,260,000	7,749,000	7,317,000	-	74%
PP 85 Percent Capture in the 1992 Representative Year	2,980,000	7,749,000	9,593,000	2,300,000	85%
2018 MP Baseline	5,170,000	7,749,000	6,660,000	-	74%
MP 85 Percent Capture in the 1992 Representative Year	2,900,000	7,749,000	8,920,000	2,270,000	85%

[a] Percent Capture = (DWF + Captured WWF) / (Overflow + DWF + Captured WWF)

5.2 Program Summary

The CSO Master Plan was developed into a program that fits into the selected funding Scenario 1. The estimated capital cost breakdown for the CSO Master Plan is illustrated in Figure 5-3. This is the base capital cost utilized for the program development. As described in Section 3.3, the upper limit of the estimated range, $2,300,800,000 has been used for the budget analysis and in developing the implementation schedule.

For the CSO Master Plan, it is assumed the program will be equally funded through a cost-sharing arrangement with the provincial and federal governments, at a one-third share each. This scenario places a limit of $30 million per year on funding from each of the three levels of government ($90 million per year total), with the program completion date being extended as necessary to complete the program.

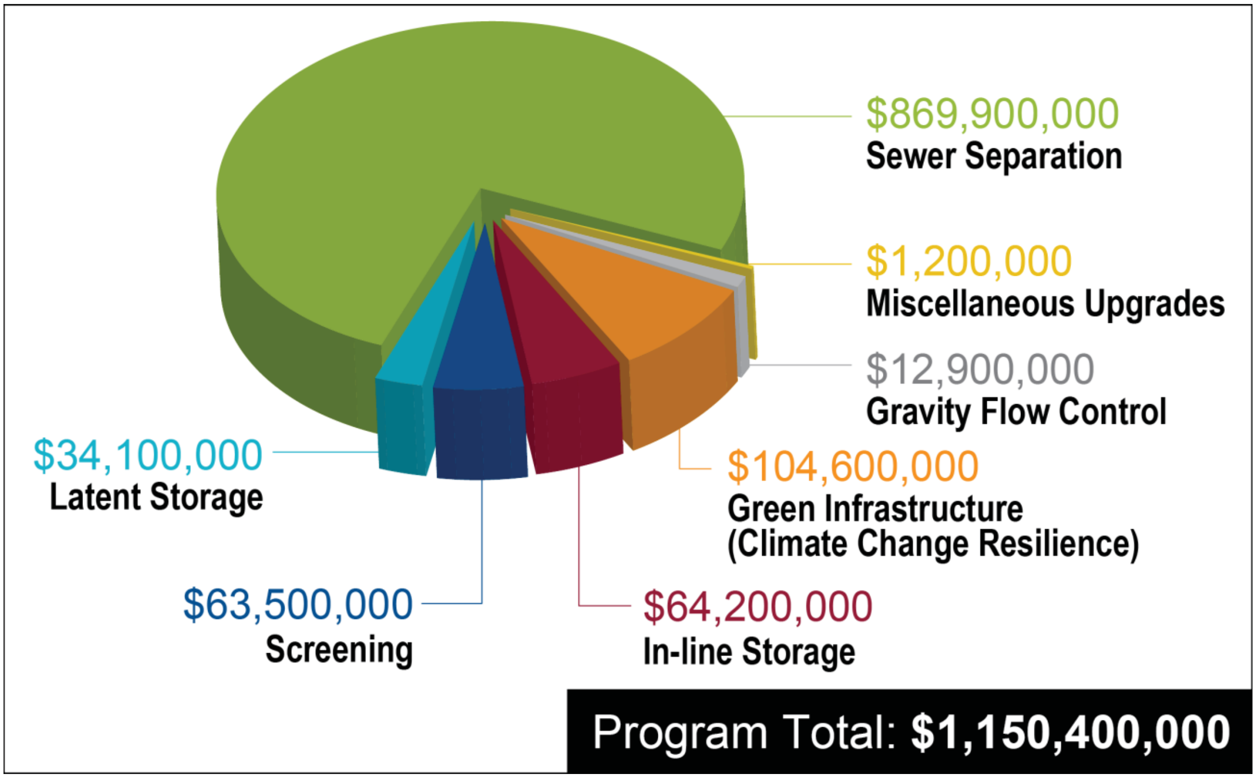

Figure 5-3: CSO Master Plan Capital Cost Summary (2019 Dollars)

The proposed projects are compiled based on the implementation strategy to form the project work schedule. Cost inflation and discounting is applied based on when a project begins. An overview of the CSO Master Plan implementation program showing when work is proposed for each CS district is shown in Figure 5-4.

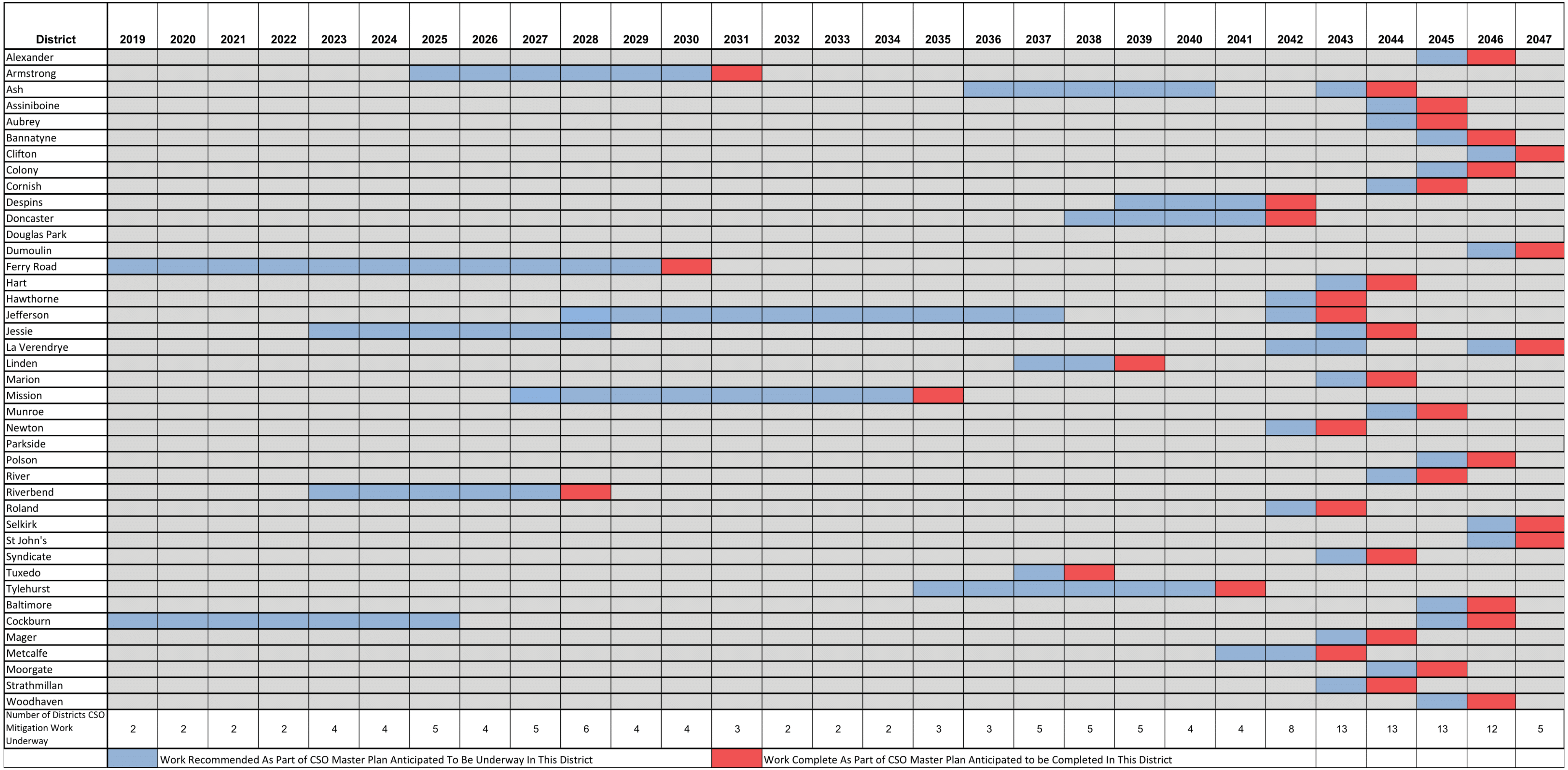

Figure 5-4. CSO Master Plan Sewer District Based Implementation Schedule

The rate of reduction in CSOs is directly impacted to the implementation period for the CSO Master Plan and the reductions can be shown as the projects are completed. Timing of the cumulative reduction in the annual CSO volume, based on the project sequencing and CSO program under Scenario 1 is shown in Figure 5-5. This shows that the 85 percent capture target would be met in the year 2047.

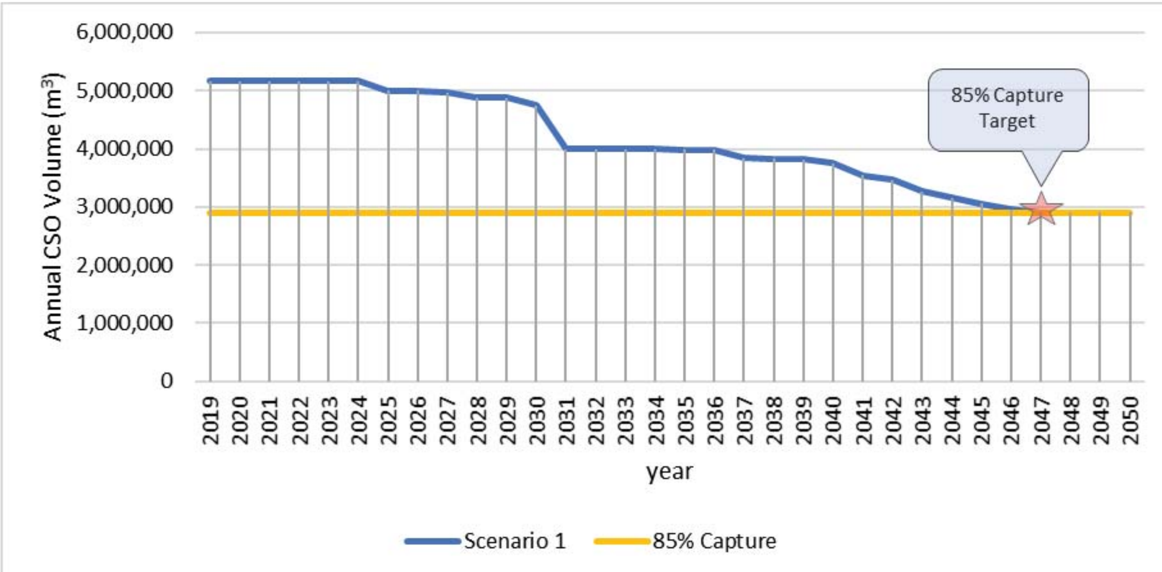

Figure 5-5. CSO Master Plan Predicted Annual CSO Volume Reductions

5.2.1 Capital Budgets

The CSO Master Plan program is based on equally shared costs by the three levels of government for a total of $90 million per year in 2019 dollars. This means that the annual budget of $90 million per year is expected to rise in line with inflation, and the associated funding provided by the three levels of government to rise with inflation as well. The programming goal was to develop relatively uniform annual budgets in 2019-dollars after accounting for the initial funding gap for the startup period.

The annual budgets based on the CSO Master Plan recommended project sequencing, in 2019 dollar terms are shown in Figure 5-6.

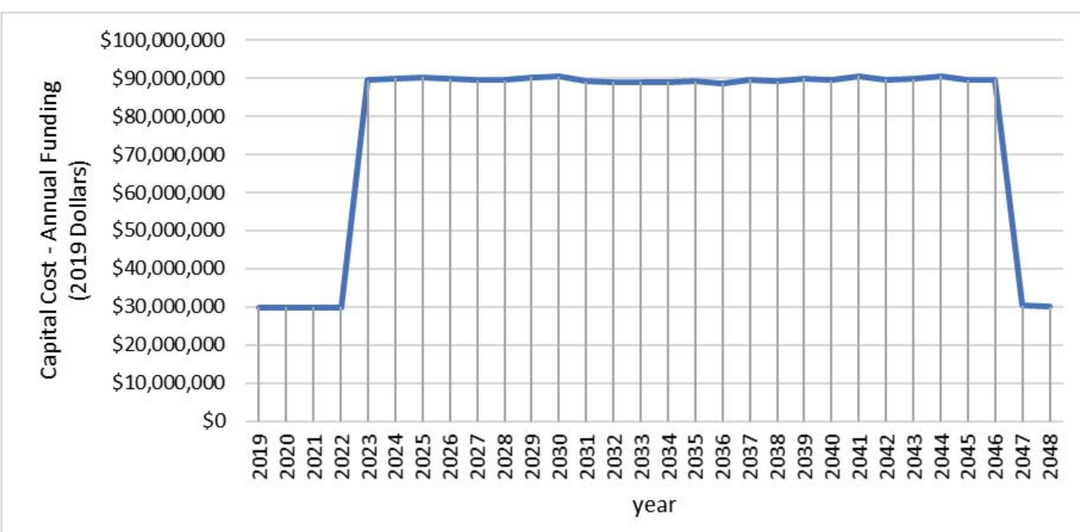

Figure 5-6. CSO Master Plan Annual Capital Budget (2019-dollars)

Figure 5-6 shows that the shared annual budget varies slightly from year to year which is a result of discrete project costs that cannot readily be smoothed out to accommodate uniform budgeting. The overall budget however is approximately $90 million per year in 2019 dollar terms. The accumulated implementation costs do not exceed the accumulated budget.

The shared annual capital budget values inflated at 3 percent per year are shown in Figure 5-7 for comparison. The inflated values show the increase to the annual budget over the implementation time period. The shared annual capital budget in the second last year of the Master Plan implementation period under Scenario 1 is approximately $199 million dollars.

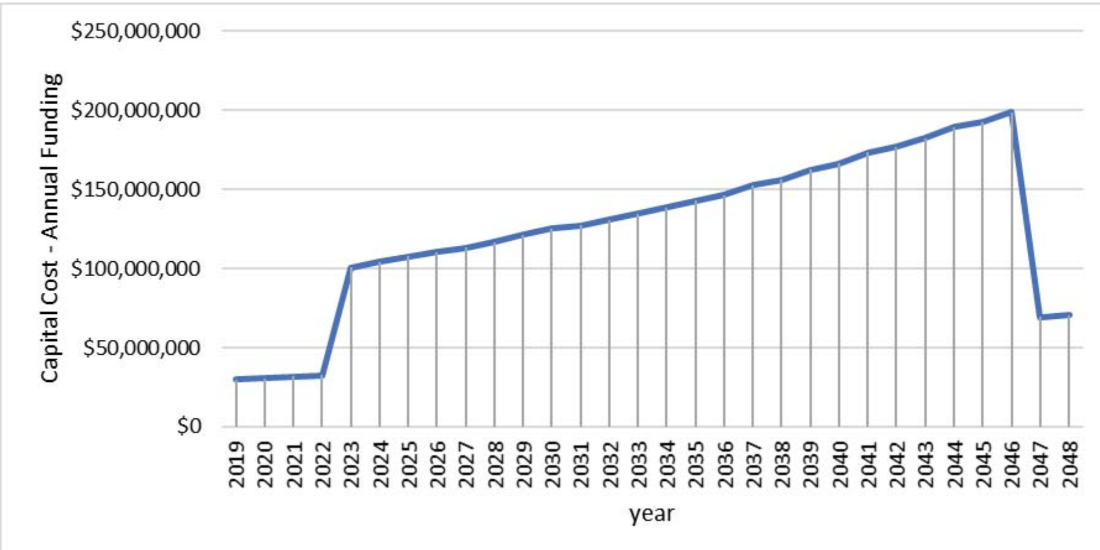

Figure 5-7. CSO Master Plan Capital Budget Inflated at 3 Percent Annually

The CSO Master Plan shared annual budget in 2019-dollar values is next plotted on a cumulative basis as shown in Figure 5-8. The projects are sequenced by year in the budget schedule, per the project sequence determined during the program development, and they show the budget value for the year of construction. Based on an escalation of 3 percent per year, the total for the future budget amounts would be $3,667,000,000 in 2047 dollars.

- The NPV of this cumulative total budgeted amount for the CSO Master Plan is $1,534,000,000 based on a 6 percent discount rate.

Expenditures that are scheduled later in the program or use longer implementation periods would reduce the NPV. shows that the implementation of the CSO Master Plan can be completed within 25 years with a starting year 1 annual budget of approximately $91 million.

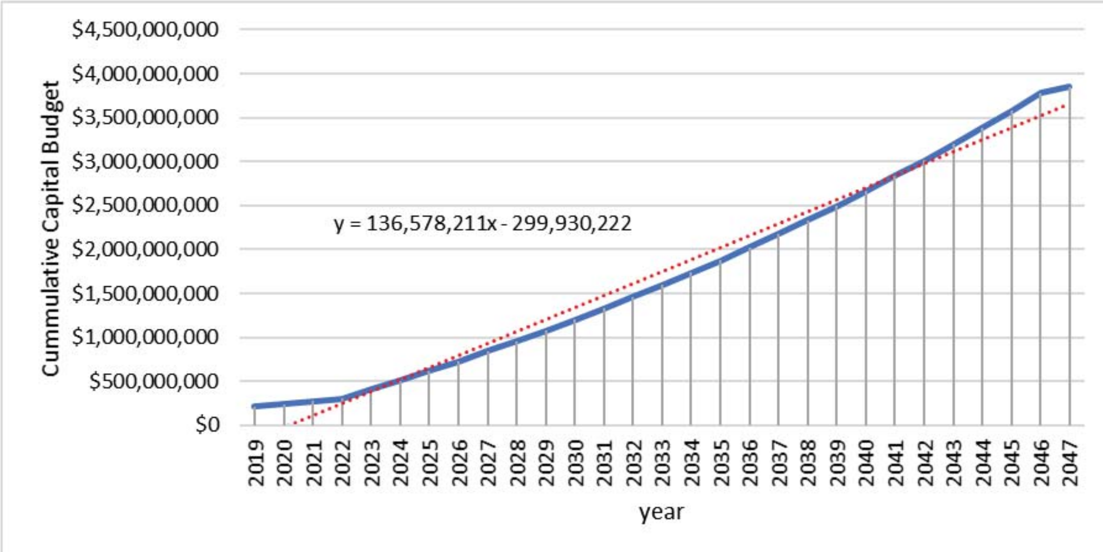

Figure 5-8. CSO Master Plan Cumulative Capital Budget with 3 Percent Inflation

The annual costs under the assumption of three-way capital cost sharing between the three levels of government will be within the $30,000,000 affordability limit identified by the City of Winnipeg. This affordability limit, and in turn cost sharing amounts with the three levels of government is assumed to increase due to inflation as part of these capital budget estimates with a year 25 inflated annual budget of approximately $199 million. There is a significant risk that this type of increase in the annual budget may not be sustainable.

5.2.2 Operations and Maintenance Budget

The additional operations and maintenance (O&M) budgeted costs associated with the projects recommended in the CSO Master Plan are considered separate from the capital cost budget. There is no target O&M budget value comparable to the capital budget, as operation and maintenance costs are a function of the control technologies selected and the timing of their implementation. The annual additional O&M budget variations in 2019 dollar terms, based on the project sequencing for Scenario 1, are shown in Figure 5-9. Upon completion of the program, the annual O&M costs in 2019 dollars terms will result in $4,490,000 additional annual O&M costs by the year 2048 in which all projects are complete.

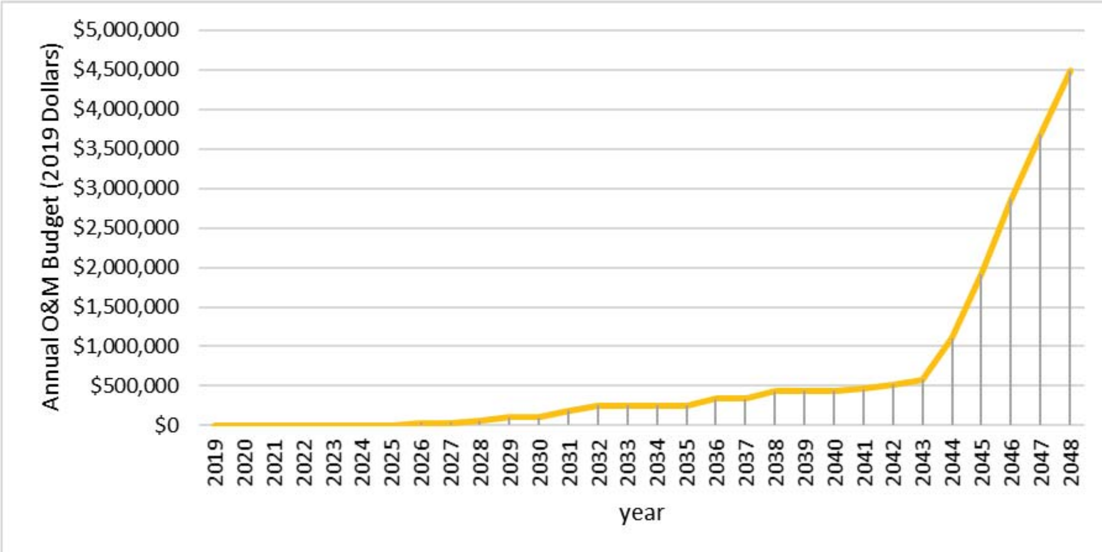

Figure 5-9. CSO Master Plan Additional Annual O&M Budget (2019-dollars)

The CSO Master Plan cumulative O&M costs under Scenario 1 are shown in Figure 5-10. Projects with higher O&M requirements have been scheduled to take place later in the program which is reflected in the figure. The steep rise in the operating budget results from the cumulative effect of having to operate and maintain the several new infrastructure components recommended in the CSO Master Plan.

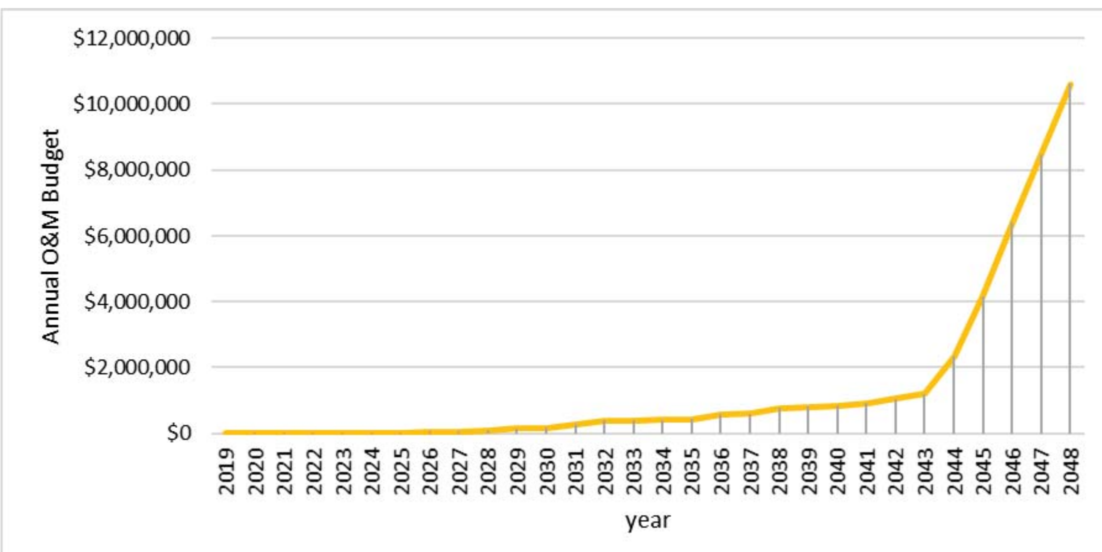

Figure 5-10. CSO Master Plan Additional O&M Budget Inflated at 3 Percent Annually

The estimated O&M costs shown in Figure 5-10 have been inflated to the year of expenditure at 3 percent annual inflation, the same as shown for the capital budgets. The inflated additional annual cost of O&M as a result of the works recommended in the CSO Master Plan, at the end of the implementation period in 2047, is estimated to be approximately $10,580,000 per year in 2048 dollars.

5.3 Monitoring and Reporting

Progress reporting for implementation of Control Option No. 1 - 85 Percent Capture in a Representative Year will be based on project completion performance modelled over time in comparison to that projected in the CSO Master Plan. Annual reporting will update on construction progress and the work plan for the subsequent year. Annual progress reporting is a requirement of EA No. 3042 Clause 13 and is stated as follows:

> *"The Licencee shall, upon approval of the Master Plan submitted pursuant to Clause 11 of this Licence, implement the plan such that progress towards meeting the required level of treatment is demonstrated annually by submission of an annual report, due March 31 of each year for the preceding calendar year. Annual submissions shall include the progress made on the plan pursuant to Clause 11 including monitoring results and the work plan for the subsequent calendar year."*

The reporting approach is dictated by selection of the percent capture performance metric. Each project of the CSO Master Plan will contribute to the percent capture improvements, and progress can only be tracked by the progress on their implementation.

The use of percent capture with the 1992 representative year means that compliance must be measured in terms of performance of the projects recommended in the hydraulic model of the sewer system, with the 1992 representative year conditions applied. The representative year will act as a benchmark where all current and future benefits will be measured against, and will not be reproducible in the natural environment. Although the representative year cannot be applied in the field; post construction monitoring will be used to verify the performance of the control options. This will include continued CSO monitoring and flow monitoring within each district where solutions have been implemented.

Real events can be measured and related to the representative year but must be used with caution because of the natural variation with these types of events. Any result or series of results that appears to over or under-perform relative to the representative year results is no guarantee that a trend is occurring and could easily change under future conditions.

Other performance metrics (including the actual volume of CSO, number of overflows, and water quality measurements) may be of interest during the reporting process but are not to be used for compliance tracking.

5.3.1 Current CSO Reporting

The City currently completes a quarterly and annual CSO reporting program to track variations and trends in system performance in terms of number and volume of CSO events throughout the year.

This reporting is based on actual rainfall and sewer system level field measurements via permanent instrumentation. Outfall monitoring instrumentation in combination with the city-wide sewer hydraulic model results are validated against each other to determine the volume and frequency of CSOs. These reports are submitted to MSD to comply with the EA No. 3042. The City also maintains reporting to MSD upon the occurrence of unique or significant events to comply with the EA Licence No. 3042. A unique or significant event is defined by the occurrence of a 10-year rainfall event within the limits of the City of Winnipeg.

5.3.2 CSO Master Plan Implementation Reporting

The City will continue with the current annual reporting process and will initiate the implementation progress reporting upon CSO Master Plan approval. The implementation reporting will include progress made on the plan, which will include the results of the updated hydraulic model to evaluate percent capture performance in comparison to the 1992 representative year. A summary of planned and completed projects and updates to a benefits register will also be included with these annual updates.

5.4 Dewatering and Treatment

The future CSO storage control solutions, lift stations, interceptor system, and STPs must function as an integrated system. Discharges from CSO storage facilities and lift stations must not overload the interceptors, and the interceptors must not overload the STPs; otherwise, CSOs will simply be relocated. The planning and management of these components is carried out through the dewatering strategy.

The approach requires that dewatering rates be developed for each combined sewer district, and that they operate within the interceptor and STP constraints. The strategy must also accommodate future growth for the separated sewer districts within the STP service area.

The CSO program will change the method and means of flow collection, and in turn overall volume of combined sewage captured in the CS system. An additional 2,300,000 m^3 of CSO will be diverted from the river to achieve 85 percent capture in the representative year. This includes 30,000 m^3, 230,000 m^3, and 2,010,000 m^3 additional volume capture for WEWPCC, SEWPCC and NEWPCC Service Areas respectively. This will encompass both an increase in captured combined sewage that is conveyed to treatment and the elimination of flow entirely entering the system because of selected district sewer separation. The reduction of flow from sewer separation benefits the whole system by increasing available capacity. The additional captured combined sewage will be gradually released to the interceptors and treatment systems to ensure these critical sewer system components are not overwhelmed. This additional level of control will require upgrading the existing system to optimize the flows, which ultimately forms the dewatering strategy.

The dewatering strategy was established for the NEWPCC as part of the Preliminary Proposal, as the NEWPCC services the majority of the combined sewage from the City. This approach has been applied to the smaller SEWPCC and West End Sewage Treatment Plant (WEWPCC) systems as well during the CSO Master Plan, to develop the dewatering strategy for the entire combined sewage sewer system. Further details on the Dewatering Strategy Approach can be found in Section 3.2 of the Part 2 – Technical Report.

5.4.1 Dewatering Upgrades

Dewatering rates were initially determined for each district based on the control options selected for the district and the requirement for a maximum dewatering time of 24 hours following the end of an overflow event. The analysis found that the capacity of all existing pumping stations will be sufficient to meet this 24 hour dewatering requirement. Even though there will be a larger volume pumped for each event, the maximum rate of pumping will be the same as currently exists, with the pumps being required to run for longer durations at the existing constant rate.

Several sewer districts do not have pumping stations and instead drain by gravity to the interceptor system. For these situations, gravity flow controllers are proposed to monitor and control the gravity discharge rate to the interceptor system. The analysis also indicated that these gravity discharge districts meet the dewatering capacity requirements. The existing offtake pipes within these gravity discharge districts are sufficiently sized currently to accommodate the 24 hour dewatering requirement.

The dewatering strategy implemented in the future assumes that a control system will be used to adjust pumping rates for each district to optimize the available conveyance and treatment capacity. This will require that monitoring and pumping rate controls be installed for each location. Pumping rates will range from diurnal dry weather low flows to the peak dewatering rates.

The dewatering strategy provides the opportunity to implement the RTC program opportunity in the future. This would be particularly effective for dealing with spatially distributed rainfalls, where districts receiving higher rainfall could dewater faster than those with low or no rainfall.

5.4.2 Wet Weather Flow Treatment Upgrades

The CSO program will have an impact on the three STPs through potential WWF increases that result from a change in the percent capture and dewatering strategy. The total WWF capture increase required to meeting the Control Option No. 1 target is equivalent to an increase of 33.9 percent in WWF collection. A 15.7 percent increase in total flow collection from the system is noted, considering DWF in the collection system.

For the NEWPCC, which has the largest potential for an increase in flows due to its large collection area, only a 2 percent increase in total flows is noted for the full representative year period. This equates to a 41.9 percent increase in wet weather collection and a 32.6 percent increase in total flow collection assessed during WWF events.

The CSO Master Plan maintains the assumption that the NEWPCC will be upgraded in the future to handle a 705 ML/d WWF treatment rate, and upgrading will be implemented and funded through the concurrent Winnipeg Sewage Treatment Program (WSTP).

The SEWPCC and WEWPCC serve relatively smaller CS areas than the NEWPCC, and there is no additional WWF treatment capacity required to meet the CSO Master Plan Dewatering Strategy.

5.5 City Investments Towards CSO Mitigation To Date

The CSO Master Plan project was initiated in 2013 and since that time the City has invested over $90 million in infrastructure and system upgrades with another $140 million committed for investment. The following list includes the type and value of investment implemented since the EA No. 3042 was issued in 2013.

- CSO Master Plan study and development - $5.4 million
- Interceptor Monitoring - $1.0 million
- District Flow Monitoring - $2.5 million
- Sewer Instrumentation - $0.5 million
- InfoWorks ICMLive - $0.4 million
- Sewer Relief Work - $74.0 million
    - Cockburn / Calrossie / Jessie - $53.0 million LDS separation
    - Ferry Road / Riverbend / Parkside / Douglas Park - $13.0 million LDS separation including the elimination of one CSO outfall in Douglas Park
    - Jefferson - $8.0 million LDS separation
- Latent Storage Dewatering Stations - $5.0 million
    - Bannatyne – McDermot SRS - $2.5 million
    - River – Fort Rouge SRS - $2.5 million
- Sewer Cleaning (outside of annual program)
    - Mission - $0.9 million
- Green Infrastructure
    - Bannatyne – North East Exchange Sustainable Drainage System - $0.5 million

Additional work has been completed outside of the CS area that also benefits the long term goals of the CSO Master Plan. This work has included:

- Upgrading the Northeast Interceptor river crossing to include a redundant crossing
- Installation of a relief sewer in the separate sewer districts surrounding the Transcona neighborhood

- Elimination of 20 cross connections between the WWS and LDS systems

5.6 Opportunities

A number of opportunities to improve the percent capture during the program were identified during the development of the CSO Master Plan. The main areas where additional gains in CSO reduction could be made are discussed in this section. Further background on each of these program opportunities can be found in the Part 2 – Technical Report.

5.6.1 Floatables Management

The CSO Master Plan includes end of pipe screening to the primary CS outfall in each combined sewer district, where it was determined to be hydraulically feasible and where complete sewer separation of the district was not recommended. In each applicable case, the primary outfall has an off-line screen installed that would capture floatables from the first flush of an overflow.

An alternative floatable management approach, focused on creating a floatables source control program and using public education to reduce floatables initially entering the sewer system has been developed by the City. This alternative approach may provide an opportunity to replace the need for end of pipe screens. The City will complete pilot studies of this alternative approach specifically in those districts where the installation of screens was determined to not be hydraulically feasible, with the goal to demonstrate and evaluate the potential of this alternative approach to replace the requirement for screening. The alternative approach to floatable management is described in more detail in Section 5.2.3 of the Part 2 - Technical Report.

5.6.2 Green Infrastructure and Climate Change Resiliency

EA No. 3042 includes a requirement to use green technology in the design and operation of all new and upgraded infrastructure. Similarly, the United States Environmental Protection Agency (US EPA) also recognizes the connection between Green Infrastructure (GI) and climate change with a publication *Green Infrastructure and Climate Change Collaborating to Improve Community Resiliency* (US EPA, 2016). This document provides a summary of a number of case studies held across the US to discuss climate change and GI.

GI technology applied as part of the CSO Master Plan has the potential to offset the impacts of climate change and reduce requirements for grey infrastructure. GI will also help in achieving the City's objectives for flood management and basement flooding. GI acts as additional storage volume for rain events and prevents runoff from entering the collection system and contributing to CSOs. This additional storage reduces the volume transferred to the STPs; reducing the sewage conveyance and treatment capacity impacts.

For the CSO Master Plan, GI has been included as a necessary component of all proposed projects. The scope of application for the various types of GI however will need be confirmed in the early stages of implementation. This will be completed through additional investigations that will determine the suitability of GI in Winnipeg, pilot green technologies, and monitor performance. The CSO Master Plan capital cost estimates have included a 10 percent allowance to allocate towards GI pilot testing, and future implementation work. Further detail on GI is included in Section 5.2.1 of the Part 2 - Technical Report.

5.6.3 Real Time Control

RTC is not required under EA No. 3042 but is recognized by the City as an opportunity to improve the operation of the system and further reduce CSO volumes. Due to Winnipeg's flat topography and large-diameter pipe network, the case for implementing an RTC program opportunity is strong. The CS area in the City represents approximately 32 percent of the sewer network. Rainfall events are not uniform across the entire area, which creates the opportunity to actively manage CS flow to temporarily delay flow to the interceptors. This would allow the interceptor to accommodate the additional flows from areas experiencing the rainfall event. RTC is generally based upon instruments placed throughout the sewer network and computer models to predict flow based on real time rainfall data and treatment flows at the STPs. An automated logic based component is then provided, where actuators open and close various valves and gates throughout the CS network based on levels and instrument readings in other areas. This allows the system to automatically restrict or accommodate flow from specific combined sewer districts based on the spatial variation of the rainfall event.

The CSO Master Plan includes recommendations for gravity flow controller installation for combined sewer districts with gravity flow to the interceptor, and installation of flow monitors and pumping controls on all lift stations. These measures specifically accommodate future RTC measures.

The primary program opportunity provided by RTC is from expanding to a global system so that the City of Winnipeg can respond to spatially distributed rainfalls and, potentially, to rainfall prediction. RTC is described in more detail in Section 5.2.2 of the Part 2 - Technical Report.

6. CSO Master Plan Implementation

The CSO Master Plan will be continually updated as the program is underway. This includes the requirement for a formal update to the plan in 2030. This Part 3 component of the overall CSO Master Plan is a living document and will be updated for each change in strategy and completed project. Each component of Part 3, including the individual DEPs, will be updated on a regular basis. This section describes the limitations, initial implementation steps and major changes that are planned or have occurred.

6.1 Design Limitations of Proposed Projects

The CSO Master Plan and the DEPs have been developed to a conceptual level of detail. The individual project selections and designs are based on the hydraulic model evaluations and high level assessments of constructability. It is expected that the proposed projects identified will change and adapt as further information is collected during the program implementation and individual project design studies. This process is illustrated in Figure 6-1.

Figure 6-1: Key Design Stages in Life of a CSO Project

The City plans to complete a number of additional evaluations based on the details presented in the DEPs to form the basis of further design and construction within each of the sewer districts. Each of the proposed projects will undergo a preliminary and detailed design stage to confirm their constructability. A potential approach to the design process would be for a collection of neighboring sewer districts to be further refined as a package during the preliminary design phase. Additional detail would be collected and evaluated to fully understand the existing sewer system and confirm selection of the optimal CSO control technology. This would be followed by detailed design where the parameters of the control technology would be finalized for construction.

Once constructed, each control option will be monitored to determine the level of performance achieved. This information will be input into the hydraulic model and applied as part of future design. System monitoring and operation and maintenance will continue for the life of the infrastructure.

6.2 Primary Implementation Tasks

There will be several responsibilities and areas of support required to implement the recommendations included in this CSO Master Plan. A list of the program management responsibilities is provided to support these future activities, with many of these tasks being dependent on future decisions as follows:

- **Administration:** The CSO program will require a high level of administration for budgeting, accounting, and reporting of routine activities.
- **Engineering Investigations:** The CSO Master Plan assumes that review, and acceptance of technologies will be completed within the implementation phase prior to some projects commencing. This includes review of control gates, flap gate control, screens and a floatables management approach, RTCs, and GI. Each of these will be evaluated within the program and may lead to pilot testing or demonstration projects.
- **Land Use Planning:** A continual process will be required to identify and account for changes to service areas, technologies, standards, and expectations, and to prepare for project implementation. Land acquisition and preliminary studies may need to take place several years before actual construction can begin.

- **Coordination:** The CSO program will impact and be impacted by other programs and services. By integration of the CSO and BFR program, the parameters for project prioritization and selection are affected. Additionally, large scale developments can impact option selection and implementation scheduling. Coordination must occur with the STPs and their upgrades . Construction projects, such as sewer construction work required as part of sewer separation, must routinely be coordinated with street works and traffic movement.
- **Project Delivery:** Alternative methods of project delivery need to be considered, as well as how studies are carried out and by whom. Conceptual designs and preliminary engineering are usually required before detailed design and tendering can commence.
- **Risk Management:** As with any large program, there are multiple risks and opportunities to be considered and dealt with. These will require management of risk responses and contingency budgets.
- **Regulatory Liaison:** The City has responsibility for reporting and responding to the Province on all matters related to the EA No. 3042. One of the major tasks will be to comply with the request for a CSO Licence update for migration to Control Option No. 2 by April 30, 2030.
- **Public Communication:** The projects associated with the CSO Master Plan recommendations will have a public engagement program focused on providing information and education as the works occur. It will be important to provide public notifications for construction works affecting the public.
- **Master Plan Maintenance:** The Master Plan is intended to be a living document. The information will be updated as the projects are completed and as new developments or redevelopments within the districts occur. Reprioritization of the projects may result from updates involving factors beyond the collections or treatment system. This is further detailed in Section 6.3 below.
- **Master Plan Update:** A formal update of the CSO Master Plan is required under EA No. 3042 by April 30, 2030. See Section 6.4 for further details of this update process.

A number of additional tasks and studies will be required prior to and during the CSO Master Plan implementation. These tasks are summarized as follows:

- **Real Time Control**: Collection system operation can be improved with the addition of RTC to the system. An evaluation of the best approach to RTC and how to integrate with the CSO Master Plan will be required.
- **Green Infrastructure**: The City intends to catalogue its existing GI asset inventory and evaluate the suitability of the types of GI for use in this climate.
- **Asset Surveys:** The City will continue to review and update the existing asset database. This includes weir heights, pipe connections, and pump arrangements.
- **Sewer Hydraulic Model Maintenance:** The InfoWorks hydraulic model of the entire City of Winnipeg sewer system will continue to be updated based on new asset information and implemented projects. Focused updates will occur to the districts anticipated to have the CSO Master Plan recommended solutions implemented in the immediate future.
- **Flow Monitoring:** The City will continue with its existing flow monitoring program. Data will be used to update the hydraulic model and to improve the understanding of the system. Flow monitoring will also be completed in districts in which the control options recommended have been implemented, to verify performance.
- **Asset Rehabilitation and Renewal:** Sewer cleaning and investigation will continue as part of the annual program. Gate chamber and lift station upgrades will also be continued.

6.3 CSO Master Plan Updates During Implementation

The CSO Master Plan is intended to be a "living" document to allow for changes over time. During implementation, the CSO Master Plan will be updated to reflect any changes made as a result of additional studies and analysis. Areas of the plan that are likely to have changes include the following:

- **Proposed Control Options:** Preliminary design is expected to include flow monitoring, hydraulic model refinement and calibration, and updated solutions. Detailed design will include the project design details required to tender and construct the work. Both phases of work must be completed prior to the implementation of any project.
- **Project Refinement and Innovation:** The proposed control options may change based on the results of pilot studies and from lessons learned with new technologies. New technologies are likely to be developed over the course of the program and should be reviewed for suitability.
- **Development:** The City is constantly changing and redevelopment within the combined sewer area will continue. This will include development and changes that were not known at the time of this study. Redevelopment will have to consider the impact to the sewer system and contribution to CSOs as part of the City's existing policy.
- **Reprioritization:** This plan has scheduled the implementation of projects based on work that is currently committed occurring first. The remaining projects are sequenced based on the level of additional CSO volume capture provided. There is potential for new information to reshape the direction of the plan, which will impact the project prioritization. The City of Winnipeg is actively working on a prioritization model that will evaluate the project sequences on a multitude of factors and will allow deviations to the project sequences as new information becomes available.

The CSO Master Plan will evolve throughout its implementation based the above points and numerous other external influences. The plan will be reassessed on a regular basis to maintain a high cost benefit ratio while achieving the CSO reduction target.

6.4 CSO Master Plan Update For Migration To Future Control Targets

The November 24, 2017 letter provided the Director's approval for the Preliminary Proposal recommendations, with the condition that "*Control Option No. 1 be implemented in such a way so that Control Option No. 2 may be eventually phase in.*" The letter required the submission of a CSO Master Plan for Control Option No. 1 - 85 Percent Capture In A Representative Year by August 31, 2019, and an update for Control Option No. 2 - Four Overflows In A Representative Year by April 30, 2030.

It is understood that the intent of the migration is to improve the performance of the combined sewer system in the City in terms of water quality. The change in the performance metric utilized for each control target creates additional risk. Specific impacts associated with upgrading to Control Option No. 2, and moving from a percentage capture to a number of overflows performance metric, are as follows:

- **Control Option No. 1 – 85 Percent Capture in a Representative Year:** This system-wide performance measure aligns with the City's current plans to continue with sewer separation in CS districts. It also accommodates selection of the most cost-effective project in other districts. The plan proposes that every one of the 41 districts will have at least some level of CSO control, but it will result in a wide range of performance. If it were most cost effective to have all CSO control within only a portion of the districts, this would be allowed with the percent capture performance measure.
- **Control Option No. 2 – Four Overflows in a Representative Year:** This option requires a maximum of four overflows in the representative year for each district. Projects completed to achieve the Control Option No. 1 performance may have to be further upgraded to meet the increased performance target. Projects in districts that are shown to have a low cost benefit may have to be completed.

To reduce the risk to the program, the City will maintain a percent capture approach on the basis that the Preliminary Proposal results show that Control Option No. 2 is approximately 98 percent capture. The estimated improvement in reduction of nutrient discharges between the two control options is marginal. The results however cannot confirm equivalent improvement in the number of days bacteria levels would exceed 200 MPN/100 ml. Water quality assessments for 98 percent capture must ultimately be completed to the same level of detail as Control Option No. 2. The assessment must demonstrate the equivalent percent capture target will result in an equivalent or better water quality conditions than Control Option No. 2. The City intends to carry out these evaluations as part of the 2030 Master Plan Update.

The City will continue implementation of the previously committed projects, which do not compromise the City's plan to meet future targets.

6.5 CSO Master Plan Update Process Summary

The steps planned for completing the Master Plan update prior to April 30, 2030 are listed as follows:

1) Submit the CSO Master Plan by August 31, 2019, in accordance with EA No. 3042 with the performance target based on Control Option No. 1 – 85 Percent Capture in a Representative Year.
2) Continue with the sewer separation projects identified in the CSO Master Plan through the initial period of implementation.
3) Complete the water quality performance evaluations and pilot studies to determine the percent capture required to meet the water quality performance identified for Control Option No. 2 in the Preliminary Proposal.
4) Collaborate with MSD regarding any changes necessary to the CSO Master Plan or EA No. 3042 in order to meet the required performance target.
5) Submit the updated CSO Master Plan before April 30, 2030, in accordance with EA No. 3042. The update will incorporate any agreed changes required to achieve Control Option No. 2 water quality performance equivalence.
6) Continued implementation of the updated CSO Master Plan following acceptance by MSD.

The update will also report on the results of the program since the submission of the CSO Master Plan in 2019. This aspect of the CSO Master Plan Update is expected to include the following:

- Update on results to date: volume of CSO, number of events, money invested.
- Discussion on path forward to meet the Control Option No. 2 water quality target.
- Conceptual cost estimate to move an increased capture rate beyond 85 percent.
- New timeline and implementation schedule for the migration to Control Option 2.
- Climate Change impacts assessed since 2019 CSO Master Plan submission.
- Update on pilot studies, alternative floatables management, RTC and GI program opportunities.

7. References

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CSO Master Plan

Part 3B – District Engineering Plans

August 2019

City of Winnipeg

CSO Master Plan

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1	08/02/2019	Final Draft Submission	SG	MF / DT	JB / DJT
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Contents

Acronyms and Abbreviations

CSO	Combined Sewer Overflow
DEP	district engineering plan
No.	Number
O&M	operations and maintenance

1. Introduction

1.1 Purpose

This document forms as part of the combined sewer overflow (CSO) Master Plan submission, specifically Part 3B – District Engineering Plans. Its purpose is to provide a summary of the scope and organization of the District Engineering Plans (DEPs) developed for each combined sewer district.

This is a supporting document to both the Part 3A – Master Plan Summary report and Part 3C –Standard Details that all form Part 3 of the CSO Master Plan. Part 3A of the CSO Master Plan provides a summary of the proposed Master Plan, while Part 3C describes the control option technologies selected as representative for use in the development of the CSO Master Plan.

Each of the DEPs for the 43 combined sewer districts are included in alphabetical order in Appendix A. The documentation includes information on the district as it currently exists as well as information on the planned CSO Master Plan upgrades developed.

The DEPs are identified as “living documents”. New information and modifications to the plans are to be completed as the preliminary and detailed design of solutions in specific districts are underway, and as specific projects are completed.

1.2 Background

The Province of Manitoba’s Environment Act Licence No. 3042 requires the development of detailed engineering plans as part of the CSO Master Plan submission. Clause 11 includes the following requirement:

> *The Licencee shall, on or before December 31, 2017, file a final Master Plan, including the detailed engineering plans, proposed monitoring plan, and implementation schedule for the approved design identified in the preliminary plan above. The Master Plan is to be filed for approval by the Director. The Licencee shall implement the plan by December 31, 2030, unless otherwise approved by the Director.*

This requirement was then confirmed in the Province’s written response to the Preliminary Proposal, submitted November 24, 2017:

> *Accordingly, please submit to me for approval a Master Plan including detailed engineering plans, proposed monitoring plans, and an implementation schedule for Control Option No. 1 as identified in your CSO Master Plan Preliminary Proposal on or before August 31, 2019 and for Control Option No. 2 as identified in your CSO Master Plan Preliminary Proposal on or before April 30, 2030.*

Although identified as “detailed” plans in the current licence and Preliminary Proposal response letter, the proposed control option solutions within each DEP included in this CSO Master Plan have been developed to a conceptual level of detail. This is considered suitable for the level of study completed during a master planning project of this nature. The preliminary and detailed levels of design will be completed for each of the solutions recommended in the DEPs once the specific solution is to be implemented in that district. As a result of this, the plans were suggested to be referred to as “district engineering plans” instead of detailed engineering plans, to avoid the potential confusion that would be assumed that the plans were at a detailed level of design. This approach was confirmed with Manitoba Sustainable Development at the June 15, 2018 Regulatory Working Committee meeting as part of the CSO Master Plan development.

A template structure for the content of the DEPs was also provided to Manitoba Sustainable Development at the June 15, 2018 Regulatory Working Committee meeting. This standard template was then utilized to streamline the creation of the remaining plans. This template will be maintained and used for future sewer planning efforts by the City Of Winnipeg in specific districts.

The DEPs identify and describe the proposed projects for each district that will achieve the 85 percent capture in a representative year target, but do not identify their order of implementation. The sequence of project implementation may be reordered at any time to accommodate potential changes to the CSO Master Plan in the future.

1.3 Overview of the District Engineering Plans

Each DEP is written as a standalone document, to allow for each DEP to be used independently. Each plan is organized in several sections to detail the existing system, planned work and the proposed project selection.

Each section of the DEPs is described as follows:

- **District Description:** Describes the sewer district location, land use, major landmarks and regional roadways. Features of historical, development or functional relevance are also described.
- **Development:** Includes a description of ongoing or planned developments that may impact the proposed solutions or present an opportunity for collaboration in relation to the CSO Master Plan work.
- **Existing Sewer System:** Describes the existing sewer collection system. A description of the existing collection system is provided in detail and gives a baseline understanding of the current sewer infrastructure for the district. Each district varies and may include any combination of a lift station, flood pumping station, weir diversion structures, gate and sluice chambers and outfall structures. Descriptions of the major flow pattern during dry weather and wet weather flow are also described. Interactions with other districts have been identified in figures within each plan and an overall district interaction overview map is provided as Appendix B.

  This section also includes a summary of existing asset data, district interconnections and critical asset data points relevant to the CSO Master Plan. Street locations, invert elevations, asset ID numbers are provided for reference for the district interconnections, as well as what district they flow to/from and whether they are gravity or pumped interconnections. Important features such as high point manholes are also provided.
- **Investment Work:** Describes previous investments and sewer related construction, or combined sewer studies completed in the district. It provides a summary of the district status in terms of data capture and lists the last study competed. This work might relate to basement flooding relief or the sewer infrastructure, flow monitoring or maintenance or calibration of permanent CSO monitoring instruments installed.
- **Control Option No. 1 Projects:** This section describes the solutions proposed for each sewer district, provides the specific details of the solutions and forms a fundamental component of the DEPs in relation to meeting the Control Option No. 1 performance target. Key design considerations are listed for each selected technology. Overview and detailed maps for the selected control options are included with each DEP to provide an indication of location and potential construction complexity.
- **Systems Operations and Maintenance:** Describes an overview of the operations and maintenance implications for each technology solution recommended in the sewer district to meet Control Option No. 1.
- **Performance Estimate:** This section summarizes the modelled performance of the proposed control solutions to provide justification of their selection. This section also provides a performance comparison to the Preliminary Proposal model results. Basic details of major updates or outstanding work within the hydraulic model for the specific district is also included, where applicable.
- **Cost Estimates:** Summarizes the capital cost estimates and provides a comparison of the capital cost estimates developed within the Preliminary Proposal. The operations and maintenance (O&M) costs are also documented, in terms of the 35-year present value cost of the O&M of the proposed

control options, and in terms of the average annual additional O&M costs in 2019 dollars. The overall CSO Master Plan cost estimate summary for the sewer districts is included as Appendix C for reference. A Basis of Estimate Technical Memorandum was developed and is included as Appendix C of the Part 2 report and documents the process that was used to develop the capital cost estimates in this section.

- **Meeting Future Performance Targets:** Describes the potential approach to meeting the future performance target of Control Option No. 2, as part of the 2030 CSO Master Plan update. A risk assessment is also included in this section in terms of the likelihood of complete separation being the only feasible solution to meet future performance targets.
- **Risks and Opportunities:** Identifies the risks and opportunities applicable to the control solutions recommended within each sewer district to meet Control Option No. 1. The applicable risks and opportunities specific to the sewer districts are also identified within this section where applicable. A description of each risk component as it applies for each control option type is identified in Appendix D.

Appendix A
District Engineering Plans

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CSO Master Plan

Alexander District Plan

August 2019

City of Winnipeg

CSO Master Plan

Project No:	470010CH
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3	08/20/2019	Final Submission For CSO Master Plan	MF	MF	SG

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1. Alexander District

1.1 District Description

Alexander district is located in the centre of the combined sewer (CS) area along the western edge of the Red River and north of Bannatyne district. Alexander is approximately bounded by Pacific Avenue and Elgin Avenue to the south, Xante Street and Trinity Street to the west, Higgins Avenue to the north, and the Red River to the east. The Canadian Pacific Railway (CPR) Mainline acts as the northern border crossing Main Street parallel with Higgins Avenue.

The land use within Alexander is distributed between industrial, multiple-use sector, and residential areas. General manufacturing exists north of Logan Avenue from Arlington Street to Stanley Street located next to the CPR Mainline. The residential sections include two-family and multi-family buildings and are located south of Logan Avenue, while the multiple-use sector is located in the eastern area of Alexander district. The National Microbiology Laboratory is the only institutional area in the district. China Town is included as part of the multiple-use sector and is located next to Main Street in the downtown area.

Main Street, Disraeli Freeway, Logan Avenue, Isabel Street, Sherbrook Street, and Arlington Street are regional transportation routes that pass through Alexander district. Greenspace within Alexander is limited due to the high residential and commercial density. Approximately 6 ha of the district is classified as greenspace. The more significant parcels of greenspace are identified as Central Community Centre, Pioneer Athletic Grounds, Dufferin Park, and a section of Fort Douglas Park on the riverbank.

1.2 Development

Alexander district includes a significant portion of the downtown area and the potential for redevelopment in the future is high. The OurWinnipeg development plan has prioritized the downtown for opportunities to create complete, mixed-use, higher density communities. Redevelopment within this area could impact the CS system and will be investigated on a case-by-case basis for potential impacts to the combined sewer overflow (CSO) Master Plan. All developments within the CS districts are mandated to offset any peak combined sewage discharge by adding localized storage and flow restrictions, in order to comply with Clause 8 of the Environment Act Licence 3042.

A portion of Main Street is located within the Alexander district. Portage Avenue is identified as Regional Mixed Use Corridor as part of the OurWinnipeg future development plans. As such, focused intensification along Main Street is to be promoted in the future.

A portion of the South Point Douglas Lands Major Redevelopment Site is located within the Alexander district. This site includes the lands adjacent to the Assiniboine River north of the Waterfront neighborhood. This Major Redevelopment Site is considered underused and will be prioritized to be developed into a higher density, mixed-use community.

Main Street, Princess Street, King Street, and Higgins Avenue within the Alexander district have been identified as part of the potential routes for the Eastern Corridor of Winnipeg’s Bus Rapid Transit. The work along these streets could result in additional development in the area. This could also present an opportunity to coordinate sewer separation works alongside the transit corridor development, providing further separation within the Alexander district. This would reduce the extent of the Control Options listed in this plan required.

1.3 Existing Sewer System

Alexander district encompasses an area of 157 ha[1] based on the district boundary GIS information, and includes a CS system and a storm relief sewer (SRS) system. Included in this area is approximately 1 ha that contains a separate land drainage sewer (LDS) system and is partially separated, and approximately 2 ha that is considered separation ready.

The Alexander district does not contain an independent lift station (LS) to transport intercepted CS, instead all CS intercepted by the primary weir is conveyed to the Interceptor system entirely by gravity. The CS system includes a diversion chamber, flood pump station (FPS) and CS outfall gate chamber..). The Alexander FPS and CS outfall are located next to the Red River at the end of Galt Avenue and Waterfront Drive. The diversion chamber is set further north from the CS outfall at Galt Avenue and Lily Street, and redirects flow from the CS to the Main Interceptor on Main Street. The CS system drains towards the Alexander CS outfall, located at the eastern end of Galt Avenue, where combined sewage is intercepted or may be discharged into the Red River under high wet weather flow (WWF) conditions. There are two main sewer trunks that connect at the diversion chamber. Sewage from the area west of Main Street is collected in a 1500 mm sewer trunk that extends along Logan Avenue. A 450 mm CS trunk collects sewage from a small area south of Galt Avenue and east of Main Street. The two sewers converge at the Lily Street diversion chamber and connect into a 600 mm interceptor that connects to the Main Interceptor on Main Street.

During WWF events, the SRS system provides relief to the CS system in Alexander district. The SRS system that extends through Alexander includes multiple interconnects with the SRS network in the Bannatyne district, where it is ultimately discharged into the Red River at the McDermot SRS outfall on the eastern end of McDermot Avenue within the Bannatyne district. Note there are no dedicated SRS outfalls within the Alexander district. The SRS system is installed in specific sections west of Main Street and connects to the CSs via interconnections with a system of high overflow pipes and weirs. Most catchbasins are still connected to the CS system, so no partial separation utilizing these SRS pipes has been completed.

During dry weather flow (DWF), the SRS system is not required; sanitary sewage is intercepted by the primary weir at the CS outfall and into the Alexander diversion chamber, where it flows by gravity through the 600 mm interceptor pipe to the Main Interceptor sewer and eventually flows to the North End Sewage Treatment Plan (NEWPCC) for treatment.

During wet weather flow (WWF), any flow that exceeds the primary diversion weir capacity overtops the weir, and is discharged through the gate chamber to the Red River. Within the gate chamber a sluice gate is installed on the CS outfall, along with a flap gate to restrict back-up from the Red River into the CS system. When the river level is high the flap gate makes it so that gravity discharge of excess CS which has overtopped the primary weir is not possible. Under these conditions the excess flow is instead pumped by the Alexander flood pumping station (FPS) to discharge to the river at a point downstream of the flap gate.

The one outfall to the Red River (one CS) is as follows:

- ID19 (S-MA70021229) – Galt CS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Alexander and the surrounding districts. Each interconnection is shown on Figure 01 and shows locations where gravity and pumped flow can cross from one district to another. Each interconnection is listed as follows:

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer mode. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System and in Section 1.8 Performance Estimate may occur.

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

Syndicate

- The 1950 mm Main Interceptor pipe flows by gravity north on Main Street into Syndicate district to carry sewage to the NEWPCC for treatment:
  - Invert at Syndicate district boundary 221.11 m (S-MH20017375)

1.3.1.2 Interceptor Connections – Upstream of Primary Weir

Bannatyne

- The 1950 mm Main Interceptor pipe flows by gravity north on Main Street into Alexander district to carry sewage to the NEWPCC for treatment:
  - Invert at Alexander district boundary 221.37 m (S-MH20017277)

1.3.1.3 District Interconnections

Aubrey

<u>CS to CS</u>

- A 375 mm CS flows east on Alexander Avenue from Alexander district into a 1450x1875 CS at the intersection of Alexander Avenue and Xante Street that enters Aubrey district:
  - Invert at Alexander district boundary 228.49 m (S-MH20017584)
- High point manhole:
  - Henry Avenue at Tecumseh Street – 229.96 m (S-MH20017866)
  - Logan Avenue – 228.77 m (S-MH20017639)
  - Pacific Avenue – 229.30 m (S-MH20017548)
  - Elgin Avenue – 229.49 m (S-MH20017513)

<u>SRS to SRS</u>

- An 1800 mm SRS flows east by gravity and a 375 mm SRS flows west on Alexander Avenue exit Alexander district and enter Aubrey district at the intersection of Alexander Avenue and Xante Street:
  - Invert at Alexander district boundary 224.43 m (S-MA20019577)
  - Invert at Aubrey district boundary 225.13 m (S-MH70028380)

Bannatyne

<u>CS to CS</u>

- A 375 mm CS flows northbound on Princess Street from Bannatyne district and connects to the CS system in Alexander district:
  - Invert at Bannatyne district boundary 227.44 m (S-MH20017220)
- High point CS manhole:
  - Arlington Street – 229.54 m (S-MH20016288)

<u>CS to SRS</u>

- A 450 mm CS flows by gravity north on Sherbrook Street. The manhole includes an interconnection to the Bannatyne SRS network with a 750 mm overflow SRS:
  - Invert at Bannatyne district boundary 227.67 m (S-MA70026573)

SRS to SRS

- A 450 mm SRS flows by gravity west on Ross Avenue to Tecumseh Street and connects to the SRS system in Alexander district:
  - Invert at Alexander district boundary 227.43 mm (S-MA70062533)
- A 525 mm SRS flows southbound by gravity from Alexander district into the Bannatyne district SRS network on Arlington Street:
  - Invert at Alexander district boundary 228.39 m (S-MH70028427)
- A 1200 mm SRS flows by gravity along Tecumseh Street and into Bannatyne district at the intersection of Tecumseh and Elgin Avenue, serving a section of Alexander district. It connects to the SRS system on William Avenue:
  - Invert at Alexander district boundary 227.03 m (S-MH70028468)
- A 1050 mm SRS flows southbound by gravity on Sherbrook Street, while a 450 mm SRS flows westbound on Ross Avenue. Both SRSs flow from Alexander district, into a manhole at the intersection of Sherbrook Street and Ross Avenue, and connect to the SRS system in Bannatyne district:
  - Invert at Bannatyne district boundary on Sherbrook Street 226.03 m (S-MH70028633)
  - Invert at Bannatyne district boundary on Ross Avenue 226.30 m (S-MA70062775)
- A 1050 mm SRS flowing southbound into Bannatyne by gravity on Isabel Street connects to the SRS network on William Avenue. The SRS interconnects with the CS system in Alexander district flowing south from Logan Avenue into Bannatyne Avenue:
  - Invert at Bannatyne district boundary 225.15 m (S-MH70032777)
- A 750 mm SRS flows from the SRS network in Alexander district into Bannatyne district by gravity on Ellen Street:
  - Invert at Bannatyne district boundary 224.90 m (S-MH70029529)
- A 750 mm SRS consisting of a weir overflows during high rainfall events at the corner of Princess Street and Rupert Avenue and flows by gravity eastbound on Rupert Avenue to connect to the SRS system in Bannatyne district:
  - Invert at Alexander district boundary 225.39 m (S-MH70045620) Weir height – 227.15 m
- A 900 mm SRS flows by gravity south on King Street from Alexander district and crosses into Bannatyne district at the intersection of King Street and Pacific Avenue:
  - Invert at Bannatyne district boundary 224.59 m (S-MH70045558)

LDS to LDS

- A 525 mm LDS serves the National Microbiology Laboratory between Alexander Avenue and William Avenue. The LDS flows by gravity into Bannatyne and connects to the SRS network in Bannatyne at the corner of Tecumseh Street and Elgin Avenue:
  - Invert at Bannatyne district boundary 229.33 m (S-MH70008110)
- A 450 mm LDS flows south into Bannatyne district at the intersection of Pacific Avenue and Waterfront Drive and is discharged to the main Bannatyne CS outfall:
  - Invert at Bannatyne district boundary on Waterfront Drive 225.92 m (S-MH70014314)

LDS to SRS

- A 300 mm LDS flows by gravity east into Bannatyne and connects to the SRS system in Bannatyne at the corner of Tecumseh Street and Elgin Avenue:
  - Invert at Bannatyne district boundary 230.10 m (S-MA70022800)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing system.

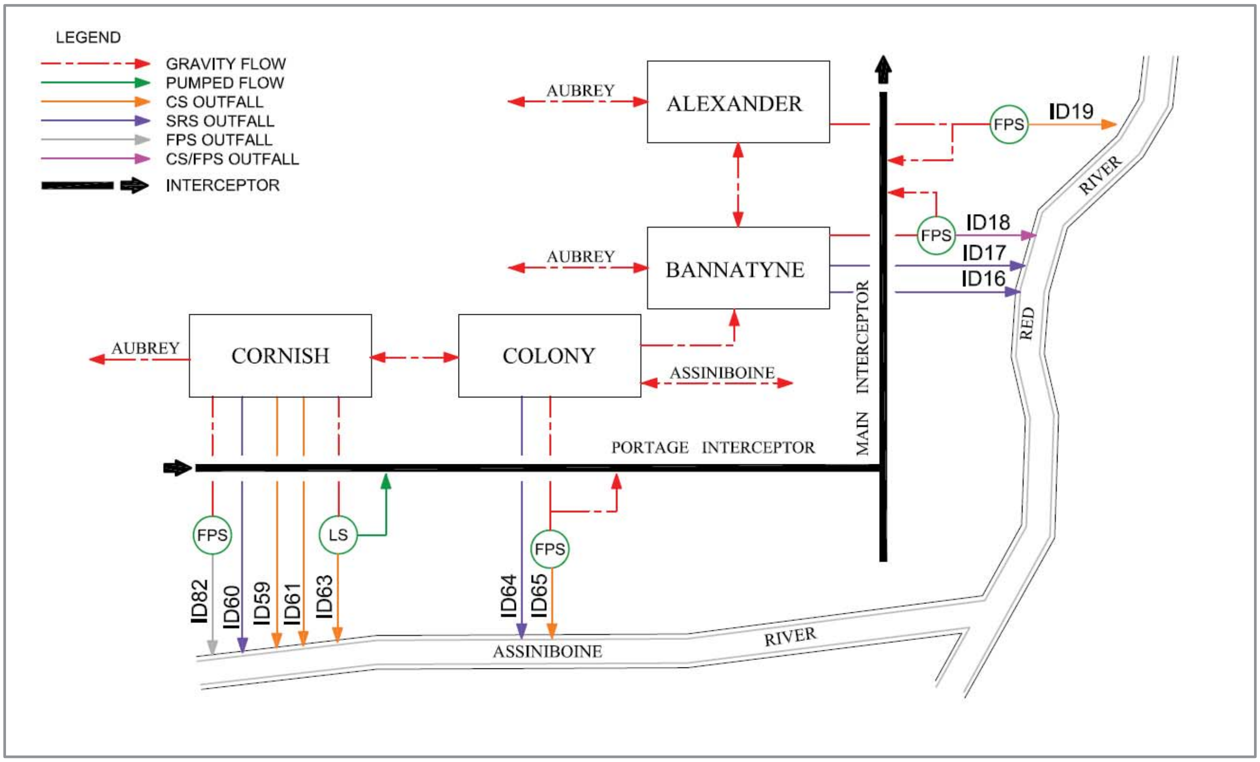

Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 01 and listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID19)	S-AC70009998.1	S-MA70021229	1500 mm	Red River Invert: 223.88 m
Flood Pumping Outfall (ID19)	S-AC70009998.1	S-MA70021229	1500 mm	Red River Invert: 223.88 m
Other Overflows	N/A	N/A	N/A	
Main Trunk	S-MH20012121.1	S-MA70021213	1500 mm	Circular Invert: 224.03 m
SRS Outfalls	N/A	N/A	N/A	No dedicated SRS outfall in this district.
SRS Interconnections	N/A	N/A	N/A	36 SRS - CS
Main Trunk Flap Gate	S-AC70009987.1	S-CG00001074	1500 x 1500 mm	Flap gate size Invert: 224.37 m
Main Trunk Sluice Gate	ALEXANDER_GC.1	S-CG00001073	1500 x 1500 mm	Invert: 223.78 m
Off-Take	S-TE70007762.2	S-MA70016914	600 mm	Invert: 224.57 m
Dry Well	N/A	N/A	N/A	Diversion structure, no LS as part of outfall.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Lift Station Total Capacity	N/A	S-MA70016914 (1)	600 mm (1)	600 mm gravity pipe relied on for pass forward flow, capacity 0.5 m^3/s(2) (downstream 300mm sluice – capacity 0.35 m^3/s)
ADWF	N/A	N/A	0.0346 m^3/s	
Lift Station Force Main	N/A	N/A	N/A	Diversion structure, no lift station force main as part of outfall.
Flood Pump Station Total Capacity	N/A	N/A	0.920 m^3/s	1 x 0.52 m^3/s 1 x 0.400 m^3/s
Pass Forward Flow – First Overflow	N/A	N/A	0.220 m^3/s	

Notes:

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

(1) Gravity pipe replacing Lift Station as Alexander is a gravity discharge district

(2) Between diversion chamber and main interceptor sewer there is a modelled 300 mm sluice that needs to be investigated. The sluice further limits the pass forward flow to 0.35 m^3/s.

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Alexander – 223.72
2	Trunk Invert at Off-Take	224.57 (diversion chamber)
3	Top of Weir	224.94
4	Relief Outfall Invert at Flap Gate	N/A
5	Relief Interconnection (S-MH70029532)	226.34
6	Sewer District Interconnection (Bannatyne)	221.37
7	Low Basement	228.60
8	Flood Protection Level (Alexander, Bannatyne)	229.78

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed in Bannatyne was the *Alexander and Bannatyne Combined Sewer Districts Sewer Relief and CSO Abatement Study* (AECOM, 2009). The study's purpose was to identify and recommend sewer relief and CSO abatement options for the Alexander and Bannatyne districts. Sewer relief projects completed as part of the basement flood relief program were last completed in 2010. An SRS latent storage pump system was installed near the McDermot SRS outfall in 2014 and has been undergoing operational evaluations since that time.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently installing instruments in the primary CSO outfalls. The Galt outfall from the Alexander CS district was included as part of this program. Instruments installed at each of the thirty nine primary CSO outfall locations have a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Expected Completion
7 – Bannatyne	2009[a]	Future Work	2013	Study Complete	N/A

[a] = Sewer relief projects: Contracts 1B, 1A, 2A, 2B, 3A, 3B, 4, 5 & 8 completed associated with this study

1.5 Ongoing Investment Work

There are plans to replace the existing diversion structure for the Galt outfall at Lily Street and Galt Avenue. As part of this work, a new off-take pipe is to be constructed leading to the interceptor for the district. This work is anticipated to take place in the next five years.

There is ongoing maintenance and calibration of permanent instruments installed within the Galt primary outfall within the Alexander district. This consists of monthly site visits in confined entry spaces to verify that physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Assiniboine district are listed in Table 1-4. The proposed CSO control projects will include gravity flow control, screening, and floatable management. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	-	-	✓	-	✓ [a]	-	-	-	✓	✓	✓

Notes: [a] = screening only, existing high-level weir

- = not included

✓ = included

The existing CS system in the Alexander district has a high level primary weir already installed. Therefore in-line storage has not been recommended in this district.

A gravity flow controller is proposed on the CS system to allow the dewatering rate from the district back into the Main Street interceptor to be monitored.

Floatable control will be necessary to capture any undesirable floatables in the sewage. All primary overflow locations are to be screened under the current CSO control plan, installation of a screening chamber will be required for the screen operation, and the existing weir will provide the mechanism for continuing capture of the existing in-line storage. In the Alexander district, a high level weir is currently in operation and the screen will be situated downstream of this structure.

GI and RTC will be applied within each district on a system-wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Gravity Flow Control

Alexander district does not include a lift station (LS) and discharges directly to the Main Interceptor by gravity. A flow control device will be required to control the diversion rate for future RTC and dewatering assessments. A standard flow control device was selected as described in Part 3C.

The flow controller will be installed at an optimal location downstream of the diversion chamber at the intersection of Galt Avenue and Lily Street. Figure 01-02 identifies a conceptual location for flow controller installation. A small chamber or manhole with access for cleaning and maintenance will be required. The flow controller will operate independently and require minimal operation interaction. The diversion weir at the CS outfall may have to be adjusted to match the hydraulic performance of the flow controller.

A gravity flow controller has been included as a consideration in developing a fully optimized CS system as part of the City's long-term objective. The operation and configuration of the gravity flow controller will have to be further reviewed for additional flow and rainfall scenarios.

1.6.3 Floatables Management

Floatables management may require installation of a screening system to capture floatable materials. The off-line screens would be designed to maintain the current level of basement flooding protection.

The type and size of screens depend on the LS and the hydraulic head available for operation. A standard design was assumed for screening and is described in Part 3C. The design criteria for screening, with gate control implemented, are listed in Table 1-5.

Table 1-5. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Top of Gate (Existing Weir)	224.94 m	Existing Static Weir Level
Normal Summer Water Level	223.72 m	
Maximum Screen Head	1.22 m	
Peak Screening Rate	0.74 m^3/s	Bypass to be installed to match district first flush peak flow rate
Screen Size	1.5 m x 1.0 m	Modelled Screen Size

The proposed screening chamber would be located within the existing combined trunk sewer downstream of the primary weir, as shown on Figure 01-01. The screens would operate once levels within the sewer surpassed the existing primary weir elevation. The overflow will continue to be directed to the outfall, with the screens located in the new screening chamber, with screened flow discharged to the upstream side of the existing gate to the river. The screening chamber would include screening pumps with a discharge returning the screened material back to the interceptor and on to the NEWPCC for removal. This would require a force main to be installed along Galt Avenue from the FPs to the downstream side of the gravity flow controller. A bypass would also be installed to limit the overflow volume to be screened to match that of the other proposed screening units in the system. The dimensions for the screen chamber to accommodate influent from the existing overflow CS sewer, the screen area, and the routing of discharge piping 3.2 m in length and 3.1 m in width.

1.6.4 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography, and soil classification for the district will be reviewed to identify applicable GI controls.

Alexander has been classified as a low to medium GI potential district. Land use in Alexander is mix of residential, commercial, and institutional, the east end of the district is bounded by the Red River. This district would be an ideal location for cisterns/rain barrels, and rain garden bioretention. There are a few commercial areas which may be suitable to green roofs and parking lot areas which would be ideal for paved porous pavement.

1.6.5 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

The flow controller will require the installation of a chamber and flow control equipment. Monitoring and control instrumentation will be required. The flow controller will operate independently and require minimal operation interaction. Regular maintenance of the flow controller chamber and appurtenances will be required.

Floatable control with outfall screening will require the addition of another chamber with screening equipment installed. The chamber will be installed downstream of the primary weir. Screening operation will occur during WWF events that surpass the in-line storage control level. WWF would be directed from the main outfall trunk and directly through the screens to discharge into the river. The screens will operate intermittently during wet weather events and will likely require operations review and maintenance after each event. The frequency of a screened event would correlate to the number overflows identified for the district. Having the screenings pumped back to the interceptor system via a small LS and force main will be required. The screenings return will require O&M inspection after each event to assess the performance of the return pump system.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. An individual model was created to represent the sewer system baseline as represented in the year 2013 and a model for the CSO Master Plan with the control options implemented in the year 2037. A summary of relevant model data is summarized in Table 1-6.

Table 1-6. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	157	157	3,212	74	N/A
2037 Master Plan – Control Option 1	157	157	3,212	74	SC

Notes:

SC – Screening

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1,8 Performance Estimate may occur.

The performance results listed in Table 1-7 are for the hydraulic model simulations using the year-round 1992 representative year. This table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan – Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. Table 1-7also includes overflow volumes specific to each individual control option: these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-7. Performance Summary – Control Option 1

Control Option	Preliminary Proposal	Master Plan			
	Annual Overflow Volume (m^3)	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [a]
Baseline (2013)	20,726	26,851	-	16	0.220 m^3/s
Control Option 1	**18,134**	**26,142**	**708**	**15**	**0.225 m^3/s**

[a] Pass forward flows assessed on the 1-year design rainfall event.

The percent capture performance measure is not included in Table 1-7, as it is applicable to the entire CS system and not for each district individually.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-8. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 to plus 100 percent.

Table 1-8. Cost Estimate – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period)
Screening	- [a]	$2,680,000 [c]	$30,000 [c]	$650,000
Gravity Flow Control	N/A [b]	$1,280,000	$35,000	$740,000
Subtotal	**N/A**	**$3,960,000**	**$65,000**	**$1,390,000**
Opportunities	N/A	$400,000	$6,000	$140,000
District Total	**N/A**	**$4,360,000**	**$71,000**	**$1,530,000**

[a] Solution developed as refinement to Preliminary Proposal work following submission of Preliminary Proposal costs. Costs for this item of work found to be $600,000 in 2014 dollars
[b] Gravity Flow Control not included in the Preliminary Proposal

[c] Cost for bespoke screenings return pump not included in Master Plan as will depend on selection of screen and type of screening return system selected

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional cost for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014-dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019-dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-9.

Table 1-9. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Screening	Screening was not included in the preliminary estimate	Added to the Master Plan
	Gravity Flow Control	A flow controller was not included in the preliminary estimate	Added for the Master Plan to further reduce overflows and optimize in-line storage provided.
Opportunities	A fixed allowance of 10 percent has been included for program opportunities.	Preliminary Proposal estimate did not include a cost for GI opportunities.	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management approach.	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation.	Preliminary Proposal estimates were based on 2014-dollar values.	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, the future performance target is 98 percent capture for the representative year measured on a system-wide basis. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-10 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified in Control Option 1.

Overall the Alexander district would be classified as a low potential for implementation of complete sewer separation as the only feasible approach to achieve the 98 percent capture in the representative year future performance target. Opportunistic separation of portions of the district may be achieve with synergies with other major infrastructure work to address future performance targets. To achieve additional future volume capture, an off-line storage element such as underground tank or storage tunnel with associated dewatering pump infrastructure would be proposed. In addition, green infrastructure could potentially be utilized in key locations to provide additional storage and increase capture volume as necessary.

Table 1-10. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Opportunistic Separation • Off-line Storage (Tank/Tunnel) • Increased use of GI

The control option for the Alexander district has been aligned to the primary outfalls being screened under the current CSO 85 percent capture control plan. The expandability of this district to meet the 98 percent capture would be assessed based on a system wide basis. The applicability of the listed migration options will be stepped than full district solutions.

The cost for upgrading to meet an enhanced performance target depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-11.

Table 1-11. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	-	-	-	-	-	-	-
2	Existing Lift Station	-	-	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	-	-	-	-
4	Construction Disruption	-	-	-	-	-	-	-	-
5	Implementation Schedule	-	-	-	-	-	-	R	-
6	Sewer Condition	-	-	-	-	-	-	-	-
7	Sewer Conflicts	-	-	-	-	-	-	-	-
8	Program Cost	-	-	-	-	-	-	-	O
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	-	-	-	-	-	O	O	-
12	Operations and Maintenance	-	-	-	-	-	R	O	R
13	Volume Capture Performance	-	-	-	-	-	O	O	-
14	Treatment	-	-	-	-	-	O	O	R

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

AECOM. 2009. *Alexander and Bannatyne Combined Sewer Districts Sewer Relief and CSO Abatement Study*. Prepared for the City of Winnipeg. April.

LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Low CS Manhole
- Low SRS Connection

Inter-System Connection
- CS - LDS
- CS - WWS
- SRS - CS
- SRS - LDS

District Boundary Crossing
- CS
- LDS
- SRS
- WWS

- Extent of Existing In-line Storage
- Interceptor Sewer
- Force Main
- Street
- Railway

- District Boundary
- Watercourse
- Greenspace
- City Owned Land

CSO MASTER PLAN PROPOSED SOLUTIONS

- Screening
- Flow Controller

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 01
District Overview Map
Sewer District: Alexander
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- Primary Weir
- CSO Outfall
- Manhole
- Flap Gate
- Sluice Gate
- Pump Location

Sewer By Type
- CS
- LDS
- WWS

Pump Station Type
- Flood Pump Station

CSO MASTER PLAN
PROPOSED SOLUTIONS
- Screening

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 01-01
Screening
Sewer District: Alexander
City of Winnipeg
Combined Sewer Overflow Master Plan

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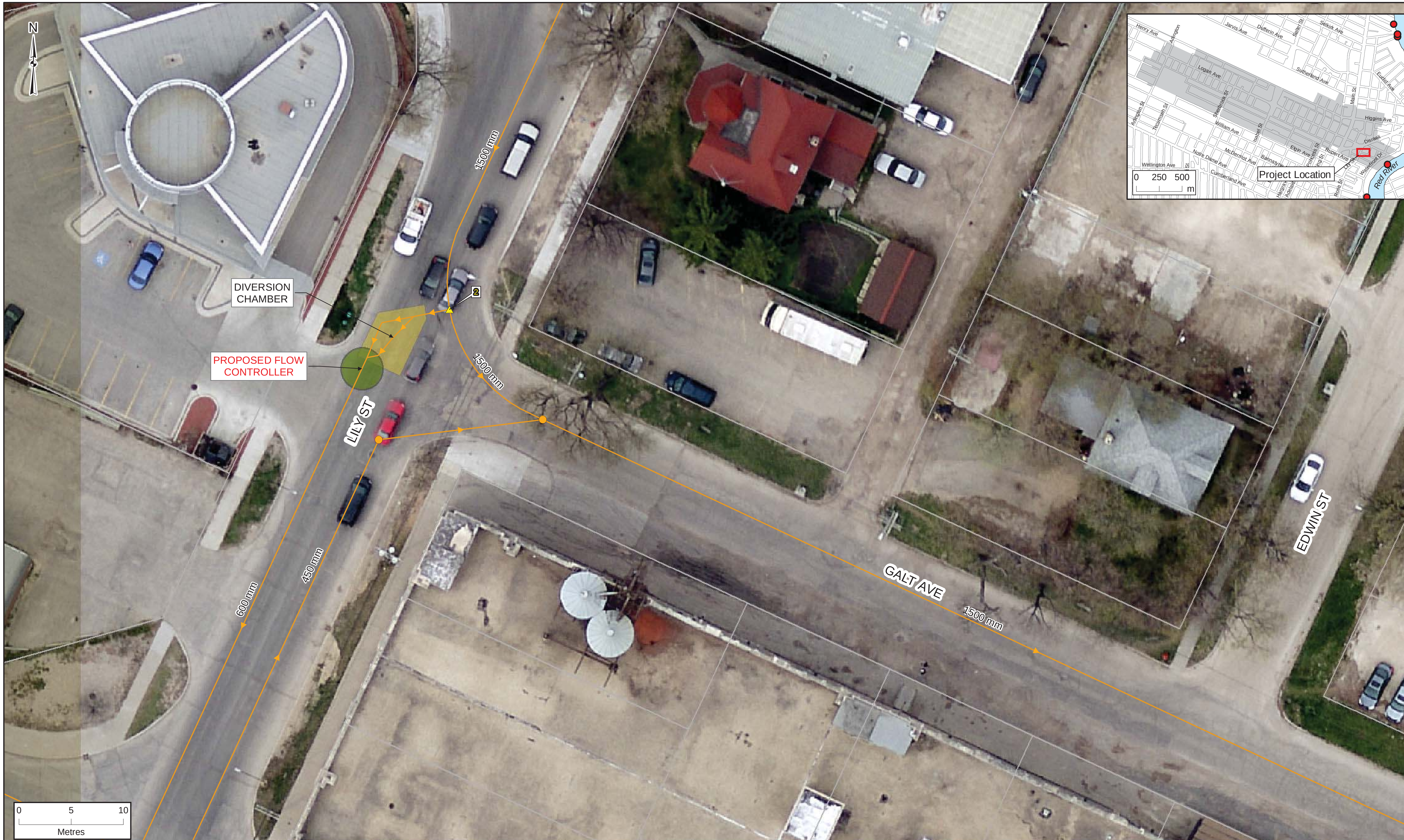

LEGEND

Critical Elevation	Sewer By Type	Pump Station Type	Land Parcel
Manhole	CS	Diversion Chamber	

CSO MASTER PLAN
PROPOSED SOLUTIONS

Flow Controller

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 01-02
Flow Controller
Sewer District: Alexander
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Armstrong District Plan

August 2019

City of Winnipeg

JACOBS

CSO Master Plan

Project No:	470010CH
Document Title:	Armstrong District Plan
Revision:	03
Date:	August 19, 2019
Client Name:	City of Winnipeg
Project Manager:	John Berry
Author:	Jack Tinker
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Document History and Status

Revision	Date	Description	By	Review	Approved
0	09/14/2018	Version 1 DRAFT	JT	SB, MF, SG	
1	02/15/2019	DRAFT 2 for City Review	JT	SG	MF
2	08/13/2019	Final Draft Submission	DT	MF	MF
3	18/19/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

Tables

Figure

1. Armstrong District

1.1 District Description

Armstrong district is located in the northern section of the combined sewer (CS) area to the west of the Red River. The district is bounded by Leila Avenue and the Canadian Pacific Railway (CPR) Winnipeg Beach to the north, McPhillips Street to the west, King Sudbury Avenue to the south, and Main Street to the east.

Armstrong district primarily includes residential area with the majority being single-family residential. The residential area is mainly located east of Sinclair Street. This district also includes commercial areas including a section of the Garden City Shopping Centre adjacent to McPhillips Street.

The CPR Winnipeg Beach line passes through the southern end of Armstrong District. Salter Street, McGregor Street, McPhillips Street, and Main Street are regional transportation routes running north to south on either side of the district, with Partridge Avenue and Leila Avenue being regional routes running east to west. Armstrong district has approximately 24 ha of greenspace including Garden City Park, Margaret Park, and Vince Leah Park.

1.2 Development

A portion of Main Street is located within the Armstrong District. Main Street is identified as Regional Mixed Use Corridor as part of the OurWinnipeg future development plans. As such, focused intensification along Main Street is to be promoted in the future.

One area within the Armstrong combined sewer district, the Garden City Shopping Centre at the intersection of McPhillips Street and Leila Avenue, has been identified as a Regional Mixed-Use Centre as part of OurWinnipeg. As such, focused intensification within this Mixed Used Centre is to be promoted in the future, with a particular focus on mixed use development.

1.3 Existing Sewer System

Armstrong district encompasses an approximate area of 151 hectares (ha)[1] based on the district boundary and includes a CS system and a storm relief sewer (SRS) system. This district does not include any areas that have separate land drainage sewer (LDS) systems or that could be considered separation ready.

The CS system includes a diversion structure and one CS outfall. All system flows collected are routed to the diversion structure located at the intersection of Main Street and Armstrong Avenue. A 2700 mm circular CS trunk collects combined sewage from all the areas west of Main Street within the Armstrong district. There is a 600 mm CS servicing the north part of the district between Main Street to Aikins Street.

During dry weather flow (DWF), sanitary sewage from the Armstrong district flows into the diversion chamber upstream of the CS outfall. Flows are diverted by the primary weir to a 600 mm secondary offtake pipe which reduces to 525 mm before it flows into the Main Interceptor and to the North End Sewage Treatment Plant (NEWPCC) for treatment.

During wet weather flow (WWF), flows that exceed the diversion capacity overtops the weir and is discharged into the river through the outfall. Sluice and flap gates are installed on the outfall to prevent river water from backing up into the CS system when the Red River levels are particularly high. However not only does the flap gate prevent river water intrusion, but it also prevents gravity discharge from the

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

Armstrong CS outfall. Under these conditions of high river level the excess flow is pumped by the Newton FPS to a point in the Armstrong CS Outfall downstream of the flap gate, where it can be discharged to the river by gravity. Temporary flood pumps are to be installed in the Armstrong district based on the flood manual high river level triggers to deal with situations such as this.

An interconnection with the Newton district is present near the diversion to allow flow from Armstrong to flow into Newton immediately upstream of the primary weir for the Armstrong district. This provides the operational ability to utilize the Newton flood pump station (FPS) to dewater Armstrong during WWF and high river level conditions when gravity discharge through the Armstrong CS outfall is not possible. This connect is kept closed and currently only used by operations for maintenance activities.

A portion of the separate sewer districts west of the Armstrong district are serviced by the Leila CS trunk sewer, and are ultimately intercepted by the Armstrong CS system This includes the entire Maples residential neighbourhood, and the Leila-McPhillips Triangle Shopping Centre/residential area. The LDS trunk sewers from these separate sewer districts connect directly to the Leila CS trunk at two locations. A 1350 mm diameter, 525 mm diameter, and 2700 mm diameter LDS sewer each connect at the intersection of Leila Avenue and Watson Street. A 1200 mm LDS sewer then connects at the intersection of McPhillips Street and Leila Avenue. A number of smaller diameter LDS systems connect into the CS trunk along Leila from the north. The wastewater from these separate sewer districts is conveyed to treatment via the Northwest Interceptor system.

The one outfall to the Red River (CS) is as follows:

- ID36 (S-MA00017633) – Armstrong CS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Armstrong and the surrounding districts. Each interconnection is shown on Figure 2 and shows locations where gravity flow can cross from one district to another. Each interconnection is listed as follows:

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

Riverbend Park (Area 9 NW)

- The 2250 mm Main Interceptor pipe flows north by gravity on Main Street from the Armstrong district to the Riverbend Park) district:
  - Invert at Armstrong district boundary 215.85 m (S-MH00000791)

1.3.1.2 Interceptor Connections – Upstream of Primary Weir

Newton

- The 2250 mm Interceptor pipe flows north by gravity on Main Street into the Armstrong district to the NEWPCC:
  - Invert at Newton district boundary 216.61 m (S-MA00000807)

1.3.1.3 District Interconnections

Maples (Area 3 [NW])

<u>LDS to CS</u>

- The 2700 mm LDS main sewer trunk flows by gravity east on Leila Avenue into the Armstrong district:
  - Invert at the Maples (Area 3 (NW)) district boundary 226.54 m (S-MA00002447)

Templeton (Area 6 (NW))

LDS to CS

- The 1500 mm LDS pipe flows south by gravity on Garden Park Drive into the Armstrong district:
  - Invert at the Armstrong district boundary 226.29 m (S-MA00001940)
- The 1350 mm LDS pipe flows south by gravity on Sinclair Street into the Armstrong district:
  - Invert at the Armstrong district boundary 226.22 m (S-MA70031211)
- The 1200 mm LDS pipe flows south by gravity on McGregor Street into the Armstrong district:
  - McGregor Street at Miravista Drive – 225.75 m (S-MH00001441)
- The 900 mm LDS pipe flows south by gravity on Diplomat Drive into the Armstrong district:
  - Invert at the Armstrong district boundary 225.85 m (S-MA00001592)
- The 525 mm LDS pipe flows south by gravity on Ambassador Row into the Armstrong district:
  - Invert at the Armstrong district boundary 226.54 m (S-MA00001635)
- The 450 mm LDS pipe flows south by gravity on Monsey Street into the Armstrong district:
  - Invert at the Armstrong district boundary 226.50 m (S-MA00001439)

Newton

CS to CS

- The 2700 mm CS main sewer trunk flows east on Armstrong Avenue out of the Armstrong district towards the Armstrong CS outfall located at the far end of Armstrong Avenue:
  - Invert at the Armstrong district boundary 223.58 m (S-MA00000802)
- The 1350 mm CS pipe diverts south onto Main Street into Newton district and connects to the Newton CS network (this connection is normally kept closed and only used for operational maintenance):
  - Invert at the Armstrong district boundary 225.03 m (S-MA00000789)
- The 600 mm CS pipe flows south by gravity on Main Street into the Armstrong district:
  - Invert at the Armstrong district boundary 224.64 m (S-MA00000784)
- The 450 mm CS pipe flows south by gravity on Main Street into the Armstrong district:
  - Invert at the Armstrong district boundary 225.55 m (S-MA00000779)
- The 450 mm CS pipe flows south by gravity on Main Street out of the Armstrong district:
  - Invert at the Armstrong district boundary 225.55 m (S-MA00000930)
- The 600 mm CS pipe flows east by gravity though Beeston Drive onto Main Street into the Newton district:
  - Invert at the Newton district boundary 225.67 m (S-MA00000869)

Jefferson East

CS to CS

- The 300 CS pipe flows south by gravity on Powers Street into the Armstrong district:
  - Invert at the Jefferson East district boundary 227.31 (S-MA00001541)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, flow controls, pumping systems, and discharge points for the existing system.

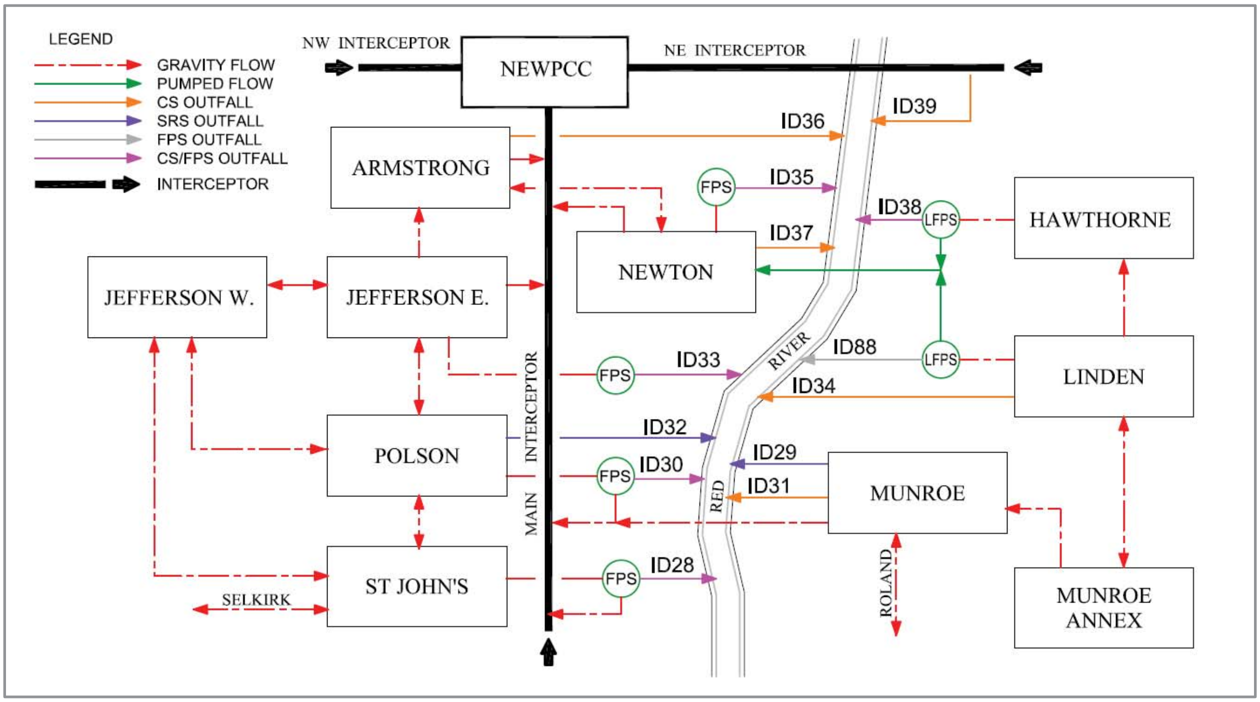


Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 02 and listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID36)	S-MH00002352.1	S-MA00017633	2700 mm	Red River Invert: 221.79 m
Flood Pumping Outfall	N/A	N/A	N/A	No Flood Pump Station in this district.
Other Overflows	N/A	N/A	N/A	
Main Trunk	S-TE00000258	S-MA00000755	2700 mm	Main CS that flows east on Armstrong Avenue Circular Invert: 223.58 m
SRS Outfalls	N/A	N/A	N/A	No SRS within this district.
SRS Interconnections	N/A	N/A	N/A	No SRS within this district.
Main Trunk Flap Gate	S-CG00000773.1	S-CG00000773	1800 mm	Invert: 222.74 m Circular
Main Trunk Sluice Gate	S-CG00000772.1	S-CG00000772	1800 mm	Invert: 222.42 m Square
Off-Take / Diversion	S-MH00000681.2	S-MA70021108	600 mm	Invert: 223.58 m
Dry Well	N/A	N/A	N/A	No lift station within Armstrong.
Lift Station Total Capacity	N/A	S-MA70021108 (1)	600 mm (1)	0.57 m3/s (1)
ADWF	N/A	N/A	0.011 m^3/s	

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Lift Station Force Main	N/A	N/A	N/A	
Flood Pump Station Total Capacity	N/A	N/A	N/A	No Flood Pump Station in this district.
Pass Forward Flow – First Overflow	N/A	N/A	0.172 m^3/s	

Notes:

(1) – Gravity diversion pipe replacing Lift Station as Armstrong is a gravity discharge district

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations relevant to the development of the Combined Sewer Overflow (CSO) control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a(
1	Normal Summer River Level	Armstrong – 223.65
2	Trunk Invert at Off-Take / Diversion	223.58
3	Top of Weir	223.98
4	Relief Outfall Invert at Flap Gate	N/A
5	Low Relief Interconnection	N/A
6	Sewer District Interconnection (Newton)	225.03
7	Low Basement	228.24
8	Flood Protection Level (Armstrong)	228.78

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed in Armstrong was the *Sewer Relief Study: Armstrong Combined Sewer District Conceptual Report* (IDE, 1993). The study's purpose was to develop sewer relief options that provide a 5-year level of protection against basement flooding and to develop alternatives for reducing and eliminating pollutants from CSOs. No other CSO study or system design work has been completed on the district sewer system since that time.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Armstrong Combined Sewer District was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations have a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Expected Completion
02 – Armstrong	1993	2016 Summer Flow Monitoring Campaign Completed	2013	Conceptual Study Completed	TBD

Note:
TBD = To Be Determined

1.5 Ongoing Investment Work

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Armstrong district. This consists of monthly site visits in confined entry spaces to verify that physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Armstrong sewer district are listed in Table 1-4. The proposed CSO control projects will include complete sewer separation. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85% Capture in a Representative Year	-	-	-	-	-	-	-	✓	✓	✓	-

Notes:

- = not included
✓ = included

Armstrong district has been identified as an early priority action for the CSO Master Plan. The upstream separate area LDS system connects directly into the CS trunk and contributes dramatically to the WWF received in the CS district. WWFs from these separated areas are utilizing capacity in the CS trunk for the Armstrong district. A complete sewer separation scheme which removes these LDS ties from the Armstrong CS system and instead directs them to a river outfall is proposed to deal with this issue. The existing CS main trunk is proposed to be an LDS pipe, which will outfall at the existing CS outfall. A new wastewater sewer (WWS) trunk along Leila and interconnecting WWS to service all properties is then proposed.

GI and RTC will be applied within each district on a system-wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Sewer Separation

The complete sewer separation project for Armstrong district will provide immediate benefits to the CSO program when implemented. The work is recommended to include installation of a WWS system to collect sanitary sewage and foundation drainage. The new WWS system will include a trunk sewer along Leila Avenue connecting into the Main Interceptor, new secondary and lateral sewers and wastewater service reconnections to all properties. The existing CS trunk sewer is then recommended to be converted to an LDS sewer. Collected stormwater runoff from the separate sewer districts to the west of Armstrong, along with within the Armstrong district itself, will continue to be routed through the existing CS trunk sewer and ultimately to the Red River via the Armstrong CS outfall. At this point the diversion structure currently utilized for the Armstrong district could be decommissioned. The approximate area of sewer separation is shown on Figure 02.

The flows to be collected after the Armstrong complete separation will be as follows:

- DWF will be collected in the new WWS and will consist of sanitary sewage combined with foundation drainage.
- WWF will flow through the converted CS system to an outfall to the Red River.

This will result in a significant reduction in WWF directed to the main interceptor after the separation project is complete. The WWS separation project will eliminate overflows from the district.

It is proposed that future post construction flow monitoring of the district is completed to verify sewer system performance.

1.6.3 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district will be reviewed to identify the most applicable GI controls.

Armstrong has been classified as a high GI potential district. Land use in Armstrong is mostly single and double family residential with large areas of commercial land use. This means the district would be an ideal location for bioswales, permeable paved roadways, cisterns/rain barrels, and rain gardens. The commercial areas in the west end of the district would be an ideal location for green roofs.

1.6.4 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

Sewer separation will create additional sewer pipes to maintain, minimal operator involvement will be required to maintain the new WWS system and additional LDS elements. This will result in additional maintenance costs over the long term, but operational costs will be minimal. There will be continued maintenance of the system required for the management of WWF in the separated sanitary sewer system. There will be potential O&M reductions as a result of the decommissioning of the diversion structure and other components of the current CS outfall arrangement. These components will no longer be necessary once the CS outfall is converted to a dedicated LDS outfall.

It is recommended to continue to maintain and operate the flow monitoring instrumentation and assess the results after district separation work has been completed. This will allow the full understanding of the non-separated storm elements (foundation drain connections to the WWS system) extent within the Armstrong district.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. An individual model was created to represent the sewer system baseline as represented in the year 2013 and a model for the CSO Master Plan with the control options implemented in the year 2037. A summary of relevant model data is summarized in Table 1-5.

Table 1-5. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Added To Model
2013 Baseline	863	863	3,759	60	N/A
2037 Master Plan – Control Option 1	127	66	3,628	12	SEP

Notes:

SEP = separation

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district. While this district is to be separated and as a result Clause 8 of Licence No. 3042 will not be in effect, the wet weather response of the district overall will still need to be assessed.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-6, are for the hydraulic model simulations using the year-round 1992 representative year applied uniformly. The table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan – Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. The table also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-6. Performance Summary – Control Option 1

Control Option	Preliminary Proposal	Master Plan			
	Annual Overflow Volume (m^3)	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow
Baseline (2013)	710,537	749,622	-	23	0.172 m^3/s [b]
LDS Separation	0	N/A	N/A	N/A	N/A
WWS Separation	N/A [a]	0	749,622	0	0.345 m3/s [c]
Control Option 1	**0**	**0**	**749,622**	**0**	**0.345 m3/s [c]**

[a] LDS trunk not simulated independently during the Preliminary Proposal assessments including offline storage tank.

[b] Pass forward flows assessed on the 1-year design rainfall event.

[c] Discharge into outfall pipe for 5-year design event but no overflow to river

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each relevant control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-7. The cost estimates are a Class 5 planning level estimate with a level of accuracy range of minus 50 percent to plus 100 percent.

Table 1-7. Cost Estimates – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost [b]	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period) [b]
Sewer Separation	- [a]	$61,080,000	$57,000	$1,220,000
In-line Control Gate	$7,680,000	N/A	N/A	N/A
Screening		N/A	N/A	N/A
Off-line Storage Tank	$4,700,000	N/A	N/A	N/A
Tunnel	$75,200,000	N/A	N/A	N/A
Subtotal	**$87,580,000**	**$61,080,000**	**$57,000**	**$1,220,000**
Opportunities	$0	$6,110,000	$6,000	$120,000
District Total	**$87,580,000**	**$67,190,000**	**$63,000**	**$1,340,000**

[a] Tunnel storage taken as sewer separation of upstream district draining to Armstrong district

[b] WWS complete separation control option selected as part of Master Plan assessment

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI opportunities, with no additional costs for RTC (depending on future monitoring of post separation WWF impacts).
- The Preliminary Proposal capital cost is in 2014-dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019-dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district.

Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-8.

Table 1-8. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Sewer Separation	Added as a result of Master Plan assessment. Initial costs based LDS separation in conjunction with a long tunnel, subsequently changed to WWS separation.	
	Control Gate	Removed from Master Plan	No longer required with complete separation work.
	Screening	Removed from Master Plan	No longer required with complete separation work.
	Off-line Storage	Removed from Master Plan	No longer required with complete separation work.
	Tunnel	Removed from Master Plan	No longer required with complete separation work.
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI Opportunities	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation	Preliminary Proposal estimates were based on 2014-dollar values	

1.10 Meeting Future Performance Targets

The proposed complete separation of the Armstrong district will achieve the 100 percent capture figure and no further work will be required to meet the future performance target. It is recommended to complete post separation modelling to confirm the target is fully achieved.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed as part of the CSO Master Plan and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-9.

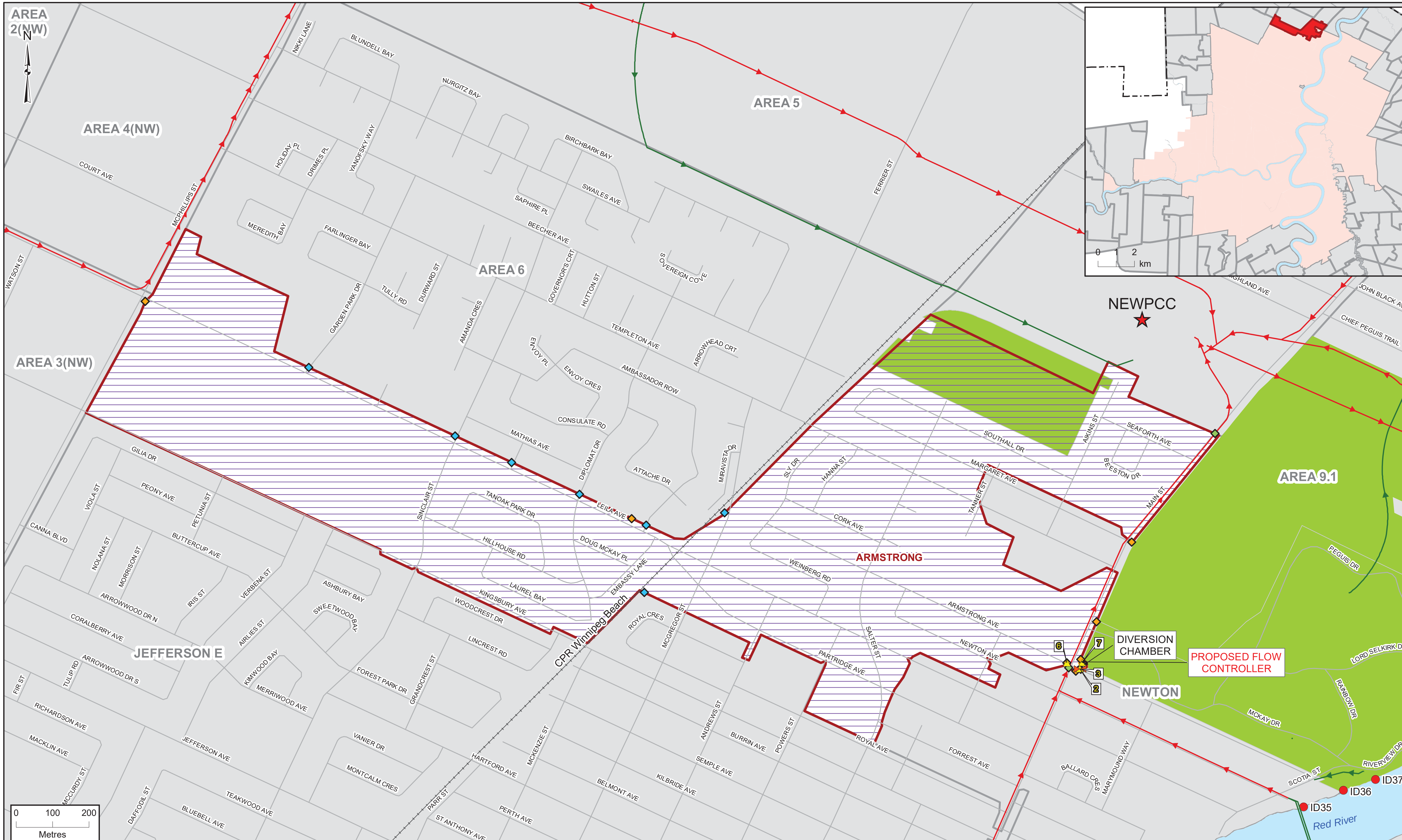
Table 1-9. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	-	-	-	O	-	-	-
2	Existing Lift Station	-	-	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	O	-	-	-
4	Construction Disruption	-	-	-	-	R	-	-	-
5	Implementation Schedule	-	-	-	-	R	-	R	-
6	Sewer Condition	-	-	-	-	-	-	-	-
7	Sewer Conflicts	-	-	-	-	R	-	-	-
8	Program Cost	-	-	-	-	R	-	-	-
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	-	-	-	-	O	O	O	-
12	Operations and Maintenance	-	-	-	-	R / O	R	O	-
13	Volume Capture Performance	-	-	-	-	-	O	O	-
14	Treatment	-	-	-	-	O	O	O	-

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

I.D. Engineering Canada Inc (IDE). 1993. *Sewer Relief Study: Armstrong Combined Sewer District Conceptual Report*. Prepared for the City of Winnipeg. September.



LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Low CS Manhole
- Sewage Treatment Plant

Inter-System Connection
- CS - WWS

District Boundary Crossing
- CS
- LDS
- WWS

- Interceptor Sewer
- Force Main
- Street
- Railway

- District Boundary
- Watercourse
- Greenspace

CSO MASTER PLAN PROPOSED SOLUTIONS

Sewer Separation - Planning

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

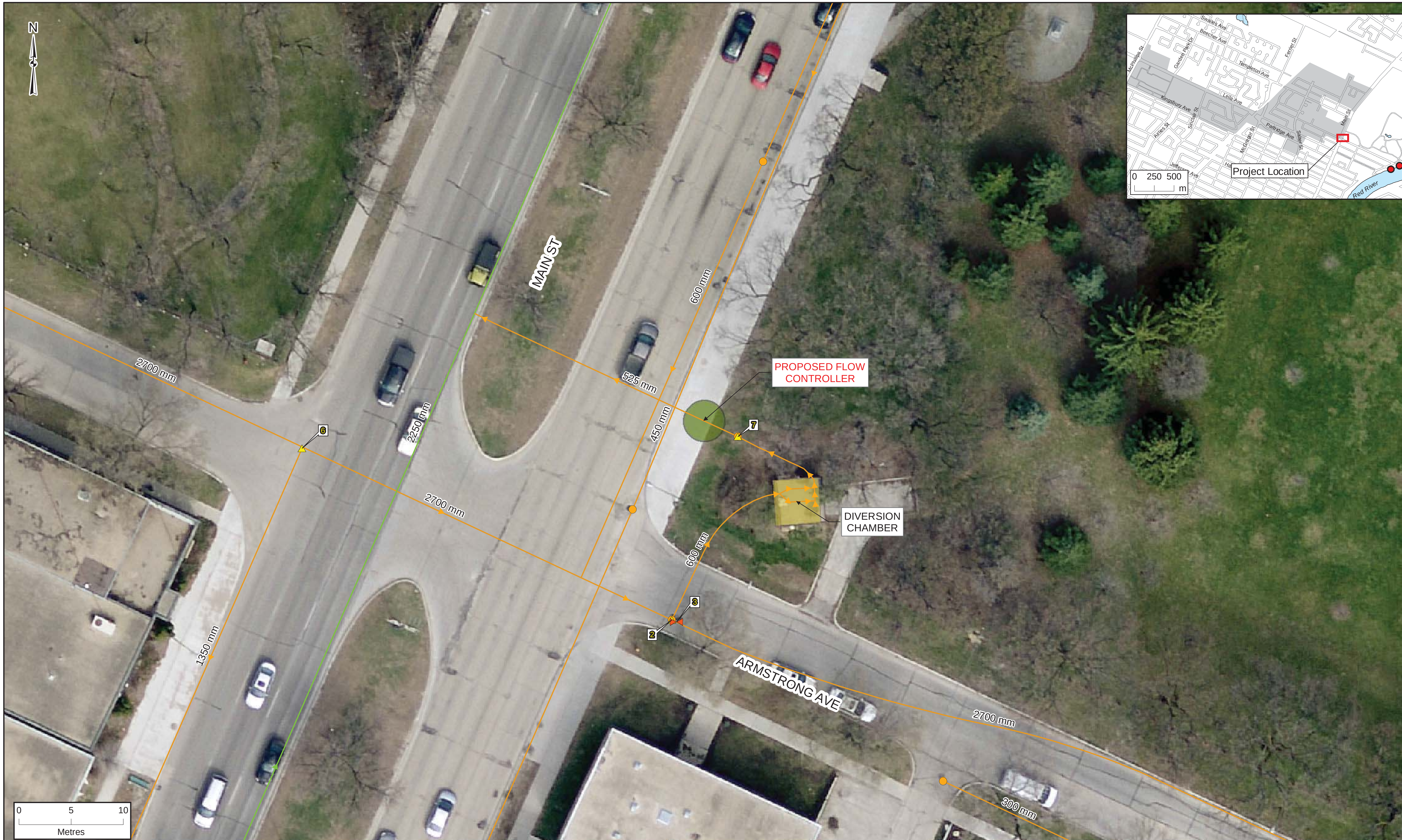
JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 02
District Overview Map
Sewer District: Armstrong
City of Winnipeg
Combined Sewer Overflow Master Plan



LEGEND

Primary Weir	Sewer By Type	Pump Station Type
Critical Elevation	CS	Diversion Chamber
Manhole	WWS	

CSO MASTER PLAN
PROPOSED SOLUTIONS
Flow Controller

ALL PROPOSED SOLUTIONS
SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg
THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 02-01
Control Gate
Sewer District: Armstrong
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Ash District Plan

August 2019

City of Winnipeg

CSO Master Plan

Project No: 470010CS
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Revision: 03
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2	06/2019	Final Draft Submission	DT	MF	MF
3	08/16/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

Tables

Figure

1. Ash District

1.1 District Description

Ash district is located towards the southwestern limit of the combined sewer (CS) area along the southern bank of the Assiniboine River. Ash is bounded by the Assiniboine River to the north; Cambridge Street to the east, Centennial Street North, Kenaston Boulevard, and Doncaster Street to the west; and Wilkes Avenue to the south. Ash district contains numerous major transportation routes that pass through the district including Kenaston Boulevard, Taylor Avenue, Grant Avenue, Corydon Avenue, and Academy Road. Kenaston Boulevard passes north-south through Ash and provides access across the Assiniboine River. The Midland rail line connects to the Canadian Pacific Railway Lariviere rail lines and passes through the center of the Ash district. Ash is surrounded by Jessie and Cockburn districts to the east, Lindenwoods East and West to the south, and Doncaster to the west.

Land use in Ash is mainly residential with the remainder being commercial use. The commercial businesses are found along the busier routes, including Corydon Avenue, Grant Avenue and Academy Avenue. The residential land is made up of single-family homes with multi-family and apartment complexes found in the southern section of Ash near Wilkes Avenue. Numerous schools and recreational areas are distributed around the district, with the Manitoba Youth Centre on Tuxedo Avenue and River Heights School and Community Centre occupying the most non-residential land use area. Approximately 53 ha of the district is classified as greenspace.

1.2 Development

A Route 90 Improvement Study is currently underway that will lead to a significant amount of construction and right of way adjustments along Route 90/Kenaston Boulevard. This work, which will impact both Doncaster and Ash districts, could impact the Combined Sewer Overflow (CSO) Master Plan. The Route 90 work is discussed further in Section 1.5.

The Waverley Underpass Project is currently ongoing at the time of writing and is anticipated to conclude in 2020. This work does not affect the CSO Master Plan.

1.3 Existing Sewer System

Ash district encompasses an area of 744 ha[1] based on the district boundary and includes both a combined sewer (CS), wastewater sewers (WWS), and a storm relief sewer (SRS) system. As shown in Figure 03, there is approximately 6 percent (45 ha) already separated and 1 percent (7 ha) of the district is considered separation ready.

The Ash CS system includes a flood pump station (FPS), CS lift station (LS), and a CS outfall gate chamber located adjacent to the Assiniboine River at Wellington Crescent and Ash Street, at the Ash CS outfall. Sewage flows collected in Ash converge to the 1720 mm by 2220 mm egg-shaped sewer trunk on Academy Road which connects to the main 2440 mm by 3150 mm egg-shaped sewer trunk on Ash Street. The CSs meet at the intersection of Ash Street and Wellington Crescent and flow to the CS outfall. CS is also received from the Doncaster and Tuxedo districts, with the intercepted CS from these districts discharging into the Ash CS system at the intersection of Willow Avenue and Doncaster Street.

The SRS predominately drains towards the Renfrew SRS outfall located adjacent to the Assiniboine River at Wellington Crescent and Renfrew Street. There are also areas of SRS constructed to provide localized relief, but which tie back into the existing CS system. Minor SRS work was completed surrounding

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

Wellington Crescent, ultimately discharging into a dedicated SRS outfall near Wellington Crescent and Academy Road.

During dry weather flow (DWF), the SRS system is not required; sanitary sewage is diverted by the primary weir at the Ash CS Outfall, through the 600 mm off-take pipe to the Ash CS LS, where it is pumped across the Assiniboine River to the Main Interceptor pipe in the Aubrey district and on to the North End Sewage Treatment Plant (NEWPCC) for treatment.

During wet weather flow (WWF), any flow in the CS system that exceeds the diversion capacity overtops the primary weir and is discharged to the river. A flap and sluice gate are in place on the CS outfall to prevent river water from flowing into the CS under high river level conditions. When the river level is high such as this, the flap back prevents gravity discharge of any excess CS which spills over the primary weir within this outfall pipe. In this case the excess flow is instead pumped by the Ash FPS to a dedicated FPS outfall where it is discharged by gravity into the river. This FPS outfall does not have a flap gate or positive gate. The FPS contains four pumps to accommodate the wet weather flow (WWF) response received by the district.

The SRS system provides relief to the CS system in Ash district during WWF events. The WWF is drained by gravity into the main SRS outfall on Renfrew Street or the smaller outfall near the western edge of Ash on Wellington Crescent. Two flap gates are located on the Renfrew outfall pipe to prevent river water from backing up into the Renfrew SRS under high river level conditions on the Assiniboine River. The Renfrew SRS outfall is also equipped with a positive gate for temporary dewatering purposes and to provide emergency protection to the SRS system from flooding during high river level conditions. SRSs are implemented throughout the district and connect to the CS via interconnections.

A small number of land drainage sewers (LDSs) exist in the northwestern part of the district. This section of LDS collects surface runoff and conveys it to a separate LDS outfall. South of the CPR Mainline the CS system has been separated with the wastewater sewer (WWS) connecting into the CS system north of the tracks.

The outfalls to the Assiniboine River are as follows:

ID55 (S-MA70033504) – Ash CS Outfall

ID51 (S-MA60006673) – Wellington SRS Outfall

ID53 (S-MA70024441) - Renfrew SRS Outfall

ID89 (S-MA70016005) – Ash FPS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Ash and the surrounding districts. Each interconnection is shown in Figure 03 and shows gravity and pumped flow from one district to another. Each interconnection is listed as follows:

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

Aubrey

- Dual 300 mm force main river crossing carries flow from the Ash LS across the Assiniboine River to the Aubrey district Man interceptor pipe and on to the North End Sewage Treatment Plant (NEWPCC) for treatment.
  - Aubrey district south of Wolseley Avenue invert = 230.64 m (S-MH70006432)

1.3.1.2 Interceptor Connections – Upstream of Primary Weir

Doncaster

- A 750 mm CS pipe under surcharged flow conditions in the Doncaster district flows by gravity southbound on Doncaster Street and connects into the CS system in Ash:
  - Willow Avenue and Doncaster Street invert = 226.37 m (S-MH60006151)

1.3.1.3 District Interconnections

Doncaster

<u>CS to CS</u>

- Common high point CS manhole:
  - Kenaston Boulevard and Corydon Avenue = 227.70 m (S-MH60006019)

Lindenwoods East (Area 3)

<u>WWS to WWS</u>

- A 250 mm WWS sanitary sewer flows into Ash district and crosses the district boundary at the intersection of Waverley Street and Victor Lewis Drive:
  - Waverley Street and Victor Lewis invert at Ash district boundary = 228.87 m

<u>LDS to LDS</u>

- A 375 mm LDS flows into Ash district at Wilkes Avenue and is discharged into a stormwater retention basin in Ash:
  - Wilkes Avenue near Waverley Street invert at Ash district boundary = 228.23 m
- A 375 mm LDS pipe from Area 3 flows northbound by gravity into Ash LDS system at Wilkes Avenue and Victor Lewis Drive:
  - Wilkes Avenue and Victor Lewis Drive invert at Ash district boundary = 228.95 m (S-MH70001787)
- Two LDS systems convey flow out of Ash district, cross the district boundary and discharge into a stormwater retention basin in Lindenwoods East:
  - Waverley Street and Victor Lewis Drive invert at Ash district boundary = 229.66 m

Lindenwoods West (Area 3.1)

<u>LDS to LDS</u>

- A 750 mm LDS system convey flow out of a small portion of Ash district, crosses the district boundary and discharges into a stormwater retention basin in Lindenwoods West:
  - Sterling Lyon Parkway and Brockville Street at Ash district boundary = 229.48 m
- A LDS siphon crosses from Lindenwoods West to Ash district, and then connects into the LDS system in Ash. This LDS system discharges either into a stormwater retention basin in Ash or the one in Lindenwoods West:
  - Wilkes Avenue and Paget Street invert at Ash district boundary = 230.24 m

Willow

<u>LDS to LDS</u>

- A 600 mm LDS overflow is located in Ash district and flows southbound by gravity into Willow district:
  - Fennell Street and Wilson Place invert at Willow district boundary = 231 m (S-MH60014575)

Jessie

<u>CS to CS</u>

- A 300 mm CS at Corydon Avenue and Cambridge Street flows eastbound by gravity into Jessie district. The manhole at the district boundary in Ash is also a high point:
  - Corydon Avenue and Cambridge Street invert at Jessie district boundary = 229.25 m (S-MH60010068)
  - Common high point CS manhole = 229.50 m

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing district.

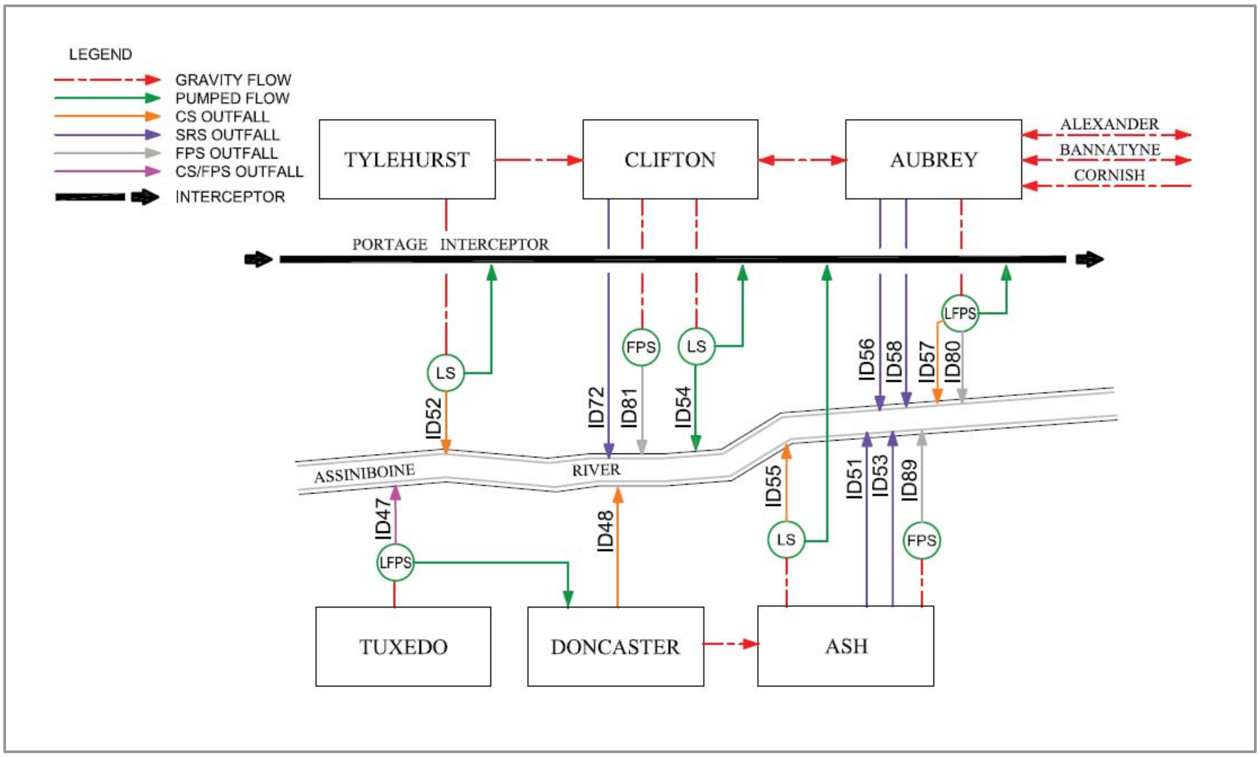

Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 03 and are listed in Table 1-1

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID55)	S-MH70011795.1	S-MA70033504	3480 mm	Assiniboine River Invert: 222.98 m
Flood Pumping Outfall (ID81)	S-AC70007362.1	S-MA70016005	2100 mm	Assiniboine River Invert: 224.87 m
Other Overflows	N/A	N/A	N/A	
Main Trunk	S-TE70007360.1	S-MA70016011	2440 x 3150 mm	Invert: 223.26 m
SRS Outfalls	S-CO70011421.1 S-MH60005292.1	S-MA70024441 S-MA60006673	2400 mm 300 mm	Assiniboine River Invert: 222.2 m Invert: 226.0 m
SRS Interconnections	N/A	N/A	N/A	30-SRS-CS Interconnections throughout district.
Main Trunk Flap Gate	S-MH70011794.1	S-CG00000743	2500 mm	Invert: 223.83 m
Main Trunk Sluice Gate	ASH_GC.1	S-CG00000744	1800 x 2100 mm	Invert: 223.47 m
Off-Take	S-TE70007363.1	S-MA70017767	600 mm	Invert: 223.47 m
Dry Well	N/A	N/A	N/A	
Lift Station Total Capacity	S-TE70027396.2 S-TE70027398.1 S-TE70027395.2 (stand-by)	N/A	0.280 m^3/s	1 x 0.19 m^3/s max discharge 1 x 0.09 m^3/s (0.19 m^3/s max discharge) 1 x 0.00 m^3/s (0.19 m^3/s max discharge)
Lift Station ADWF	N/A	N/A	0.101 m^3/s	Ash district ADWF as 0.094 m^3/s
Lift Station Force Main	S-YY70021058.2	S-MA70044147	300 mm	2 x 300 mm
Flood Pump Station Total Capacity	N/A	N/A	5.24 m^3/s	3 x 1.42 m^3/s, 1 x 0.98 m^3/s
Pass Forward Flow – First Overflow	N/A	N/A	0.660 m^3/s	

Notes:

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Ash – 223.85 Renfrew – 223.88 Wellington – 224.21
2	Trunk Invert at Off-Take	223.47
3	Top of Weir	224.03
4	Relief Outfall Invert	Renfrew - 222.48
5	Relief Interconnections (S-MH60006951)	224.97

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
6	Sewer District Interconnection (Doncaster Street and Tuxedo Avenue)	Invert at district boundary: 226.62
7	Low Basement	230.43
8	Flood Protection Level	230.30

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed in Ash was in 1981 with the Ash District Combined Sewer Relief (M.M. Dillon Ltd, 1981). This study discussed the upgrading of the Ash CS district to reduce surcharge levels and basement flooding.

Significant SRS construction was completed throughout Ash from 1979 - 1981 to relief the basement flooding risk in the district. This work included the construction of the dedicated SRS outfall at Wellington Crescent and Waverley Street to compliment the Renfrew SRS outfall constructed in the 1960s. Ultimately this Waverley outfall was converted do a dedicated LDS outfall providing partial separation to the Ash district.

In 2013 further SRS relief work was completed in the northwest corner of the Ash District to provide localized CS relief to properties on Wellington Crescent immediately east of Kenaston Boulevard. This work included the construction of the Wellington dedicated SRS outfall.

Starting in 2014, the City initiated a preliminary design study to focus on relief of the Waverley Street and Taylor Avenue. The Waverley Underpass Study provided a high level design for a grade separation of Waverley Street and the Canadian National Railway (CNR) that passes through Ash District. The objective of this study was to improve the transportation network within the area. The construction is currently underway with plans for the project to be completed in late 2019. The construction impacts the portions of the southeast Ash district: primarily along Waverley Street, from Grant Avenue to Wilkes Avenue and along Taylor Avenue. From Lindsay Street to Cambridge Street Improvements to the land drainage were proposed, mainly the separation of Taylor Avenue and Waverley Street, The area south of Taylor Avenue has already been previously separated as part of this work.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Ash Combined Sewer District was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations has a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Expected Completion
3 - Ash	1981	Future Work	2013	Planning Separation	N/A

Source: Report on Ash District Combined Sewer Relief, 1981

1.5 Ongoing Investment Work

Proposed investment work is being considered for Route 90 from Taylor Avenue to Ness Avenue, which will occur in both Doncaster and Ash. Kenaston Boulevard runs through the north section of Ash and, therefore, will affect the sewer systems in this district. The existing combined sewers will be evaluated for separation potential as part of the Route 90 Widening Project. Opportunistic separation will be incorporated where there is benefit. The separation costs may be reduced if separation work is planned as part of road reconstruction.

There is ongoing maintenance and calibration of permanent instruments installed within the Ash outfall. This consists of monthly site visits in confined entry spaces to verify that physical readings concur with displayed transmitted readings and replacing desiccants when necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Ash sewer district are listed in Table 1-4. The proposed CSO control projects will include latent storage with flap gate control, partial separation, in-line storage via control gate floatables control via screening. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	✓	✓	-	✓	✓	-	-	✓	✓	✓	✓

Notes:

- = not included
✓ = included

The existing CS and SRS systems are suitable for use as in-line and latent storage. These proposed control options would take advantage of the existing CS and SRS pipe networks for additional storage volume. Existing DWF levels experienced within the collection system, and overall district operations would remain the same. Additional WWF during rainfall events however will be collected from the SRS and CS systems and forwarded to the NEWPCC for treatment.

Floatable control will be necessary to capture any floatables in the sewage. Floatables will be captured with all implemented control options to some extent, but screening may be added as required to reach the desired floatable capture level. Installation of a control gate will be required for the screen operation. The control gate installation will additionally provide the mechanism for capture of the additional in-line storage.

Partial separation has been proposed to be completed in conjunction with the Route 90 widening work and opportunistic additional separation would be beneficial at intersecting local roads. This is also part of the Doncaster district proposed control option work.

GI and RTC will be applied within each district on a system wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Sewer Separation

The partial sewer separation project for Ash will provide benefits to the CSO program when complete. The work includes installation of a new LDS trunk and collector sewers within the district as part of the Route 90 Widening Project. The existing CS trunks along Kenaston Boulevard will be separated into distinct storm and sanitary sewer systems, which will allow for sanitary sewage that contains untreated domestic, industrial, and commercial wastes to be separated from the storm runoff. A new LDS system would allow the storm runoff to be discharged into the Assiniboine River during rainfall events. The existing combined sewers would be retained for use as separate WWS to convey sanitary sewage through the Ash sewer system to the appropriate treatment plant. The approximate area of sewer separation is shown on Figure 03.

The flows to be collected after the Ash partial separation will be as follows:

- Dry weather flows will remain the same for Ash district with all DWF being diverted to the Ash CS LS and into Aubrey district.
- The Ash WWF response overall will be reduced as the section along Route 90 will consist of sanitary sewage combined with foundation drainage.

Partial sewer separation will provide a reduction of overflows when evaluated with the 1992 representative year. In addition to reducing the CSO volume, the benefits of the Ash partial separation include a reduction of the amount of flood pumping required at the Ash FPS. The complete sewer separation work proposed in this CSO Master Plan for the upstream districts of Doncaster and Tuxedo will also contribute to the reductions experienced in the Ash district, as the intercepted CS from each of these districts also contribute to the CS within the Ash district.

1.6.3 Latent Storage

Latent storage is proposed as a control option for the Ash district. The latent storage level in the system is controlled by the river level, and the resulting backpressure of the river level on the SRS outfall flap gate, as explained in Part 3C. However, the level of the Renfrew SRS outfall is only partially above the NSWL when modelled with the 1992 representative year. This only provides a modest benefit in terms of additional volume capture with latent storage at this location controlled only by the river level. Therefore, a mechanical gate control has been additionally recommended for this control option, to provide the additional latent storage volume. This will allow the SRS outfall flap gate to remain closed regardless of the river level conditions on the Assiniboine River. Details of the SRS flap gate control are provided in the standard details in Part 3C. The latent storage design criteria are identified in Table 1-5. The storage volumes indicated in Table 1-5are based on the river level conditions over the course of the 1992 representative year, with supplemental mechanical flap gate control provided as required.

Table 1-5. Latent Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	222.69 m	
NSWL	223.88 m	
Trunk Diameter	2400 mm	
Design Depth in Trunk	1190 mm	
Maximum Storage Volume	1779 m^3	
Force Main	150 mm	
Flap Gate Control	Yes	
Pump Station	Yes	
Nominal Dewatering Rate	0.03 m^3/s	Based on 24 hour emptying requirement

Table 1-5. Latent Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
RTC Operational Rate	TBC	Future RTC/dewatering review on assessment

Notes:
NSWL – normal summer water level
RTC – Real Time Control

The addition of a pump and force main that connects back to the CS system will be required for latent storage. A conceptual layout for the latent storage pump station (LSPS) and force main is shown on Figure 03-02. The LSPS will be located adjacent to the existing gate chamber near Wellington Crescent. The LSPS will direct flows southwest to the nearby 300 mm CS sewer on Renfrew Street and into the manhole (S-MH70028046) on the south curb on Wellington Crescent and the back lane of Renfrew Street. This location for latent storage dewatering return was evaluated and capable of accommodating the returned pump flow and selected as appropriate. The pump station will operate to dewater the SRS system in preparation for the next runoff event, to meet the requirement for the system to be ready for the next event within a 24-hour period after completion of the previous event.

The LSPS would connect to the SRS outfall chamber and discharge back to the CS system once capacity allows. Figure 03 identifies the extent of the SRS system within Ash district that would be used for latent storage. The maximum storage level is directly related to the NSWL and the size and depth of the SRS system. Once the level in the CS system exceeds the in-line control gate (see Section 1.6.4), the mechanical flap gate control provided at the Renfrew SRS outfall will be deactivated. At this point the combined sewage within the SRS system will be discharged to the river, assuming river levels are sufficiently low to allow discharge. The Wellington SRS system located in the northwest corner of the Ash district was also evaluated. The Wellington SRS outfall pipe invert elevation was found to be consistently above the NSWL under the 1992 representative year. It therefore, does not contribute to the available latent storage in Ash utilizing the Renfrew SRS outfall.

The lowest interconnection between the combined sewer and relief pipe was found to be higher than the proposed latent and in-line storage control levels. This will allow the two systems would function independently to provide additional volume capture.

As described in the standard details in Part 3C wet well sizing within the LSPS will be determined based on the final pump selection, operation and dewatering capacity required. The interconnecting piping between the new gate chamber and the LSPS would be sized to provide sufficient flow to the pumps while all pumps are operating.

1.6.4 In-Line Storage

In-line storage has been proposed as a CSO control for the Ash district. The in-line storage will require the installation of a control gate at the CS outfall. The gate will increase the storage level in the existing CS to provide an overall higher volume capture and provide additional hydraulic head for screening operations.

A standard design was assumed for the control gate, as described in Part 3C. The standard approach was initially used for conceptual gate sizing by assuming it to be the lesser of the height of half of the site-specific trunk diameter or the maximum height of the gate available. The bypass weir and control gate levels were then subsequently assessed to a level below the existing FPS operational levels, as the half trunk diameter initial level assessment indicated that the FPS operated prior to the opening of the control gate. This would increase the operational run period of the FPS and is not considered beneficial to the control option.

The design criteria for in-line storage are listed in Table 1-6.

Table 1-6. In-Line Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	223.30 m	
Trunk Diameter	2440 x 3150 mm	Egg-shaped
Gate Height	0.90 m	Flood pumping station assessment max operational level
Top of Gate Elevation	224.40 m	
Maximum Storage Volume	2000 m^3	
Nominal Dewatering Rate	0.28 m^3/s	Existing CS LS pump capacity
RTC Operational Rate	TBD	Future RTC/dewatering review on assessment

Note:
RTC = Real Time Control

TBD = to be determined

The proposed control gate will cause combined sewage to back-up in the collection system to the extent shown on Figure 03. The extent of the in-line storage and volume is related to the top elevation of the bypass side weir. The level of the top of the bypass weir and adjacent control gate level are determined in relation to the critical performance levels in the system for basement flooding protection: when the system level increases above the bypass weir crest and proceeds above the top of the control gate during high flow events, the gate drops out of the way. At this point, the district will only provide its original interception capacity via the primary weir for the district, and all excess CS would flow to the weir and discharge to the river. . After the sewer levels in the system drops back below the bypass side weir critical performance level, the control gate moves back to its original position to capture the receding limb of the WWF event. The CS LS will continue with its current operation while the control gate is in either position, with all DWF being diverted to the CS LS and pumped. The CS LS will further dewater the in-line storage provided during a WWF event as downstream capacity becomes available.

Figure 03-01 provides an overview of the conceptual location and configuration of the control gate, bypass weir and screening chambers. The proposed control gate will be installed in a new chamber within the existing trunk sewer alignment near the existing FPS. The dimensions of the chamber will be 5.1 m in length and 3.7 m in width to accommodate the gate, with an allowance for a longitudinal overflow weir. The proposed location is within the existing Ash CS LS and gate chamber layout and based on the available potential space. The existing sewer configuration may require the construction of an additional off-take pipe to be completed, if the future detailed design establishes that the proposed gate chamber cannot encompass the existing primary weir chamber. This will allow CS flows captured by the proposed control gate to be diverted to the Ash CS LS, ensuring that the system performs as per the existing conditions. The existing primary weir would remain in place to allow flow diversion to continue when the control gate is in its lowered position. The physical requirements for the off-take and station sizing for a modification to pumping capacity have not been considered in detail, but they will be required in the future as part of an RTC program or FPS rehabilitation or replacement project.

The nominal rate for dewatering is already set at the existing CS LS pumping capacity. This allows dewatering through the existing interceptor system within 24 hours following a runoff event, allowing it to recover in time for a subsequent event. Future RTC / dewatering assessment will be necessary to define additional rates. This would provide some flexibility in the ability to increase the dewatering rate for spatial rainfall events. This would dewater the district more quickly, to capture and treat more volume for these localized storms by using the excess interceptor capacity where the runoff is less.

1.6.5 Floatables Management

Floatables management will require installation of a screening system to capture floatable materials. The off-line screens will be proposed to maintain the current level of basement flooding protection. The type and size of screens depend on the specific station configuration and the head available for operation. A standard design was assumed for screening and is described in Part 3C. The design criteria for screening with gate control implemented, are listed in Table 1-7.

Table 1-7. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Top of Gate	224.40 m	
Bypass Weir Crest	224.30 m	
Normal Summer Water Level	223.85 m	
Maximum Screen Head	0.69 m	
Peak Screening Rate	0.65 m^3/s	
Screen Size	1.5 m x 1.0 m	Modelled Screen Size

The proposed side overflow bypass weir and screening chamber will be located adjacent to the proposed control gate and existing CS trunk, as shown on Figure 03-01. The screens will operate with the control gate in its raised position. A side bypass weir upstream of the gate will direct the flow to the screens located in the new screening chamber, with screened flow discharged to the downstream side of the gate to the river. The side bypass weir height will be set to the critical performance level of the control gate. The screening chamber will include screenings pumps with a discharge returning the screened material to the LS for routing to the NEWPCC for removal.

The dimensions for the screen chamber to accommodate influent from the side weir, the screen area, and the routing of discharge downstream of the gate are 3.2 m in length and 3.1 m in width. The existing sewer configuration may have to be modified to accommodate the new chamber.

1.6.6 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district will be reviewed to identify applicable GI controls.

Ash has been classified as a medium GI potential district. Land use in Ash is mainly residential with a small amount of commercial, and the north end of the district is bounded by the Assiniboine River. This district would be an ideal location for cisterns/rain barrels, and rain garden bioretention. There are a few commercial areas which may be suitable to green roofs and parking lot areas which would be ideal for paved porous pavement.

1.6.7 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

Sewer separation will include the installation of additional sewers that will require inspection, cleaning and rehabilitation. This will result in additional maintenance costs over the long term, but operational costs will be minimal. The existing larger CS pipes within separated part of the district may also receive insufficient flows with the separation work for proper scouring velocities in the sewer pipes. This could result in solids settling within the sewers and requiring more frequent cleaning operations. The impacts of the reduced flows in larger CS pipes will be evaluated as part of the sewer separation design for the district.

In-line storage will impact the existing sewer and will require the addition of a new chamber and a moving gate at the outfall. In-line storage dewatering will be controlled with the existing Clifton CS LS, which will require more frequent and longer duration pump run times. Lower velocities will occur in the CS trunk in the vicinity of the control gate due to lower pass forward flows, and may create additional debris deposition requiring cleaning. Additional system monitoring, and level controls will be installed, which will require regular scheduled maintenance.

Floatable control with outfall screening will require the addition of another chamber with screening equipment installed. The chamber will be installed adjacent to the control gate chamber and will operate in conjunction with it. Screening operation will occur during WWF events that surpass the in-line storage control level. WWF will be directed from the main CS trunk, over the side weir in the control gate chamber and through the screens to discharge into the river. The screens will operate intermittently during wet weather events and will likely require operations review and maintenance after each event. The frequency of a screened event will correlate to the number overflows identified for the district. Having the screenings pumped back to the interceptor system via a small LS and force main will be required. The screenings return will require O&M inspection after each event to assess the performance of the return pump system.

The latent storage will take advantage of the SRS infrastructure already in place; therefore, minimal additional maintenance will be required for the sewers. The proposed LSPS and dewatering pumps will require regular maintenance that would depend on the frequency of operation. The flap control gate mechanisms will require maintenance inspections for continued assurance that the flap gate would open during WWF events, expected to be based on the number of overflows for the district.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. Two versions of the sewer system model were created and used to measure system performance. The 2013 Baseline model represents the sewer system baseline in the year 2013 and the 2037 Master Plan – Control Option 1 model, which includes the proposed control options in the year 2037. A summary of relevant model data is provided in Table 1-8.

Table 1-8. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	818	818	21,358	24	N/A
2037 Master Plan – Control Option 1	818	774	21,258	23	IS, Lat St, SC, SEP, FGC

Notes:

IS = In-line StorageLat St = Latent Storage
SC = Screening
SEP = Separation

FGC – Flap Gate Control

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-9 are for the hydraulic model simulations using the year-round 1992 representative year. The table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. The table also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-9. Performance Summary – Control Option 1

	Preliminary Proposal	Master Plan			
Control Option	Annual Overflow Volume (m^3)	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [c]
Baseline (2013)	356,385	341,484	-	27	0.660 m^3/s
Latent Storage	347,453 [a]	315,960 [b]	25,524	22	0.660 m^3/s
Latent & In-Line Storage		312,942 [b]	3,018	22	0.569 m^3/s
Latent (flap gate control), In-Line & Partial Separation	N/A [a]	258,264	54,678	22	0.617 m^3/s
Control Option 1	**355,500**	**258,264**	**83,220**	**22**	0.617 m^3/s

[a] Latent storage and in-line storage not simulated independently during the Preliminary Proposal assessment. Separation not included in PP

[b] Assessment completed with individual district models and full model impact overflows provided

[c] Pass forward flows assessed on the 1-year design rainfall event

The percent capture performance measure is not included in Table 1-9, as it is applicable to the entire CS system and not for each district individually.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-10. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-10. District Cost Estimate – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance (Over 35-year period)
Latent Storage	N/A [a]	$2,590,000	$72,000	$1,550,000
Flap Gate Control	N/A [b]	$2,340,000	$33,000	$710,000
In-Line Storage	N/A [a]	$5,100,000 [d e]	$61,000	$1,320,000
Screens		$2,550,000 [f]	$55,000	$1,190,000
Partial Separation [c]	N/A [c]	$29,100,000	$17,000	$370,000
Subtotal	**N/A**	**$41,680,000**	**$238,000**	**$5,140,000**
Opportunities	N/A	$4,170,000	$24,000	$510,000
District Total	**N/A**	**$45,850,000**	**$262,000**	**$5,650,000**

[a] Latent Storage, Screening and In-Line Storage not included in the original Preliminary Proposal 2015 costing submission. Solution developed as refinement to Preliminary Proposal work following submission of Preliminary Proposal costs. Costs for the Latent Storage item of work found to be $1,710,000 in 2014 dollars, Costs for the Screening and In-Line Storage items of work found to be $4,320,000 in 2014 dollars.

[b] Flap Gate Control not included in the Preliminary Proposal 2015 costing

[c] Costs for sewer separation may be shared with Public Works budget for the Route 90 widening. Sewer separation not originally proposed as proposed as part of Preliminary Proposal costing.

[d] Cost associated with new off-take construction, as required, to accommodate control gate location and allow intercepted CS flow to reach existing Ash CS LS not included.

[e] Full control gate structure not needed at Renfrew SRS as existing chamber structure to be utilized for flap gate control. Cost revised after submission of preliminary CO1MP costs. Cost for this item found to be $2,760,000 in 2019 dollars.

[f] Cost for bespoke screenings return/force main not included in Master Plan as will depend on selection of screen and type of screening return system selected

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional cost for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014-dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019-dollar values.

- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-11.

Table 1-11. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	In-Line Storage	A control gate was not included in the Preliminary Proposal estimate.	Added for the MP to further reduce overflows
	Screening	Not included in the Preliminary Proposal estimate.	Added in conjunction with the Control Gate.
	Latent Storage	Not included in the Preliminary Proposal estimate.	Added for the MP to further reduce overflows
	Flap Gate Control	Not included in Preliminary Proposal estimate	Added for improvement to Master Plan options
	Partial Separation	Not included in the Preliminary Proposal estimate.	Added for the MP to further reduce overflows
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation.	Preliminary estimates were based on 2014-dollar values	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, the future performance target is 98 percent capture for the representative year measured on a system-wide basis. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-12 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified for Control Option 1.

Overall the Ash district would be classified as a low potential for implementation of complete sewer separation as the only feasible approach to achieve the 98 percent capture future performance target in the representative year. However, opportunistic sewer separation within portions of the district may be completed in conjunction with other major infrastructure work to address future performance targets. In addition, green infrastructure and off-line-tank or tunnel storage may be utilized in key locations to provide additional storage and increase capture volume.

Table 1-12. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Increased GI • Off-Line Storage (Tank/Tunnel) • Opportunistic Separation

The Ash district control options have been selected to align with the system wide basis to achieve the 85 percent capture performance target. The expandability of this district to meet the 98 percent capture future target would be achieved on a stepped approach from the system wide basis. The interaction with the upstream district control options implementation i.e. separation of Tuxedo and Doncaster, will also impact this district's performance.

The cost for upgrading to meet an enhanced performance target depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-13.

Table 1-13. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	R	R	-	-	O	-	-	-
2	Existing Lift Station	-	R	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	O	-	-	-
4	Construction Disruption	-	-	-	-	R	-	-	-
5	Implementation Schedule	-	-	-	-	R	-	R	-
6	Sewer Condition	R	R	-	-	-	-	-	-
7	Sewer Conflicts	R	R	-	-	R	-	-	-

Table 1-13. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
8	Program Cost	**O**	**O**	-	-	**R**	-	-	**O**
9	Approvals and Permits	-	-	-	-	-	**R**	-	-
10	Land Acquisition	-	-	-	-	-	**R**	-	-
11	Technology Assumptions	**R**	-	-	-	**O**	**O**	**O**	-
12	Operations and Maintenance	**R**	**R**	-	-	**R / O**	**R**	**O**	**R**
13	Volume Capture Performance	**O**	**O**	-	-	-	**O**	**O**	-
14	Treatment	**R**	**R**	-	-	**O**	**O**	**O**	**R**

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

City of Winnipeg. 2008. *Study Details, Route 90 Study*. Accessed July 10, 2018. http://www.winnipeg.ca/publicworks/construction/studies/route90-studyDetails.stm.

M.M. Dillon Ltd. 1981. *Ash District Combined Sewer Relief*. December.

LEGEND

Primary Weir	Inter-System Connection	District Boundary Crossing	Interceptor Sewer	District Boundary
Critical Elevation	CS - WWS	CS	Force Main	Watercourse
CSO Outfall	SRS - CS	LDS	Street	Greenspace
Low CS Manhole	SRS - LDS	WWS	Railway	
Low SRS Connection	SRS - WWS			

CSO MASTER PLAN PROPOSED SOLUTIONS

- Proposed Control Gate
- Proposed SRS Latent Storage Pump
- Latent Storage Limit
- Extent of In-line Storage
- Latent Force Main
- Sewer Separation - Planning
- Sewer Separation - Complete

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 03
District Overview Map
Sewer District: Ash
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Manhole
- Flap Gate
- Sluice Gate
- Pump Location
- Force Main
- Sewer By Type
  - CS
  - WWS
- Control Structure Type
  - Gate Chamber
- Pump Station Type
  - Flood Pump Station
  - Lift Station

CSO MASTER PLAN
PROPOSED SOLUTIONS
- Control Gate
- Screening

ALL PROPOSED SOLUTIONS
SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 03-01
Control Gate and Screening
Sewer District: Ash
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Assiniboine District Plan

August 2019

City of Winnipeg

CSO Master Plan

Project No: 470010CH
Document Title: Assiniboine District Plan
Revision: 03
Date: August 18, 2019
Client Name: City of Winnipeg
Project Manager: John Berry
Author: Jack Tinker
File Name: Assiniboine_Plan_Final_CO1MO_08182019

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Document History and Status

Revision	Date	Description	By	Review	Approved
0	08/30/2018	DRAFT for City Comment	DT	SB / MF / SG	
1	02/15/2019	DRAFT 2 for City Review	JT	MF	SG
2	06/07/2019	Final Draft Submission	DT	MF	MF
3	08/18/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

Tables

Figure

1. Assiniboine District

1.1 District Description

Assiniboine district is located in the centre of the combined sewer (CS) area north of the Assiniboine River. Assiniboine is approximately bounded by Osborne Street, Memorial Boulevard, and Vaughan Street to the west; Graham Avenue to the north; Garry Street and Main Street to the east; and the Assiniboine River to the south.

Land use within Assiniboine district is comprised mostly of the downtown living and multiple-use sectors. Broadway is the approximate dividing line between the two sectors with the downtown living sector to the south and the multiple-use sector to the north. This includes a mix of high-rise office buildings, commercial businesses, apartment blocks, and hotel complexes. A character sector is located in the west which includes the Manitoba Legislative Building and grounds. Overall, this district includes the majority of the downtown area and includes major buildings such as the RBC Winnipeg Convention Centre, City Place, and the Manitoba Courts.

All roadways in the downtown area are considered regional transportation routes. Aside from the Legislative grounds, greenspace is limited to Bonnycastle Park located south of Assiniboine Avenue along the Assiniboine River. Approximately 8 ha of the district is classified as greenspace.

1.2 Development

Assiniboine district includes a significant portion of the downtown area and the potential for redevelopment in the future is high. The OurWinnipeg development plan has prioritized the Downtown for opportunities to create complete, mixed-use, higher density communities. Redevelopment within this area could impact the combined sewer and would be investigated on a case-by-case basis for potential impacts to the combined sewer overflow (CSO) Master Plan. All developments within the CS districts are mandated to offset any peak combined sewage discharge by adding localized storage and flow restrictions, in order to comply with Clause 8 of the Environment Act Licence 3042.

1.3 Existing Sewer System

Assiniboine district encompasses an approximate area of 86 ha[1] based on the GIS district boundary information. The district includes a CS system and a storm relief sewer (SRS) system. This district does not include any areas that may be identified as land drainage sewer-separated or separation ready. The CS system drains toward the Assiniboine outfall, located at the corner of Assiniboine Avenue and Main Street where CS is diverted to the Main Interceptor.

Two main sewer trunks collect the sewage that flows to the Assiniboine primary CS outfall. A 1350 mm CS captures flow from the southeastern section of the Bannatyne district and a 1200 mm CS trunk sewer collects flow representing the Assiniboine district proper. The 1200 mm CS trunk sewer extends along Assiniboine Avenue with collector pipes along Carlton Street and Smith Street. The southeastern section of the Bannatyne district serviced by the Assiniboine primary outfall collects flow along Main Street south of Graham Avenue within the Bannatyne district boundary, and also includes a separate 600 mm CS that services the area of The Forks south of Graham Avenue. These two CSs connect into a 1350 mm CS trunk sewer which flows by gravity south towards the Assiniboine diversion chamber.

During dry weather flow (DWF), the SRS is not required, and sanitary sewage flows to the diversion chamber upstream of the Assiniboine CS outfall and is diverted by the primary weir to a 1120 mm interceptor pipe. From here the intercepted DWF flows by gravity north to the Main Interceptor and

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System and in Section 1.8 Performance Estimate may occur.

eventually to the North End Sewage Treatment Plant (NEWPCC) for treatment. During wet weather flow (WWF), flow that exceeds the diversion capacity overtops the primary weir and is discharged to the river. Sluice and flap gates are installed on the Assiniboine CS outfall to prevent river water from backing up into the CS system. When the river level is high along the Assiniboine River, the flap gate remains closed and gravity discharge is not possible. In this situation the build-up of CS within the Assiniboine outfall is pumped by the Assiniboine flood pump station (FPS) through the Assiniboine CS outfall downstream of the flap gate, allowing it to discharge to the river.

As well during WWF events, an SRS system provides relief to the CS system in Assiniboine district. The SRS system extends throughout the district and has multiple interconnections with the CS system. Most catch basins are still connected to the CS system, so no partial separation has been completed utilizing this SRS system. Combined sewage relieved from the CS system and entering the SRS system is ultimately collected in a SRS trunk sewer running along Donald Street. This SRS trunk is drained by gravity to a dedicated SRS outfall at Donald Street and Assiniboine Avenue, immediately east of the Mid-Town Bridge. A sluice gate is located in the outfall pipe to prevent river water from backing up into the SRS system under high river level conditions along the Assiniboine River. A new flap gate is also planned to be constructed at this SRS outfall.

There are also two secondary CS outfalls within the Assiniboine district, which provide relieve to the CS in the district under WWF events and allow direct discharge to the Assiniboine River at different points, thereby relieving the system and reducing the possibility of basement flooding. The Kennedy CS outfall is located at Kennedy Street and Assiniboine Avenue, within the far upstream portion of the main trunk sewer for the Assiniboine district. If the WWF exceeds the capacity of this portion of the trunk sewer, then it will spill over a weir connecting to the Kennedy outfall and will overflow to the Assiniboine River. The Hargrave outfall is located immediately west of the Mid-Town Bridge. The secondary outfall is located within the main trunk sewer for the Assiniboine district, after it has received CS from approximately one-third of the district. If the WWF exceeds the capacity of this portion of the trunk sewer, it will spill over a weir connecting to the Hargrave outfall and will overflow to the Assiniboine River. Both sluice and flap gate protection are provided on both the Kennedy and Hargrave secondary outfall, to prevent river water from backing up into the CS system under high river level conditions along the Assiniboine River.

The four outfalls to the Assiniboine River (three CSs and one SRS) are as follows:

- ID71 (S-MA70008123) – Assiniboine CS Outfall
- ID68 (S-MA20014087) – Hargrave Secondary CS Outfall
- ID66 (S-MA70068974) – Kennedy Secondary CS Outfall
- ID69 (S-MA20014095) – Donald SRS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Assiniboine and the surrounding districts. Each interconnection is shown on Figure 04 and shows locations where gravity flow can cross from one district to another. Each interconnection is listed as follows:

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

Bannatyne

- The 1650 mm Main Interceptor pipe flows by gravity eastbound on Broadway from Assiniboine district into Bannatyne district:
  - Main Interceptor on Broadway Invert at District Boundary – 223.16 m (S-MH20012896)
- The 450 mm diversion CS from the Assiniboine CS outfall connects to the 1120 mm interceptor that flows by gravity north on Main Street to the Main Interceptor at Broadway into Bannatyne district:
  - Main Street – 224.28 m (S-MA70008109)

1.3.1.2 Interceptor Connections – Upstream of Primary Weir

Colony

- The 1500 mm Main interceptor pipe flows by gravity eastbound on Broadway from Colony district into Assiniboine district:
  - Main Interceptor Along Broadway Avenue – Invert at District Boundary – 223.16 m (S-MH20012896)

1.3.1.3 District Interconnections

Colony

<u>CS to CS</u>

- High sewer overflow from Assiniboine district north into Colony district:
  - Carlton Street and Portage Avenue Overflow Invert – 229.11 m (S-MH20014164)

<u>SRS to SRS</u>

- A 1350 mm SRS extends into Colony district, servicing Portage Place Shopping Centre, and flows by gravity from Colony district southbound into Assiniboine district on Kennedy Street:
  - Kennedy Street Invert at District Boundary – 225.64 m (S-MA20015634)

<u>SRS to CS</u>

- A 1050 mm SRS flows diverts flow from the Colony CS system and flows by gravity southbound on Donald Street and connects to the SRS network in the Assiniboine district:
  - Portage Ave and Donald Street Overflow (Top of Overflow Weir) Into 1050 mm SRS – 228.09 m (S-MH20014250)
- A 450 mm overflow SRS diverts flow from the Colony CS system and flows by gravity into the Assiniboine SRS system along St. Mary Avenue:
  - St. Mary Avenue Overflow (Top of Overflow Weir) Into 450 mm SRS – 228.32 m (S-MH20013465)
- Three separate high sewer overflows SRS pipes connect at manhole at the intersection of Graham Avenue and Edmonton Street within Assiniboine district. A 450 mm SRS overflow pipe collects SRS from this manhole northbound on Edmonton Street into Colony district and connects to the CS system in Colony district:
  - Edmonton Street and Graham Avenue 450 mm Overflow Invert – 227.83 m (S-MA20015704)

Bannatyne

<u>CS to CS</u>

- A 1350 mm CS flowing by gravity connects to the diversion chamber at the Assiniboine CS outfall from servicing southeastern portion of Bannatyne district into Assiniboine district:
  - Main Street CS Pipe Invert at District Boundary – 225.75 m (S-MA70008114)

<u>SRS to CS</u>

- A 525 mm SRS diverts flow from Bannatyne CS System, and then flows by gravity westbound along Graham Avenue into the SRS system in Assiniboine district:
  - Graham Avenue and Garry Street SRS Overflow (Top of Overflow Weir) Into 525 SRS – 228.85 m (S-MH20014497)

- A 300 mm SRS diverts flow from Bannatyne CS System, and then flows by gravity southbound on Fort Street into the CS system in Assiniboine district:
  - York Avenue and Fort Street SRS Overflow (Top of Overflow Weir) Into 300 SRS – 229.31 m (S-MH20014456)
- A 300 mm diversion SRS with two overflow connections diverts flow from the Bannatyne CS System, and then flows by gravity south on Smith Street and connects to the Assiniboine SRS system at the intersection of Smith Street and Graham Avenue:
  - Smith Street and Graham Avenue SRS Overflow #1 (Top of Overflow Weir) Into 300 SRS – 228.67 m (S-MH20014271)
  - Smith Street and Graham Avenue SRS Overflow #2 (Top of Overflow Weir) Into 300 SRS – 229.08 m (S-MH20014178)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing district.

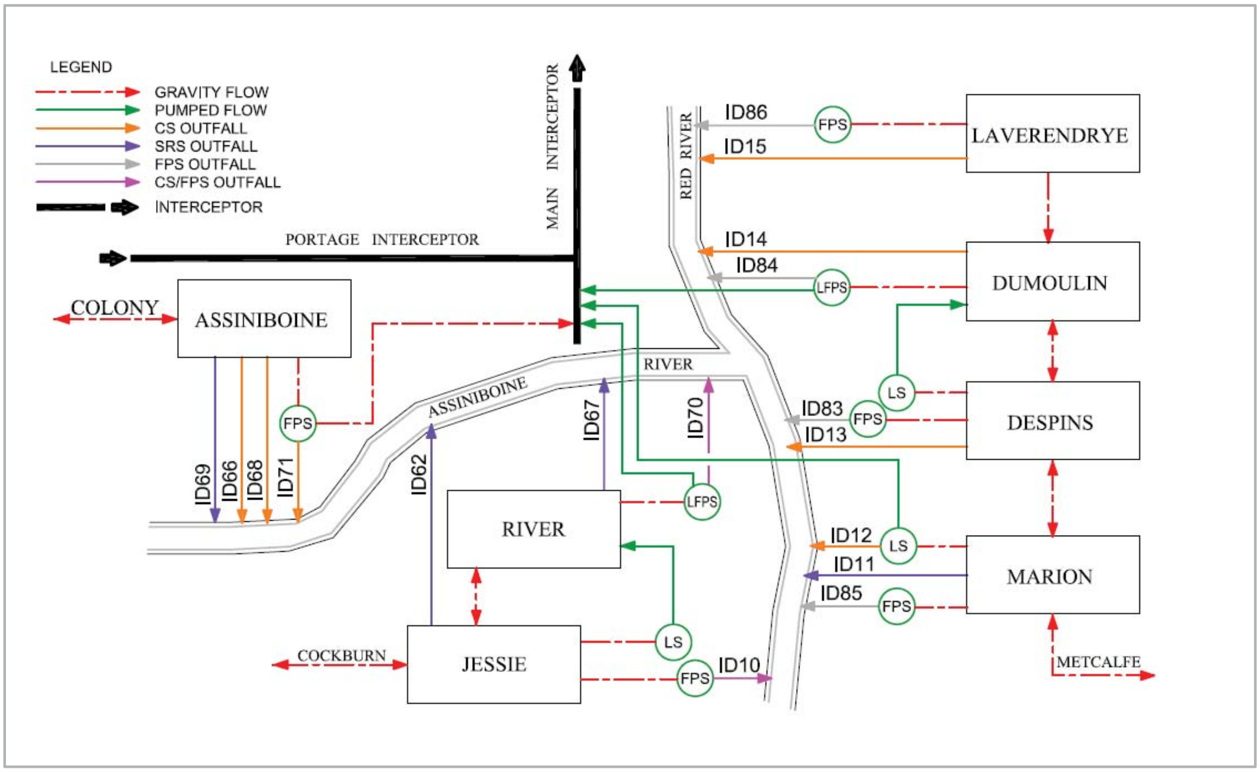

Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 04 and listed in Table 1-1

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID71)	S-RE70003466.1	S-MA70008123	1400 mm	Assiniboine River Invert: 222.04 m
Flood Pumping Outfall (ID71)	S-RE70003466.1	S-MA70008123	1400 mm	Assiniboine River Invert: 222.04 m

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Other Overflows (ID66 & ID68)	S-AC70028554.1 S-AC20004773.1	S-MA70068974 S-MA20014087	750 mm 750 mm	Invert: 222.43 m Invert: 222.03 m
Main Trunk	S-MH20011932.1	S-MA70008096	1200 mm	Circular Invert: 225.83 m
SRS Outfalls (ID69)	S-CO70003060.1	S-MA20014095	1900 mm	Invert: 221.80 m
SRS Interconnections	N/A	N/A	N/A	41 SRS - CS
Main Trunk Flap Gate	S-AC70008475.1	S-CG00000720	1525 mm	Invert: 223.97 m
Main Trunk Sluice Gate	ASSINIBOINE_GC.1	S-CG00000721	1721 x 1721 mm	Invert: 223.70 m
Off-Take	ASSINIBOINE_WEIR.2	S-MA70008109	450 mm	Invert: 225.94 m
Dry Well	N/A	N/A	N/A	
Lift Station Total Capacity	ASSINIBOINE_WEIR.2 (1)	S-MA70008109 (1)	450 mm (1)	1.236 m3/s (1)
ADWF	N/A	N/A	0.031 m^3/s	
Lift Station Force Main	N/A	N/A	N/A	
Flood Pump Station Total Capacity	N/A	N/A	1.4 m^3/s	1 x 1.4 m^3/s
Pass Forward Flow – First Overflow	N/A	N/A	0.841 m^3/s	1-year design event

Notes:

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

(1) – Gravity pipe replacing Lift Station as Assiniboine is a gravity discharge district

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation[a]
1	Normal Summer River Level	Assiniboine – 223.828 Donald – 223.83 Hargrave – 223.831 Kennedy – 223.833
2	Trunk Invert at Off-Take	225.94
3	Top of Weir	226.41
4	Relief Outfall Invert at Flap Gate	Donald – 222.44
5	Low Relief Interconnection (S-MH20012805)	227.378
6	Sewer District Interconnection (Colony)	225.38
7	Low Basement	228.90
8	Flood Protection Level (Assiniboine)	229.91

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed in Assiniboine was the *Conceptual Design of Combined Sewer Relief for Assiniboine Sewer District* (Comeau, 1989). The study's purpose was to assess the level of protection against basement flooding and to provide appropriate methods for providing relief to the district. No other work has been completed on the district sewer system since that time.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Assiniboine CS district was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations have a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Planned Completion
4 – Assiniboine	1989	Future Work	2013	Study Complete	N/A

1.5 Ongoing Investment Work

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Assiniboine district. This consists of monthly site visits in confined entry spaces to verify that physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

Upgrades to the Donald SRS outfall are under design at the time of writing, to be implemented in the near future. This work will include the addition of a flap gate to existing gate chamber at this outfall, which includes only a positive sluice gate at this time. This work will be critical to allow for latent storage implementation.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Assiniboine district are listed in Table 1-4. The proposed CSO control projects will include latent storage, and floatables management via screening. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	✓	-	✓	-	-	-	-	-	✓	✓	✓

Notes:

- = not included
✓ = included

The height of the existing weir is sufficient that it negates the need to add a control gate to provide in-line storage. The existing height of the weir provides an existing storage of 143 m^3. Since this district already has an existing high level weir, this has been taken as acceptable for basement flooding protection.

The existing SRS system is suitable for use as latent storage. These control options will take advantage of the existing SRS pipe network for additional storage volume.

The Assiniboine district discharges to the interceptor by gravity; therefore, a gravity flow controller is proposed on the CS system to optimize the dewatering rate from the district back into the Main Street interceptor.

Floatable control will be necessary to capture any undesirable floatables in the sewage. Floatables will be captured with all implemented control options to some extent, but screening may be added as required to reach the desired capture level.

GI and RTC will be applied within each district on a system wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Latent Storage

Latent storage is proposed as a control option for Assiniboine district. The latent storage level in the system is controlled by the river level on the Assiniboine River, and the resulting backpressure of the river level on the SRS outfall flap gate, as explained in Part 3C. The latent storage design criteria are identified in Table 1-5. The storage volumes indicated in Table 1-5 are based on the NSWL for the 1992 representative year.

Table 1-5. Latent Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	Donald – 222.44 m	Flap gate invert
NSWL	223.83 m	
Trunk Diameter	1950 mm	
Design Depth in Trunk	1390 mm	

Table 1-5. Latent Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Maximum Storage Volume	420 m^3	
Force Main	150 mm	
Flap Gate Control	N/A	Flap gate control was established as not required for this work.
Lift Station	Yes	
Nominal Dewatering Rate	0.03 m^3/s	Based on 24 hour emptying requirement
RTC Operational Rate	TBD	Future RTC / dewatering review on performance

Note:

NSWL – normal summer water level RTC – Real Time Control

The addition of a pump and force main that connect to the CS system are necessary for the latent storage to be emptied. A conceptual layout for the latent storage pump station (LSPS) and force main is shown on Figure 04-02. The LSPS will be located to the east of the existing SRS outfall chamber to avoid interference with nearby residential lands and disruption to existing sewers. The latent force main will flow north and connect to the Assiniboine CS system and into the manhole (S-MH20012737) on Assiniboine Avenue.

The LSPS would connect to the SRS outfall chamber and discharge back to the CS system once capacity allows. This SRS outfall chamber is currently being upgraded to include a flap gate to allow latent storage to be utilized, see Section 1.5 above. Figure 04 identifies the extent of the SRS system within Assiniboine district that would be used for latent storage. The maximum storage level is directly related to the 1992 representative year NSWL and the size and depth of the SRS system. Once pressure from the level in the SRS exceeds the river level backpressure, the flap gate opens, and the combined sewage is discharged to the river.

As part of the evaluation of the latent storage volume using the continuous NSWL river conditions during the 1992 representative year, it was found that additional flap gate control will not be required to meet Control Option 1. In situations where non modelled assessments are to be completed, the actual river levels will be both lower and higher than the NSWL level at various points throughout an annual year. Where the level is below NSWL, the latent volume will be less than predicted during the MP assessment, while conversely when the level is above the NSWL, the latent volume will be more than predicted. The continuous assessment is seen as a conservative approach since the majority of the representative year rainfall events occur when the river levels are higher than the NSWL.

It should also be noted that the lowest interconnection between the combined sewer and SRS relief pipe network is higher than the proposed latent and existing in-line storage control levels, meaning that the two systems would function independently.

As described in the standard details in Part 3C wet well sizing will be determined based on the final pump selection, operation and dewatering capacity required. The interconnecting piping between the SRS gate chamber and the pump station would be sized to provide sufficient flow to the pumps while all pumps are operating.

1.6.3 Gravity Flow Control

Assiniboine district does not include a LS and discharges to the Main Interceptor by gravity, and only restricted by the off-take pipe flow capacity. A flow control device will be required to control and monitor this diversion rate for future RTC and dewatering assessments. A standard flow control device was selected as described in Part 3C.

The flow controller will include flow measurement and a gate to control the discharge flow rate. This has been taken as part of the City's future vision to develop a fully integrated CS system network and will be needed to review flows during spatial rainfall WWF scenarios. The CSO Master Plan assessment utilized a uniform rainfall event, and no further investigative work has been completed within the CSO Master Plan. The operation and configuration of the gravity flow controller will have to be further reviewed for additional flow and rainfall scenarios.

The flow control would be installed at an optimal location on the connecting off-take sewer between the Main Interceptor and existing diversion chamber. Figure 04-01 identifies a conceptual location for flow controller installation. The location proposed would be constructed within the right of way of Main Street, a major arterial roadway. Additional modelling assessment would also be needed to reconfirm the flows within the off-take at this point, and to investigate if the existing off-take pipe may need to be resized as a result of this work. Survey work would be involved to confirm levels in area as part of model maintenance and improvement. The construction is expected to be significant from a traffic aspect due to the location proposed, although construction traffic will be of a short term nature, and will not require the same closures as that for construction of new sewers with separation projects. A small chamber or manhole with access for cleaning and maintenance will be required. The flow controller will operate independently and require minimal operation interaction.

1.6.4 Floatables Management

Floatables management will require installation of a screening system to capture floatable materials; in-line screens will be proposed to maintain the current level of basement flooding protection.

The type and size of screens depend on the specific station configuration and the head available for operation. A standard design was assumed for screening and is described in Part 3C. The design criteria for screening, with an in-line control gate implemented, are listed in Table 1-6.

Table 1-6. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Top of Gate	226.42 m	Existing weir level
Bypass Weir Crest	N/A	In-line screening
NSWL	223.83 m	
Maximum Screen Head	2.59 m	
Peak Screening Rate	0.91 m^3/s	
Screen Size	1.5 m wide x 1 m high	Modelled Screen Size

The proposed screening chamber will be located in-line to the existing weir and existing CS trunk, as shown on Figure 04-01. The flow to the screens located in the new screening chamber, with screened flow discharged to the downstream side of the screening chamber to the river. The screening chamber will include screenings pumps with a discharge returning the screened material to the main interceptor for routing to the NEWPCC for removal.

1.6.5 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district was reviewed to identify the most applicable GI controls.

Assiniboine has been classified as a medium GI potential district. Land use in Assiniboine is downtown living and multiple-use sectors, the south end of the district is bounded by the Assiniboine River. This means the district would be an ideal location for bioswales, and green roofs. There are a few parking lot areas which would be ideal for paved porous pavement.

1.6.6 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 Systems Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

The latent storage will take advantage of the SRS infrastructure already in place; therefore, minimal additional maintenance will be required for the sewers. The proposed LSPS will require regular maintenance that would depend on the frequency of operation. Additional system monitoring, and level controls will be installed which will require regular scheduled maintenance.

The gravity flow controller will require the installation of a chamber and flow control equipment. Monitoring and control instrumentation will be required. The gravity flow controller will operate independently and require minimal operation interaction. Regular maintenance of the flow controller chamber and appurtenances will be required, which are further elaborated in Part 3C of the CSO Master Plan.

Floatable control with outfall screening will require the addition of another chamber with screening equipment installed. Screening operation will occur during WWF events that surpass the existing in-line storage control level. WWF would be directed from the main outfall trunk, over the existing primary weir and through the screens to discharge into the river. The screens will operate intermittently during wet weather events based on actual overflows and will likely require operations review and maintenance after each event. The frequency of a screened event would correlate to the number overflows identified for the district. The collected screenings will be transferred back to the main trunk via a small bespoke pump station and force main. Additional maintenance for the screening pumps will be required at regular intervals and after screening events.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. An individual model was created to represent the sewer system baseline as represented in the year 2013, and a second model was created for the CSO Master Plan evaluation purposes, with all the control options recommended for the district to meet Control Option 1 implemented in the year 2037. A summary of relevant model data is summarized in Table **1**-7.

Table 1-7. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Added To Model
2013 Baseline	102	102	7,325	65	N/A
2037 Master Plan – Control Option 1	102	102	7,325	65	Lat St, SC,

Notes:

Table 1-7. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Added To Model

Lat St = Latent Storage
SC = Screening

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-8 are for the hydraulic model simulations using the year-round 1992 representative year. This table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. Table 1-8also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-8. Performance Summary – Control Option 1

Control Option	Preliminary Proposal	Master Plan			
	Annual Overflow Volume (m^3)	Master Plan Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [b]
Baseline (2013)	11,244	13,005	-	16	0.841 m^3/s
Latent Storage	9,734	11,549	1,457	11	0.653 m^3/s
Off-line Storage Tank	5,302 [a]	N/A	N/A	N/A	N/A
Control Option 1	**5,302 [a]**	**11,549**	**1,457**	**11**	**0.653 m^3/s**

[a] Preliminary Proposal included offline storage tank which was not proposed for the CO1MP assessment

[b] Pass forward flows assessed on the 1-year (Baseline) and 5-year (Latent & CO1) design rainfall events at main Assiniboine CS outfall. No overflow for 1-year event.

The selection of an off-line tank during the Preliminary Proposal has been reevaluated during the CSO Master Plan phase as not appropriate. It was found that the performance provided by the other more cost effective control options in all other CS districts achieved the 85 percent capture prior to the requirement for off-line storage tanks in specific districts. The updated cost considerations have also resulted in the removal of this solution from the Assiniboine district.

The percent capture performance measure is not included in Table 1-8, as it is applicable to the entire CS system and not for each district individually.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-9. The cost estimates are AACE Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-9. Cost Estimates – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance (Over 35-year period)
Latent Storage	$1,790,000	$2,580,000	$74,000	$1,600,000
Off-line Storage Tank	- [a]	N/A [c]	N/A	N/A
Screening	- [a]	$2,910,000 [d]	$34,000 [d]	$740,000
Gravity Flow Control	N/A [b]	$1,300,000	$34,000	$740,000
Subtotal	**$1,790,000**	**$6,790,000**	**$143,000**	**$3,080,000**
Opportunities	N/A	$680,000	$14,000	$310,000
District Total	**$1,790,000**	**$7,470,000**	**$158,000**	**$3,390,000**

[a] Solution developed as refinement to Preliminary Proposal work following submission of Preliminary Proposal costs. Costs for Off-line storage item of work found to be $2,980,000 and Screening item of work found to be $450,000 both in 2014 dollars

[b] Gravity flow control not included in the Preliminary Proposal 2015 costing

[c] Off-line storage not taken forward as a Master Plan Control Option 1 solution.

[d] Cost for bespoke screenings return pump/force main not included in Master Plan as will depend on selection of screen and type of screening return system selected

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional costs for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014 dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019 dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of alternative plans, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table.

Table 1-10. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Latent Storage	Unit cost updates	
	Screening	Screening was not included in the preliminary estimate	
	Removal Of Off-line Storage Tank	Off-line storage not taken forward as a Master Plan Control Option 1 solution, not considered cost effective to meet CO1 target.	
	Gravity Flow Control	A flow controller was not included in the preliminary estimate	Added for the Master Plan to optimize existing static in-line performance.
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management Approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation.	Preliminary Proposal estimates were based on 2014-dollar values.	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, a future performance target of 98 percent capture for the representative year measured on a system-wide basis was evaluated. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-11 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified for Control Option 1.

Overall the Assiniboine district would be classified as low potential for implementation of complete sewer separation as the only feasible approach to achieve the 98 percent capture in the representative year future performance target. The increased volume capture via the inclusion of a flap gate on the latent storage infrastructure could potentially be achieved. In addition, green infrastructure and off-line storage tank or tunnel storage may be utilized in key locations to provide additional storage and increase capture volume. Opportunistic separation of portions of the district may be achieved with synergies with other major infrastructure work to address future performance targets.

Table 1-11. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Increased use of latent storage (Flap Gate Control) • Increased use of GI Off-line Storage (Tank/Tunnel) • Opportunistic Separation

The Assiniboine district control options have been aligned to the primary outfall being screened under the proposed 85 percent capture control plan. This may limit the expandability nature to achieve the 98 percent capture but would require to be based on the system wide assessment.

The cost for upgrading to meet an enhanced performance target depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-12.

Table 1-12. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	R	-	-	-	-	-	-	-
2	Existing Lift Station	-	-	-	-	-	-	-	-
3	Flood Pumping Station	-	-	-	-	-	-	-	-
4	Construction Disruption	-	-	-	-	-	-	-	-
5	Implementation Schedule	-	-	-	-	-	-	-	-
6	Sewer Condition	R	-	-	-	-	-	-	-
7	Sewer Conflicts	R	-	-	-	-	-	-	-
8	Program Cost	-	-	-	-	-	-	-	O
9	Approvals and Permits	-	-	-	-	-	-	-	-
10	Land Acquisition	-	-	-	-	-	-	-	-
11	Technology Assumptions	R	-	-	-	-	O	O	-
12	Operations and Maintenance	R	-	-	-	-	R	O	R
13	Volume Capture Performance	O	-	-	-	-	O	O	-
14	Treatment	-	-	-	-	-	-	O	R

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

Comeau, J.E. 1989. *Conceptual Design of Combined Sewer Relief for Assiniboine Sewer District*. Prepared for the Water and Waste Department.

LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Low CS Manhole
- Low SRS Connection

Inter-System Connection
- CS - WWS
- SRS - CS

District Boundary Crossing
- CS
- SRS
- WWS

- Extent of Existing In-line Storage
- Interceptor Sewer
- Force Main
- Street
- Railway

- District Boundary
- Watercourse
- Greenspace
- City Owned Land

CSO MASTER PLAN PROPOSED SOLUTIONS
- Proposed SRS Latent Storage Pump
- Latent Storage Limit
- Latent Force Main

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 04
District Overview Map
Sewer District: Assiniboine
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- Primary Weir
- Critical Elevation
- Manhole
- Flap Gate
- Sluice Gate
- Pump Location
- Force Main
- Sewer By Type
  - CS
  - WWS
- Control Structure Type
  - Gate Chamber
- Pump Station Type
  - Discharge Box
  - Flood Pump Station
  - Wet Well

CSO MASTER PLAN PROPOSED SOLUTIONS

- Screening
- Flow Controller

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 04-01
Flow Controller
Sewer District: Assiniboine
City of Winnipeg
Combined Sewer Overflow Master Plan

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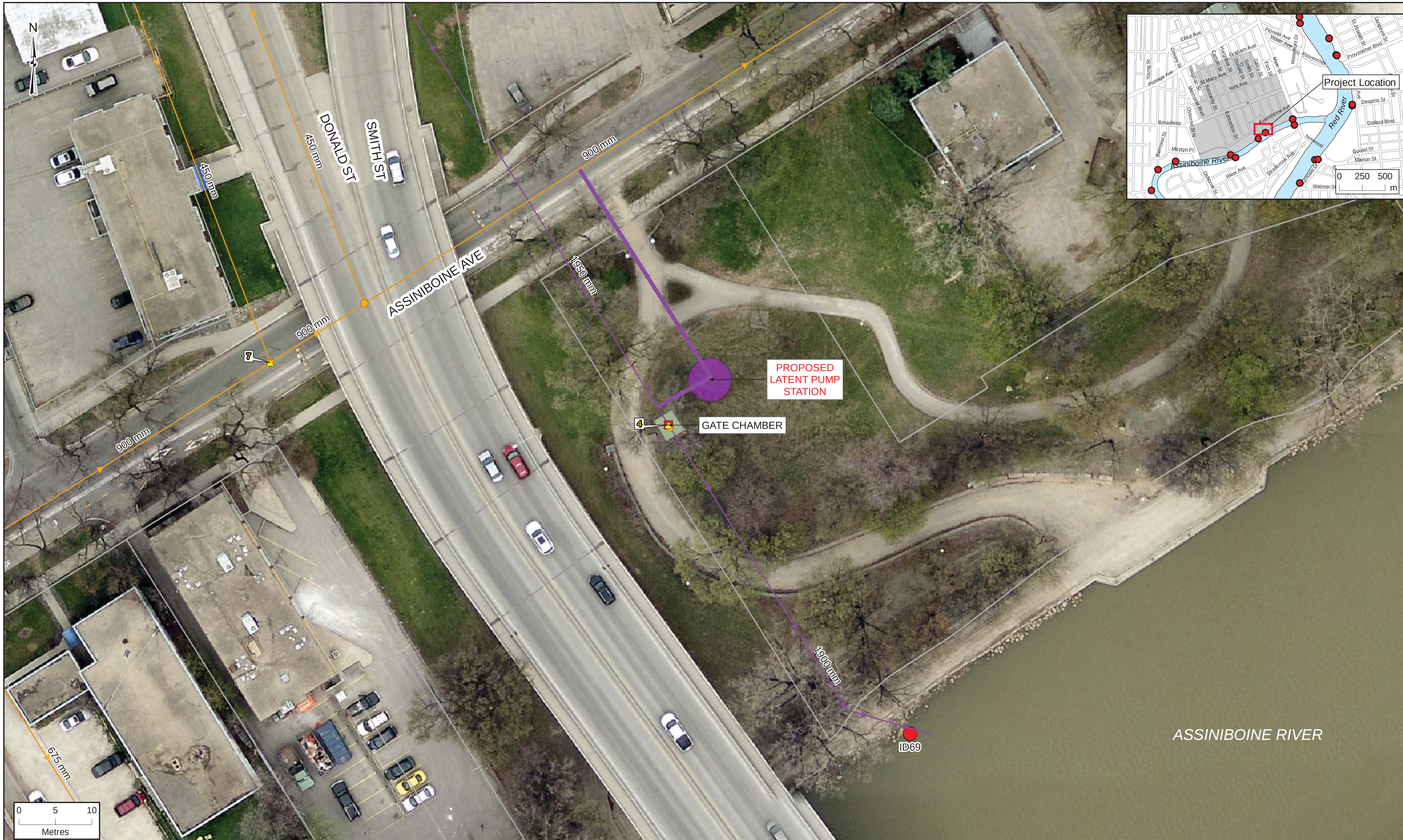

LEGEND

- Critical Elevation
- CSO Outfall
- Manhole
- Sluice Gate

Sewer By Type
- CS
- SRS

Control Structure Type
- Gate Chamber

- Land Parcel

CSO MASTER PLAN
PROPOSED SOLUTIONS
- Proposed Latent Force Main
- Latent Pump

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 04-02
Latent SRS Control
Sewer District: Assiniboine
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Aubrey District Plan

August 2019

City of Winnipeg

CSO Master Plan

Project No: 470010CH
Document Title: Aubrey District Plan
Revision: 04
Date: August 16, 2019
Client Name: City of Winnipeg
Project Manager: John Berry
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Document History and Status

Revision	Date	Description	By	Review	Approved
0	08/30/2018	Version 1 DRAFT	DT	SB / SG / MF	
1	02/15/2019	DRAFT 2 for City Review	MF	SG	MF
2	05/2019	Final Draft Submission	DT	MF	MF
3	06/2019	Revised Final Draft Submission	DT	MF	SG
4	08/16/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

Tables

Figure

1. Aubrey District

1.1 District Description

Aubrey district is in the central portion of the combined sewer (CS) area north of the Assiniboine River. As a district, Aubrey has a unique configuration due to the northern section of Aubrey extending into Clifton district and separating Aubrey district. It is approximately bounded by the Canadian Pacific Railway (CPR) Winnipeg Yards to the north; Erin Street, Minto Street, and Goulding Street to the west; the Assiniboine River to the south; and Burnell Street and Arlington Street to the east. The section of Aubrey district that divides Clifton district is bordered by McCrossen Street to the west, Dublin Avenue and Notre Dame Avenue to the north, and Clifton Street to the east.

The land use within Aubrey district is distributed between primarily industrial and residential areas, as well as commercial businesses located along Portage Avenue and McPhillips Street. The northern area of Aubrey is primarily heavy manufacturing with the CPR Weston Shops and Yards, and the Pacific Industrial lands. The central and southern sections of Aubrey district include residential land consisting of single- and two-family homes and apartment buildings distributed throughout the district. The area of Notre Dame Avenue has mostly been developed as light and heavy industrial. Commercial corridors are located along the various east-west streets in the southern sections of Aubrey, including Ellice Avenue, Wellington Avenue, and Sargent Avenue, among others.

Many major transportation routes pass through the district: McPhillips Street, Logan Avenue, Notre Dame Avenue, Wall Street, Ellice Avenue, and Portage Avenue

Greenspace is limited in the Aubrey district, with small parks located within the residential areas. These parks include Stanley Knowles Park and Sargent Park. Notable non-residential buildings in the Aubrey district include the CPR Winnipeg Yard that spans the northern section, the Royal Canadian Mounted Police Winnipeg Office, and the McPhillips Station Casino.

1.2 Development

A portion of Portage Avenue is located within the Aubrey District. Portage Avenue is identified as Regional Mixed Use Corridor as part of the OurWinnipeg future development plans. As such, focused intensification along Portage Avenue is to be promoted in the future.

1.3 Existing Sewer System

Aubrey district encompasses an area of approximately 537 ha[1] based on the GIS district boundary data. This includes an area of approximately 17 ha (3 percent of the district area) that is considered separation ready and approximately 16 ha (3 percent of the district area) of greenspace. There is no completed separation in the district.

The CS system includes a flood pump station (FPS), a CS lift station (LS) system and two independent storm relief sewer (SRS) systems. Four outfalls are in the district including one CS, one FPS and two SRS.

The CS system flows to the Aubrey outfall, located at the southern end of Aubrey Street. A single 2800 mm CS trunk sewer collects flow from most of the district. This trunk extends north along Aubrey Street to Portage Avenue. The section of the district north of Notre Dame Avenue is serviced by a 700 mm CS on Logan Avenue that connects to a 900 mm by 1200 mm egg-shaped CS on McPhillips Street. This, in turn, flows to a 1675 mm by 2150 mm egg-shaped trunk on Lipton Street that increases in size as it flows

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

south and into a 2050 mm by 2650 mm egg-shaped trunk on Aubrey Street which connects into the 2800 trunk sewer and towards the Aubrey outfall. This Lipton/Aubrey trunk sewer also receives combined sewage from the southern section of the district. Sewers along major roads such as Portage Avenue, Ellice Avenue, St Matthews Avenue, Sargent Avenue, Wellington Avenue, Notre Dame Avenue, and McPhillips Street act as collector pipes and feed into the Aubrey and Lipton Streets trunk sewers. A separate 300 mm CS, which collects sewage from Palmerston Avenue, connects to the trunk at the Aubrey outfall immediately upstream of the primary weir.

During dry weather flow (DWF), flow is diverted by the primary weir to the Aubrey CS LS and pumped to the interceptor sewer on Wolseley Avenue which flows by gravity to the NEWPCC for treatment. The Aubrey district receives the intercepted combined sewage flow from the Ash CS district, via a force main river crossing across the Assiniboine River. The flow from Ash CS lift station (LS) connects to the interceptor on Wolseley upstream of the Aubrey interceptor connection.

During wet weather flow (WWF), any flow that exceeds the diversion capacity overtops the primary weir and is discharged to the Assiniboine river. Sluice and flap gates are installed on the Aubrey CS outfall to prevent back-up of the Assiniboine River into the CS system under high river levels in the Assiniboine River. When the Assiniboine River levels are high during WWF events however, no gravity discharge is possible due to the flap gate installed on the CS outfall. Under these high river level conditions, the excess flow is pumped by the FPS, where it is routed to the dedicated FPS outfall to the river. The FPS outfall does not have a flap gate or sluice gate installed.

During WWF events as well, the SRS systems provide relief to the CS system in the Aubrey district. The SRS systems extend throughout Aubrey and have multiple interconnections with the CS system. Most catch basins are still connected to the CS system, so no partial separation has been completed. Combined sewage relieved from the CS system and entering the SRS system is routed to one of two SRS trunk sewers. The first SRS trunk sewer collecting SRS from the western portion of the district is located along Aubrey Street and is drained by gravity through the Aubrey SRS outfall to the Assiniboine River. The second SRS trunk sewer collecting SRS from the eastern portion of the district is located along McPhillips Street/Burnell Street/Lenore Street and flows by gravity through Ruby SRS outfall to the Assiniboine River.

The four outfalls to the Assiniboine River (one CS, two SRSs, and one FPS) are as follows:

- ID57 (S-MA70017579) – Aubrey CS Outfall
- ID82 (S-MA70017556) – Aubrey FPS Outfall
- ID56 (S-MA70017585) – Ruby SRS Outfall
- ID58 (S-MA70022480) – Aubrey SRS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Aubrey and the surrounding districts. Each interconnection is shown on Figure 05 and shows locations where gravity and pumped flow can cross from one district to another. Each interconnection is listed in the following subsections.

1.3.1.1 Interceptor Connection – Downstream of Primary Weir

Cornish

- The 1200mm Main Interceptor, a gravity sewer discharges into the Cornish district from the Aubrey district and carries sewage to the NEWPCC for treatment:
  - Invert at the manhole S-MH20008231 in Portage Avenue. This gravity pipe flows through multiple districts, including Aubrey, and on to the NEWPCC.

1.3.1.2 Interceptor Connection – Upstream of Primary Weir

Ash

- Dual 300 mm force main river crossing carries flow from the Ash LS across the Assiniboine River to the Aubrey district Man interceptor pipe and on to the North End Sewage Treatment Plant (NEWPCC) for treatment.
    - o Aubrey district south of Wolseley Avenue invert each force main pipe = 230.64 m (S-MH70006432)

Clifton

- A 1050mm Main Interceptor sewer discharges via gravity into the Aubrey district from the Clifton district and carries sewage to the NEWPCC for treatment:
    - Portage Avenue – 226.68 m (S-TE70008265)

1.3.1.3 District Interconnections

Clifton

<u>CS to CS</u>

- High Point Manholes (flow is directed into both districts from these manholes):
    - Midland Street – 230.72 m (S-MH20010625)
    - Notre Dame Street – 230.28 m (S-MH20010674)
    - Wall Street (near Wall Street East) – 229.04 m (S-MH20009426) (also to SRS)
    - Wolseley Avenue – 230.22 m (S-MH70039558)
    - Pacific Avenue West and Quelch Street – 228.87 m (S-MH20011789)
    - Alexander Avenue and Quelch Street – 228.57 m (S-MH20010968)
    - Portage Avenue and Clifton Street – 227.24 m (S-MH20010003)
- A 750mm bifurcation pipe directs excess flow from the Clifton district to the Aubrey district at the intersection of Roy Avenue and Cecil Street :
    - Cecil Street – 227.88 m (S-MH20010899)
- A 750 mm bifurcation pips from Aubrey flows southbound on Quelch Street and excess flows connect to the CS system south in the Clifton district on Logan Avenue:
    - Logan Avenue – 227.03 m (S-MH20010965)

<u>CS to SRS</u>

- High Point Manhole(s):
    - Minto Street – 227.56 m (S-MH20008769)
    - Goulding Street – 229.9 m (S-MH20008710)
    - Goulding Street – 229.53 m (S-MH20008700)
    - Wolseley Avenue and Basswood Place – 229.65 m (S-MH70005332)
- A 450 mm SRS overflow pipe connects from the Aubrey district to the SRS system in Clifton district at Keewatin Street and Alexander Avenue:
    - Alexander Avenue –228.27 m (S-MH20011401)

- A 300 mm SRS overflow pipe connects into the SRS system in Clifton district to reduce sewage back-up of the CS network in Aubrey on Pacific Avenue West:
  - Pacific Avenue West – 227.84 m (S-MH20011392)
- A 300 mm diversion pipe provides relief to the CS on Sprague Street and flows from a high point manhole into the Clifton district flowing eastbound on Wolseley Avenue:
  - Wolseley Avenue –229.42 m (S-MH20010522)

<u>SRS to CS</u>

- A 600 mm SRS overflow pipe from Aubrey's CS system flows into Clifton district on Notre Dame Avenue near Clifton Street North:
  - Notre Dame Avenue – 227.91 m (S-MH20011679)
- A 375 mm SRS overflow pipe from Aubrey's CS system flows into Clifton district on Logan Avenue near Wiens Street and connects to the SRS along Logan Avenue:
  - Logan Avenue – 228.83 m (S-MH20011446)

<u>SRS to SRS</u>

- A 2700 mm SRS trunk conveys flow by gravity southbound on Midland Street from Aubrey district into Clifton district to Clifton's SRS outfall:
  - Midland Street– 225.53 m (S-TE20003059)
- A 2250 mm SRS trunk flows by gravity from northern Clifton into Aubrey district at the intersection of Notre Dame Avenue and Flint Street. It also connects to a SRS coming eastbound from Aubrey and then it connects the SRS that flows south on Midland Street:
  - Flint Street and Notre Dame Avenue –225.68 m (S-MH20011539)
- A 1650 mm SRS flows by gravity from northern Clifton collecting overflow from the CS system, into Aubrey district on Notre Dame Avenue. It then connects the SRS that flows south on Midland Street:
  - Notre Dame Avenue –227.22 m (S-MH20010742)
- A 1350 mm SRS flows by gravity from the Aubrey district into Clifton district along Quelch Street at Logan Avenue:
  - Logan Avenue – 226.91 m (S-MH20010964)
- A 1,350 mm SRS pipe flows by gravity from the Aubrey district into Clifton along Worth Street:
  - Worth Street – 226.94 m (S-TE20003936)

<u>WWS to CS</u>

- A 250 mm WWS pipe flows westbound from the Aubrey district on Pacific Avenue into the Clifton CS system:
  - Pacific Avenue – 227.92 m (S-MH20011757)

Alexander

<u>CS to CS</u>

- A 200 mm CS servicing a small area of Aubrey district flows by gravity to connect with the 750 mm CS that connects to the Alexander CS system in Alexander district at the corner of Alexander Avenue and Xante Street:
  - Alexander Avenue and Xante Street Invert at District Boundary – 228.41 m (S-MA20019569)
- High Point Manholes (flow is directed into both districts from these manholes):

- Henry Avenue and Tecumseh Street – 228.95 m References Alexander District, 229.96 m References Aubrey District (S-MH20017866)
- Logan Avenue and Trinity Street – 228.77 m References Alexander District, 226.94 m References Aubrey District (S-MH20017639)
- Pacific Avenue and Arlington Street – 229.3 m (S-MH20017548)
- Elgin Avenue and Arlington Street – 229.49 m (S-MH20017513)

<u>LDS to SRS</u>

- A 375 mm LDS services surface runoff from portion of Alexander district, and flows from Aubrey SRS by gravity westbound along Alexander Avenue and connects to the SRS system in the Aubrey district at the corner of Alexander Avenue and Xante Street:
  - Xante Street and Alexander Avenue Invert at District Boundary – 224.94 m (S-MA70062373)

Bannatyne

<u>CS to CS</u>

- A 300 mm CS pipe acts as overflow at Winnipeg Avenue and Arlington Street to relief CS system in Aubrey district, and then flows by gravity northbound along Arlington Street into the CS System in the Bannatyne District:
  - Winnipeg Avenue and Arlington Street CS Overflow Invert into 300 mm CS – 228.91 m (S-MH20016213)
- High point manhole:
  - William Avenue and Arlington Street – 229.77 m (S-MH20017498)
  - Bannatyne Avenue and Lark Street – 229.10 m (S-MH20016063)
  - McDermot Avenue and Arlington Street – 229.46 m (S-MH20016155)
  - Notre Dame Avenue and Arlington Street – 229.43 m (S-MH20016156)

<u>SRS to CS</u>

- A 1200 mm SRS relieving several blocks from Bannatyne district CS system flows by gravity southbound on Arlington Street into a manhole at Arlington Street and Winnipeg Avenue that connects with the Aubrey CS system.
  - Winnipeg Avenue and Arlington Street Invert at District Boundary – 226.63 m (S-MA70062569)

<u>SRS to SRS</u>

- A 300 mm SRS overflow pipe diverts flow from Aubrey district CS system at Notre Dame Avenue and Arlington Street, and then flows by gravity to connect into the 1350 mm SRS along Notre Dame Avenue and flows into Bannatyne district SRS system.
  - Notre Dame Avenue and Arlington SRS Overflow Invert into 300 SRS – 229.92 m (S-MH20016162)
- A 250 mm SRS overflow pipe diverts flow from Aubrey district CS system at high point CS manhole at Notre Dame Avenue and Arlington Street, and then flows by gravity to connect into the 1350 mm SRS along Notre Dame Avenue and flows into Bannatyne district SRS system.
  - Notre Dame Avenue and Arlington SRS Overflow Invert into 300 SRS – 229.53 m (S-MH20016156)
- A 1350 mm SRS overflow pipe diverts flow from Aubrey district CS system at Winnipeg Avenue and Arlington Street, and then flows by gravity to connect into the 1350 mm SRS along Notre Dame Avenue and flows into Bannatyne district SRS system.

- Winnipeg Avenue and Arlington SRS Overflow (Top of Overflow Weir) Into 1350 mm SRS – 228.12 m (S-MH70028506)

- A 300 mm SRS overflow pipe diverts flow from Aubrey district CS system at Notre Dame Avenue and Home Street, and then flows by gravity northbound along Home Street and flows into Bannatyne district SRS system.
  - Notre Dame Avenue and Home Street SRS Overflow Invert (Top of Overflow Weir) Into 300 mm SRS – 229.44 m (S-MH20016212)
- A 375 mm SRS overflow pipe diverts flow from Aubrey District CS system at Winnipeg Avenue near Tecumseh Street, and then flows eastbound on Winnipeg Avenue into the SRS system in the Bannatyne district.
  - Winnipeg Avenue and Tecumseh Street SRS Overflow (Top of Overflow Weir) Into 375 mm SRS – 228.99 m (S-MH70028288)

Cornish

<u>CS to CS</u>

- The 1200 mm Interceptor pipe along Wolseley flows by gravity carrying intercepted CS from the Cornish district and crosses into the Aubrey district on Wolseley Avenue:
  - Wolseley Avenue Interceptor Invert at District Boundary - 226.21 m (S-MA20013757)
- The 1200 mm Main Interceptor pipe along Wolseley flows by gravity carrying intercepted CS from the Douglas Park, Ferry Road, Riverbend, Parkside, Tylehurst, and Clifton districts and crosses into the Aubrey district on Wolseley Avenue:
  - Main Interceptor Along Wolseley Invert at District Boundary - 226.18 m (S-MA20013779)
- High Point Manholes (flow is directed into both districts from these manholes):
  - Portage Avenue and Burnell Street – 229.09 m (S-MH20013779)

<u>SRS to SRS</u>

- A 600 mm SRS divert flow from Aubrey CS System, and then flows by gravity eastbound on Wellington Avenue into the SRS System in the Cornish district:
  - Wellington Avenue and Home Street 600 mm SRS Overflow Invert – 227.55 m (S-MH20016115)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing district.

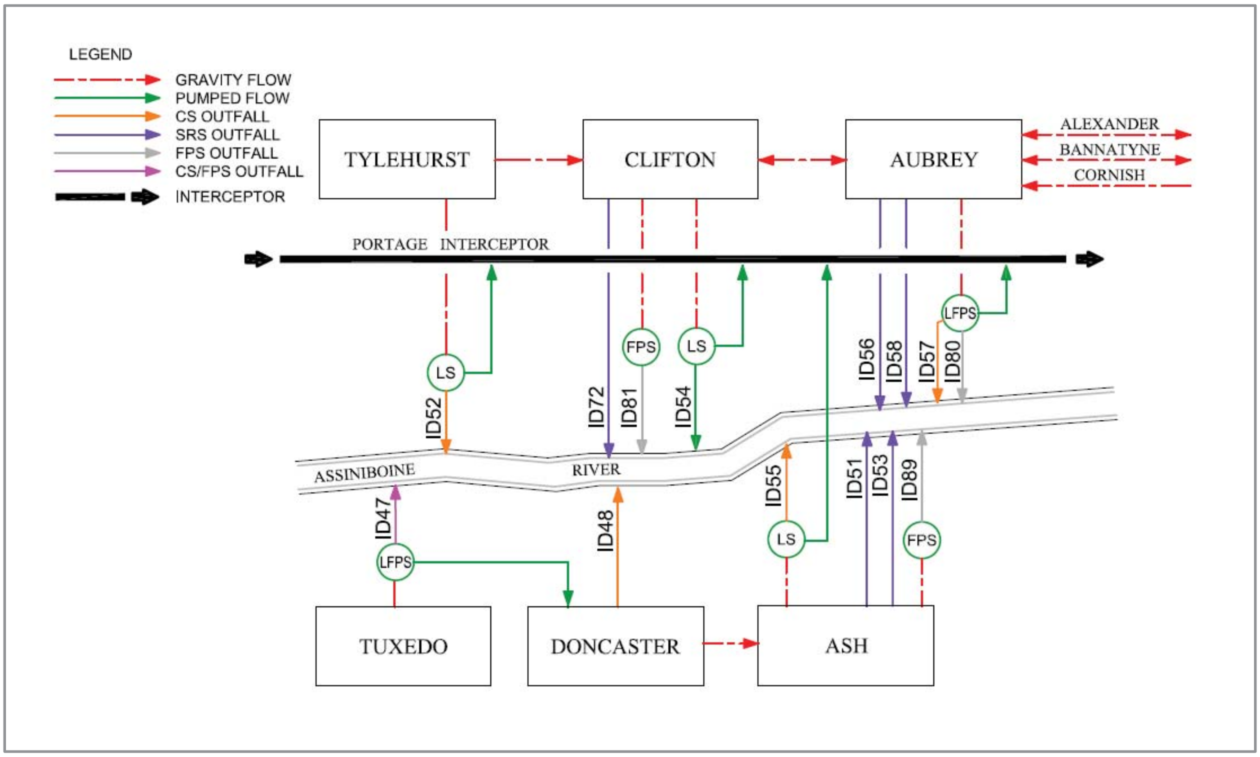

Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 05 and listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID57)	S-MH70006676.1	S-MA70017579	2850 mm	Assiniboine River Invert: 221.00 m
Flood Pumping Outfall (ID82)	S-AC70008105.1	S-MA70017556	2100 mm	Assiniboine River Invert: 224.81 m
Other Overflows	N/A	N/A	N/A	
Main Sewer Trunk	S-MH20012470.1	S-MA20013760	2800 mm	Circular Invert: 223.32 m
SRS Outfalls (ID56 & ID58)	S-CO70008120.1 S-CO70010647.1	S-MA70017585 S-MA70022480	2890 mm 2700 mm	Invert: 221.00 m Invert: 221.15 m
SRS Interconnections	N/A	N/A	N/A	101 SRS – CS
Main Trunk Flap Gate	S-TE70008067 Weir.1	S-CG00000724	2100 mm	Invert: 224.00 m
Main Trunk Sluice Gate	AUBREY_GC.1	S-CG00000725	1500 x 1500 mm	Invert: 223.61 m
Off-Take	S-TE70008067.2	S-MA70017460	600 mm	Circular Invert: 223.32 m
Dry Well	N/A	N/A	N/A	No dry well in lift station design.
Lift Station Total Capacity	N/A	N/A	0.44 m^3/s	1 x 0.235 m^3/s 1 x 0.205 m^3/s

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Lift Station ADWF	N/A	N/A	0.054 m^3/s	
Lift Station Force Main	S-TE70008096.1	S-MA70017546	600 mm	Invert: 229.17 m
Flood Pump Station Total Capacity	N/A	N/A	5.24 m^3/s	3 x 1.42 m^3/s 1 x 0.98 m^3/s
Pass Forward Flow – First Overflow	N/A	N/A	0.225 m^3/s	

Notes:

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Aubrey – 223.85 Ruby – 223.85 Aubrey – 223.85
2	Trunk Invert at Off-Take	223.32
3	Top of Weir	224.48
4	Relief Outfall Invert at Flap Gate	Ruby – 221.46 Aubrey – 221.18
5	Low Relief Interconnection (S-MH20010140)	225.88
6	Sewer District Interconnection (Alexander)	224.94
7	Low Basement	230.59
8	Flood Protection Level (Aubrey)	230.22

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed in Aubrey was the 1986 Basement Flood Relief study (Girling, 1986). No other work has been completed or evaluated the district sewer system since that time.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Aubrey CS district was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations have a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Expected Completion
5 – Aubrey	1986	Future Work	2013	Study Complete	N/A

1.5 Ongoing Investment Work

The proposal for the replacement of the existing positive gates and gate chamber located on both SRS outfall pipes has been planned. A Request for Proposals (RFP) was issued in 2016 (Bid Opp. 125-2016), which required the replacement of the positive gate housed with individual buried chamber structures located on the Ruby SRS and the Aubrey SRS pipe. Two new gate chamber structures will have a new positive gate (with electric actuator) and flap gate installed within each structure. These will be located along the west property alignment of 980 Palmerston (Robert Steen Community Centre) for the Ruby SRS outfall and on Aubrey Street on the south side of Palmerston Avenue for the Aubrey SRS outfall.

Within each structure, there will also be provision for a permanently installed submersible pipe, located on the upstream side of the positive gate with discharge piping to the adjacent combined sewer. These have been developed by the City and have been issued as Bid Opportunities 865-2018 (Aubrey SRS) and 798-2016 (Ruby SRS).

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Aubrey district. This consists of monthly site visits in confined entry spaces to verify that physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet CSO Control Option 1 – 85 Percent Capture in a Representative Year for the Aubrey district are listed in Table 1-4. The proposed CSO control options will include in-line storage via control gate, latent storage and screening. Program opportunities, including green infrastructure (GI) and real time control (RTC), will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85% Capture in a Representative Year	✓	-	-	✓	✓	-	-	-	✓	✓	✓

Notes:

- = not included
✓ = included

The existing CS and SRS systems are suitable for use as in-line and latent storage. These control options will take advantage of the existing CS pipe network for additional storage volume. Existing DWF from the collection system will remain the same, and overall district operations will remain the same. Additional CS to SRS interconnections are proposed to allow the WWF flows to enter both SRS systems to maximize the potential existing latent storage volumes. The full interaction between the district's CS and SRS system are recommended to be fully confirmed to validate these additional interconnections.

All primary overflow locations are to be screened under the current CSO control plan. Installation of a control gate will be required for the screen operation, and additionally it will provide the mechanism for capture of the in-line storage.

GI and RTC will be applied within each district on a system-wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Latent Storage

Latent storage is a suitable control option for Aubrey district. The latent storage level is controlled by the river level and the resulting backpressure of the river level on the Ruby and Aubrey SRS outfall flap gates, as explained in Part 3C. The storage volumes indicated in Table 1-5 are based on the river level conditions with the NSWL during the 1992 representative year at each specific outfall location. The latent storage design criteria are identified in Table 1-5.

As part of the initial evaluation, the hydraulic model indicated that no excess CS from the CS system would enter the Aubrey SRS system under the 1992 representative year conditions. This was the first of such occurrences when modelling potentially latent storage solutions. The Aubrey SRS however includes two independent, extensive SRS systems with dedicated outfalls, and therefore provides the opportunity to store large amounts of the wet weather flow received. This would further reduce the burden on the in-line storage utilizing the Aubrey CS system. that will each provide additional storage volume. In situations such as this, the typical latent storage upgrade of providing mechanical flap gate control will not provide sufficient performance improvements. The issue is primarily due to insufficient flows entering the SRS system.

The performance was found to be greatly improved by introducing additional CS-SRS interconnections to divert excess flow from the CS system into the SRS systems under the majority of 1992 representative year conditions. Therefore, to ensure that the potential volume capture available from these existing latent storage systems was optimized, additional interconnections between the CS system and both SRS were also proposed. The proposed interconnection locations were selected in order to divert flow from directly upstream of the CS LS, and can be seen on Figure 05-01 and Figure 05-02. The first interconnection to divert excess CS into the Aubrey SRS system connects from manhole S-MH20012470 and ties immediately upstream of the Aubrey SRS outfall gate chamber. The second interconnection to tie into the Ruby SRS system would also connect from manhole S-MH20012470 in the CS system and then tie immediately upstream of the Ruby SRS outfall gate chamber. The existing CS sewer pipe at the point of these proposed interconnections will have the largest flow within the Aubrey district and will ensure that the SRS systems would receive flow volume to optimize the use of the available latent storage. An investigation into the model assumptions and existing upstream CS to SRS interconnections will be necessary to confirm the extent of these new downstream interconnections and the volume of WWF entering both SRS systems.

Table 1-5. Latent Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	Ruby – 221.46 m Aubrey – 221.18 m	Flap Gate inverts
NSWL	Ruby – 223.85 m Aubrey – 223.851 m	
Trunk Diameter	Ruby – 2700 mm Aubrey – 2890 mm	

Table 1-5. Latent Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Design Depth in Trunk	Ruby – 2390 mm Aubrey – 2671 mm	
Maximum Storage Volume	Ruby – 8,877 m^3 Aubrey – 7,969 m^3	Total Storage: 16,846 m^3
Force Main Diameter	Ruby – 225 mm Aubrey – 225 mm	
Flap Gate Control	Ruby – N/A Aubrey – N/A	
Lift Station	Ruby – Yes Aubrey – Yes	
Nominal Dewatering Rate	Ruby – 0.075 m^3/s Aubrey – 0.075 m^3/s	Based on 24-hour emptying requirement
RTC Operational Rate	Ruby – TBC Aubrey – TBC	Future RTC/ dewatering assessment. Possibly based on 2 times nominal rate

Notes:

NSWL = normal summer water level

RTC = Real Time Control

The addition of the two latent storage pump stations (LSPS) and force mains that connect back to the CS system are necessary for the latent storage to be emptied after each storm event. A conceptual layout for each LSPS and force main location is shown on Figure 05-01 and Figure 05-02. These layouts are based on the work undertaken by the City as part of Bid Opportunities for the Aubrey and Ruby SRS gate chamber work.

The Aubrey SRS LSPS, shown on Figure 05-01, would be located upstream of the existing SRS gate chamber close to the proposed CS screening and control gate. The force main will connect back to the main CS system upstream of the Aubrey LS. An interconnection between the CS and SRS system is proposed to ensure the full SRS latent storage is utilized. A 225 mm pipe would achieve this interconnection.

The Ruby SRS LSPS, shown on Figure 05-02, is proposed be located to the north of the Ruby gate chamber within the grounds of the Robert Steen Community Centre at the corner of Palmerston Avenue and Ruby Street. The force main will connect to the 300 mm CS at the manhole at the junction of Ruby Street and Palmerston Avenue (pipe capacity stated as 105 litres per second [L/s] and latent pumps at 75 L/s within Bid Opportunity 798-2016). If during the more detailed assessment it is noted that the pipe section is inadequate, the force main would connect to the next manhole downstream at the southern end of Lipton Street on Palmerston Avenue. Minor disruption to the access to the Robert Steen Community Centre is envisaged; the parallel streets of Lipton Street and Lenore Street will allow access to all locations during construction. An interconnection from the main CS system to the SRS pipe system is required to fully utilize the latent storage within the Ruby SRS system. A new 225 mm pipe would be constructed, connecting the main CS trunk in Aubrey Street to SRS pipe in Palmerston Avenue. Normal disruption along Palmerston Avenue would be encountered with trenchless pipe installation construction work. The presence of groundwater in close proximity to the river bank in this area has encountered in the past. All latent storage associated construction work will require an Ground Water Management Plan to be undertaken.

Both LSPSs will operate to empty the SRS after filling from a runoff event in preparation for the next runoff event. The Ruby SRS and Aubrey SRS outfalls will be upgraded with flap and sluice gates as part of a separate project. A single chamber will house the sluice gate, flap gate, and submersible wet well chamber.

The evaluation of the latent storage volume was completed using the continuous NSWL river conditions, and it was found that additional flap gate control will not be required to meet Control Option 1. In situations where non modelled assessments are to be completed, the actual river levels will be both lower and higher than the 1992 representative year NSWL level at various points throughout the year. Where the level is below NSWL, the latent volume will be less than predicted during the MP assessment, while conversely when the level is above the NSWL, the latent volume will be more than predicted. The continuous assessment is seen as a conservative approach since the majority of the representative year rainfall events occur when the river levels are higher than the NSWL.

1.6.3 In-line Storage

In-line storage has been proposed as a CSO control for Aubrey district. In-line storage will require the installation of a control gate at the CS outfall. The gate will increase the storage level in the existing CS to provide an overall higher volume capture and will provide additional hydraulic head for screening operations.

A standard design was assumed for the control gate, as described in Part 3C. A standard approach was used for conceptual gate sizing by assuming it to be the lesser of the height of half of the site-specific trunk diameter or the maximum height of the gate available. The design criteria for the in-line storage are listed in Table 1-6.

Table 1-6. In-Line Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	223.32 m	Downstream invert of pipe at weir
Trunk Diameter	2800 mm	
Gate Height	1.43 m	Gate height based on half trunk diameter assumption
Top of Gate Elevation	224.85 m	
Maximum Storage Volume	2,080 m^3	
Nominal Dewatering Rate	0.440 m^3/s	Based on existing CS LS pump rate
RTC Operational Rate	TBC	Future RTC/dewatering assessment to be undertaken

The proposed control gate will cause combined sewage to back-up within the collection system to the extent shown on Figure 05. The extent of the in-line storage and volume is related to the top elevation of the bypass side weir. The level of the top of the bypass side weir and adjacent control gate level are determined in relation to the critical performance levels in the system for basement flooding protection: when the system level increases above the bypass weir crest and proceeds above top of the control gate during high flow events, the gate drops out of the way. At this point, the district will only provide its original interception capacity via the primary weir for the district, and all excess CS would flow over the weir and discharge to the river. After the sewer levels in the system drops back below the bypass side weir critical performance level, the control gate moves back to its original position to capture the receding limb of the WWF event. The Aubrey CS LS will continue with its current operation while the control gate is in either position, with all DWF being diverted to the CS LS and pumped to the North Main Interceptor pipe on Wolseley Avenue. The CS LS will further dewater the in-line storage provided during a WWF event as downstream capacity becomes available.

Figure 05-01 provides an overview of the conceptual location and configuration of the control gate, bypass weir, and screening chambers. The proposed control gate will be installed in a new chamber within the trunk sewer alignment and be located north of the Aubrey outfall gate chamber. The dimensions of a new chamber to provide an allowance for a side weir for floatables control are 5 m in length and 3.5 m in width. The existing sewer configuration may require the construction of an additional off-take pipe to be completed, if the future detailed design establishes that the proposed gate chamber cannot encompass the existing primary weir chamber. This will allow CS flows captured by the proposed control gate to be diverted to the Aubrey CS LS, ensuring that the system performs as per the existing conditions. The existing primary weir would remain in place to allow flow diversion to continue when the control gate is in its lowered position. The work required for the control gate construction is located within a residential street with minor disruptions expected.

The nominal rate for dewatering is set at the existing CS LS capacity. This allows dewatering through the existing interceptor system within 24 hours following the runoff event, allowing it to recover in time for a subsequent event. This future RTC will provide the ability to capture and treat more volume for localized storms by using the excess interceptor capacity where the runoff is less. Further assessment of the actual impact of the future RTC/dewatering arrangement will be necessary to review the downstream impacts.

1.6.4 Floatables Management

Floatables management will require installation of a screening system to capture floatable materials. The off-line screens will be designed to maintain the current level of basement flooding protection.

The type and size of screens depend on the specific station configuration and the hydraulic head available for operation. A standard design was assumed for screening and is described in Part 3C.

The design criteria for screening, with an in-line control gate implemented, are listed in Table 1-7.

Table 1-7. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Top of Gate	224.85 m	
Bypass Weir Crest	224.75 m	
NSWL	223.85 m	
Maximum Screen Head	0.9 m	
Peak Screening Rate	0.85 m^3/s	
Screen Size	1.5 m wide x 1 m high	Modelled Screen Size

The proposed side bypass overflow weir and screening chamber will be located adjacent to the existing combined trunk sewer, as shown on Figure 05-01. The screens will operate once levels within the sewer surpassed the bypass weir elevation. A side bypass weir upstream of the gate will direct the initial overflow to the screens located in the new screening chamber, with screened flow discharged to the downstream side of the gate to the river. The screening chamber may include screenings pumps with a discharge returning the screened material back to the interceptor and on to the NEWPCC for removal. The provision of screening pumps is dependent on final level assessment within the existing infrastructure and the Aubrey trunk has potential for gravity screenings return to occur. This will be confirmed during future assessment stage.

The dimensions for the screen chamber to accommodate influent from the side bypass weir, the screen area, and the routing of discharge downstream of the gate are 6 m in length and 2.5 m in width.. The screening chamber is expected to be located within a residential street with minor disruptions expected.

1.6.5 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district will be reviewed to identify the most applicable GI controls.

Aubrey has been classified as a medium GI potential district. Land use in Aubrey is mostly single-family residential with smaller areas of commercial and industrial land use. This means the district would be an ideal location for bioswales, permeable paved roadways, cisterns/rain barrels, and rain gardens. The industrial areas in the north end of the district would be an ideal location for green roofs.

1.6.6 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

In-line storage will impact the existing sewer and will require the addition of a new chamber and a moving gate at the outfall. In-line storage dewatering will be controlled with the existing CS LS which will require more frequent and longer duration pump run times. Lower velocities in the CS trunks may create additional debris deposition and require more frequent cleaning. Additional system monitoring, and level controls will be installed which will require regular scheduled maintenance.

The latent storage will take advantage of the SRS infrastructure already in place or under construction; therefore, minimal additional maintenance will need to be anticipated. The proposed latent LSPS at both locations will require regular maintenance that will depend on the frequency of operation. Operational issues have been experienced in the past with large inflow and infiltration flow occurring within the SRS surrounding the Ruby SRS outfall specifically. The proposed latent LSPS may address this issue and remove the additional O&M currently associated with this location.

Floatable control with outfall screening will require the addition of another chamber with screening equipment installed. The chamber will be installed adjacent to the control gate chamber and will operate in conjunction with it. Screening operation will occur during WWF events that surpass the in-line storage control level. WWF would be directed from the main outfall trunk, over the side weir in the control gate chamber and through the screens to discharge into the river. The screens will operate intermittently during wet weather events and will likely require operations review and maintenance after each event. The frequency of a screened event would correlate to the number overflows identified for the district. Having the screenings pumped back to the interceptor system via a small LS and force main will be required. Additional maintenance for the pumps will be required at regular intervals in line with typical lift station maintenance and after significant screening events.

1.8 Performance Estimate

1.8.1 InfoWorks Model

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. An individual model was created to represent the sewer system baseline as represented in the year 2013 and a second model was created for the CSO Master Plan evaluation purposes, with all of the control options recommended for the district to meet Control Option 1 implemented in the year 2037. A summary of relevant model data is provided in Table 1-8.

Table 1-8. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Added To Model
2013 Baseline	445	443	16,875	36	N/A
2037 Master Plan – Control Option 1	445	443	16,875	36	IS, Lat St, SC

Notes:

IS = In-line Storage
Lat St = Latent Storage
SC = Screening

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-9 are for the hydraulic model simulations using the year-round 1992 representative year. This table lists the results for the Baseline, for each individual control option, and for the proposed CSO Master Plan – Control Option 1. The Baseline and Control Option 1 performance number represent the comparison between the existing system and the proposed control options. Table 1-9 also includes overflow volumes specific to each individual control option: these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-9. Performance Summary – Control Option 1

Control Option	Preliminary Proposal Annual Overflow Volume (m^3)	Master Plan Overflow Reduction (m^3)	Overflow Reduction (m^3)	Number Overflows	Pass Forward Flow at First Overflow [b]
Baseline (2013)	260,852	141,643	-	27	0.484 m^3/s
In-Line Storage	246,277 [a]	120,521	21,122	27	0.484 m^3/s
In-Line + Latent Storage		120,521	0	27	0.542 m^3/s
In-Line + Latent Storage with additional interconnections	N/A	81,709	38,812	14	0.542 m^3/s
Control Option 1	**246,277**	**81,709**	**59,934**	**14**	**0.542 m^3/s**

[a] Latent and In-line Storage were not simulated independently during the Preliminary Proposal assessment.

[b] Pass forward flows assessed on the 1-year design rainfall event

The percent capture performance measure is not included in Table 1-9, as it is applicable to the entire CS system and not for each district individually.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-10. The cost estimates are Class 5 planning level estimates with a level of accuracy of minus 50 to plus 100 percent.

Table 1-10. Cost Estimates – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance (Over 35-year period)
Latent Storage	$3,500,000	$5,560,000 [b]	$172,000	$3,710,000
In-Line Storage	- [a]	$2,920,000 [c]	$46,000	$990,000
Screening		$2,840,000 [d]	$51,000	$1,100,000
Subtotal	**$3,500,000**	**$11,470,000**	**$270,000**	**$5,800,000**
Opportunities	N/A	$1,150,000	$27,000	$580,000
District Total	**$3,500,000**	**$12,620,000**	**$297,000**	**$6,380,000**

[a] Solution developed as refinement to Preliminary Proposal work following submission of Preliminary Proposal costs. Costs for this item of work found to be $3,980,000 in 2014 dollars

[b] Latent Storage capital cost includes the chambers, sluice and flap gate construction that has been assigned to Bid Opps 789-2016 (Ruby SRS) and 865-2018 (Aubrey SRS) work. Future capital cost will only include the latent pumps and force mains as well as the additional CS to SRS interconnection pipework. Cost for these items taken to reduce to $480,000 in 2019 dollars.

[c] Cost associated with new off-take construction, as required, to accommodate control gate location and allow intercepted CS flow to reach existing Aubrey LS not included.

[d] Cost for bespoke screenings return pump/force main not included in Master Plan as will depend on selection of screen and type of screening return system selected

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:
- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional cost for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is on 2014 dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019 dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-11.

Table 1-11. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Latent Storage	Latent storage work currently underway by City of Winnipeg.	Original capital costs updated.
	Control Gate	A control gate was not included in the Preliminary Proposal estimate	Added for the MP to further reduce overflows
	Screening	Screening was not included in the Preliminary Proposal estimate	Added in conjunction with the Control Gate
	Latent Interconnections	Added as part of Master Plan	Based on modelling performance optimization.
Opportunities	A fixed allowance of 10 percent has been included for program opportunities.	Preliminary Proposal estimate did not include a cost for GI opportunities.	
Lifecycle Costs	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation.	Preliminary Proposal estimates were based on 2014-dollar values.	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, the future performance target is 98 percent capture for the representative year measured on a system-wide basis. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture, Table 1-12 provides a description of how the regulatory target adjustment could be met by building off proposed work identified in Control Option 1.

Overall the Aubrey district would be classified as a low potential for implementation of complete sewer separation as the only feasible approach to achieve the 98 percent capture future performance target in the representative year. Increased volume capture from the latent storage arrangements already constructed as part of meeting Control Option 1 could be achieved by construction of flap gate control mechanisms. This would allow excess flow to be stored in the SRS system even under low river level conditions. Further increases in the control gate height, and in term level of volume capture could also be potentially completed in this district to meet future performance targets. Off-line storage elements such as an underground tank or storage tunnel with associated dewatering pump infrastructure could also be utilized to provide additional volume capture. Finally, focused use of green infrastructure, and reliance on said green infrastructure to provide volume capture benefits could be utilized to meet future performance targets.

Table 1-12. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Increased use of GI • Increased use of latent storage (flap gate control) • Increased use of in-line storage • Off-line Storage (Tunnel/tank)

The control options selected for the Aubrey district have been aligned for the 85 percent capture performance target based on the system wide basis. The expandability of this district to meet the 98 percent capture would be through the potential additional development of the latent storage, via flap gate control. This would require the detailed investigation and performance of the interconnections between the CS and two SRS systems with this district.

The cost for upgrading to an enhanced performance target depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-13.

Table 1-13. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	R	R	-	-	-	-	-	-
2	Existing Lift Station	-	R	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	-	-	-	-
4	Construction Disruption	-	-	-	-	-	-	-	-
5	Implementation Schedule	-	-	-	-	-	-	R	-
6	Sewer Condition	R	R	-	-	-	-	-	-
7	Sewer Conflicts	R	R	-	-	-	-	-	-
8	Program Cost	O	O	-	-	-	-	-	O
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	R	-	-	-	-	O	O	-
12	Operations and Maintenance	R	R	-	-	-	R	O	R
13	Volume Capture Performance	O	O	-	-	-	O	O	-
14	Treatment	R	R	-	-	-	O	O	R

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

Girling, R.M. 1986. *Basement Flooding Relief Program Review – 1986.*

LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Low CS Manhole
- Low SRS Connection

Inter-System Connection
- CS - WWS
- SRS - CS

District Boundary Crossing
- CS
- SRS
- WWS

- Interceptor Sewer
- Force Main
- Street
- Railway

- District Boundary
- Watercourse
- Greenspace

CSO MASTER PLAN PROPOSED SOLUTIONS

- Proposed Control Gate
- Proposed SRS Latent Storage Pump
- Latent Storage Limit
- Extent of In-line Storage
- Latent Force Main

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 05
District Overview Map
Sewer District: Aubrey
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Manhole
- Flap Gate
- Sluice Gate
- Pump Location

Sewer By Type
- CS
- SRS
- WWS

Control Structure Type
- Gate Chamber

Pump Station Type
- Flood Pump Station
- Lift Station

CSO MASTER PLAN
PROPOSED SOLUTIONS
- Proposed Latent Force Main
- CS-SRS Interconnection
- Control Gate
- Gate Chamber
- Screening
- Latent Pump

ALL PROPOSED SOLUTIONS
SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 05-01
Control Gate and Screening - Latent SRS Control
Sewer District: Aubrey
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Manhole
- Flap Gate
- Sluice Gate
- Pump Location

Sewer By Type
- CS
- SRS
- WWS

Control Structure Type
- Gate Chamber

Pump Station Type
- Flood Pump Station
- Lift Station

CSO MASTER PLAN
PROPOSED SOLUTIONS
- Proposed Latent Force Main
- CS-SRS Interconnection
- Control Gate
- Gate Chamber
- Screening
- Latent Pump

ALL PROPOSED SOLUTIONS
SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 05-02
Latent SRS Control
Sewer District: Aubrey
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Baltimore District Plan

August 2019

City of Winnipeg

JACOBS

CSO Master Plan

Project No:	470010CH
Document Title:	Baltimore District Plan
Revision:	04
Date:	August 18, 2019
Client Name:	City of Winnipeg
Project Manager:	John Berry
Author:	Danny Tinker
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Document History and Status

Revision	Date	Description	By	Review	Approved
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1	02/15/2019	DRAFT 2 for City Review	DT	SG/MF	MF
2	06/2019	Final Draft Submission	DT	MF	MF
3	07/2019	Revised Final Draft Submission	DT/MF	MF	MF
4	08/18/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

Tables

Figure

1. Baltimore District

1.1 District Description

Baltimore district is located towards the southern limit of the combined sewer (CS) area and is included within the South End Sewage Treatment Plant (SEWPCC) catchment area. Baltimore is bounded by Daly Street to the west, Glasgow Avenue to the north and the Red River to the east and south. Figure 06 provides an overview of the sewer district and the location of the proposed Combined Sewer Overflow (CSO) Master Plan control options.

Osborne Street (Highway 62) is a regional road that passes through Baltimore district; this turns into Dunkirk Drive after the St. Vital Bridge, which crosses over the Red River, in the Mager district to the south. The northern portion of Osborne Street abuts the Jessie district and goes underneath the Southwest Transit Corridor. Baltimore district also contains the eastern end of Jubilee Avenue, which is a high traffic route that connects Pembina Highway and Osborne Street. The Southwest Rapid Transitway (SWRT) briefly enters and exits the district in the northwest.

The land usage is categorized as mainly residential (over 50 percent), with the remainder of developed land identified as commercial along Osborne Street. Non-residential use in the area includes the Riverview Health Centre, located in the northeastern section of the district, and part of the Winnipeg Transit Fort Rouge Garage located on Brandon Avenue.

The only available green space is that which borders the Red River, running along the edge of the district and can be seen in the overhead view in Figure 06.

1.2 Development Potential

There is limited land area available for new development within Baltimore district. No significant developments that would impact the CSO Master Plan are planned or expected.

One area within the Baltimore combined sewer district has been identified as a Major Redevelopment Site, the Fort Rouge Yards. This site includes the lands immediately east of the Fort Rouge rail lines, and the Bus Rapid Transit corridor. This Major Redevelopment Site is considered underused and will be prioritized to be developed into a higher density, mixed-use community.

1.3 Existing Sewer System

The Baltimore district has an approximate area of 200 ha[1] based on the district boundary. There is approximately 3 percent of the district by area (7 ha) which has been partially separated.

The CS system includes a flood pump station (FPS), CS lift station (LS), one combined CS / flood pump station (FPS) outfall, and four storm relief sewer (SRS) outfalls. All domestic wastewater and CS flow collected in Baltimore district are routed to Baltimore Road, where the CS, LS, FPS and outfall are located.

The CS collected throughout the district flows into the main 1350 mm by 1800 mm sewer trunk that leads to the CS LS, FPS and outfall located at the eastern end of Baltimore Street. The Baltimore interceptor sewer extends from Cockburn district along Rosedale Avenue to Osborne Street and then connects to Baltimore Road from Osborne Street.

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[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

During dry weather flow (DWF), flow is diverted by the primary weir to the Baltimore CS LS and pumped through the Baltimore force main that runs parallel to Churchill Drive and then across the Red River via river crossing that runs parallel to the St. Vital Bridge, then tying into a gravity sewer flowing to the Mager CS LS. The Mager LS pumps to the south end interceptor system, which flows by gravity to the South End Sewage Treatment Plant (SEWPCC). During wet weather flow (WWF), any flow that exceeds the diversion capacity of the primary weir is discharged into the Baltimore outfall, where it is discharged to the Red River by gravity. Sluice and flap gates are installed on the CS outfall to prevent back-up of the Red River into the CS system under high river level conditions. Under these high river level conditions and when gravity discharge through the outfall is not possible, the excess flow is pumped by the Baltimore FPS through the CS outfall to the Red River.

An SRS system was designed and installed throughout the Baltimore district to increase the level of basement flood protection by diverting flow to existing pipes with sufficient capacity or directly to the Red River. Baltimore has four SRS outfalls, each located along the edge of the Red River. Eccles West and Eccles East are positioned for the northeastern section of Baltimore, Hay for the northwestern section, and Osborne for the southern section of the district to relieve the system during WWF surcharge. In these areas, high point off-take pipe interconnections divert WWF from the CS system to the SRS system that directs flow either to an SRS outfall or back to the Baltimore CS outfall. Sluice and flap gates are also installed on the SRS outfall to prevent back-up of the Red River into the SRS system under high river level conditions.

The five outfalls to the Red River are as follows:

- ID05 (S-MA60013599) – Baltimore CS Outfall
- ID02 (S-MA70006325) – Osborne SRS Outfall
- ID07 (S-MA70022370) – Eccles East SRS Outfall
- ID08 (S-MA70006655) – Eccles West SRS Outfall
- ID09 (S-MA70005806) – Hay SRS Outfall

1.3.1 District-to-District Interconnections

There are four district-to-district interconnections between Baltimore and the neighboring Cockburn district. The Baltimore force main transfers flow across the Red River to Mager district. The force main crosses the Red River parallel to the St. Vital Bridge. Interconnections include gravity and pumped flow from one district to the other. Each interconnection is listed in the following subsections:

1.3.1.1 Interceptor Connections – Upstream Of Primary Weir

Cockburn

- The Cockburn CS LS discharges into the Baltimore Interceptor, a gravity sewer beginning at Cockburn Street and Rosedale Avenue that flows through the Baltimore district to the Baltimore CS LS. This interceptor also receives the CS collected from the Baltimore district.
  - Rosedale Avenue at Baltimore District Boundary invert – 228.28 m (S-MA60012254)

1.3.1.2 Interceptor Connections – Downstream Of Primary Weir

Baltimore

- The 450 mm Baltimore LS force main flows under pressure into Mager district at Kingston Row and Edinburgh Street:
  - Dunkirk Avenue force main at connection point to Mager CS – 226.56 m (S-MA50017754)

1.3.1.3 District Interconnections

Cockburn

<u>CS to CS</u>

- High Point Manholes (flow is directed into both districts from these manholes):
  - Montague Avenue and Nassau Street South – 228.88 m References Both Districts (S-MH60010528)
  - McNaughton Avenue and Nassau Street South – 228.82 m References Both Districts (S-MH60010544)
  - Churchill Drive – 229.71 m References Both Districts (S-MH60010728)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing district.

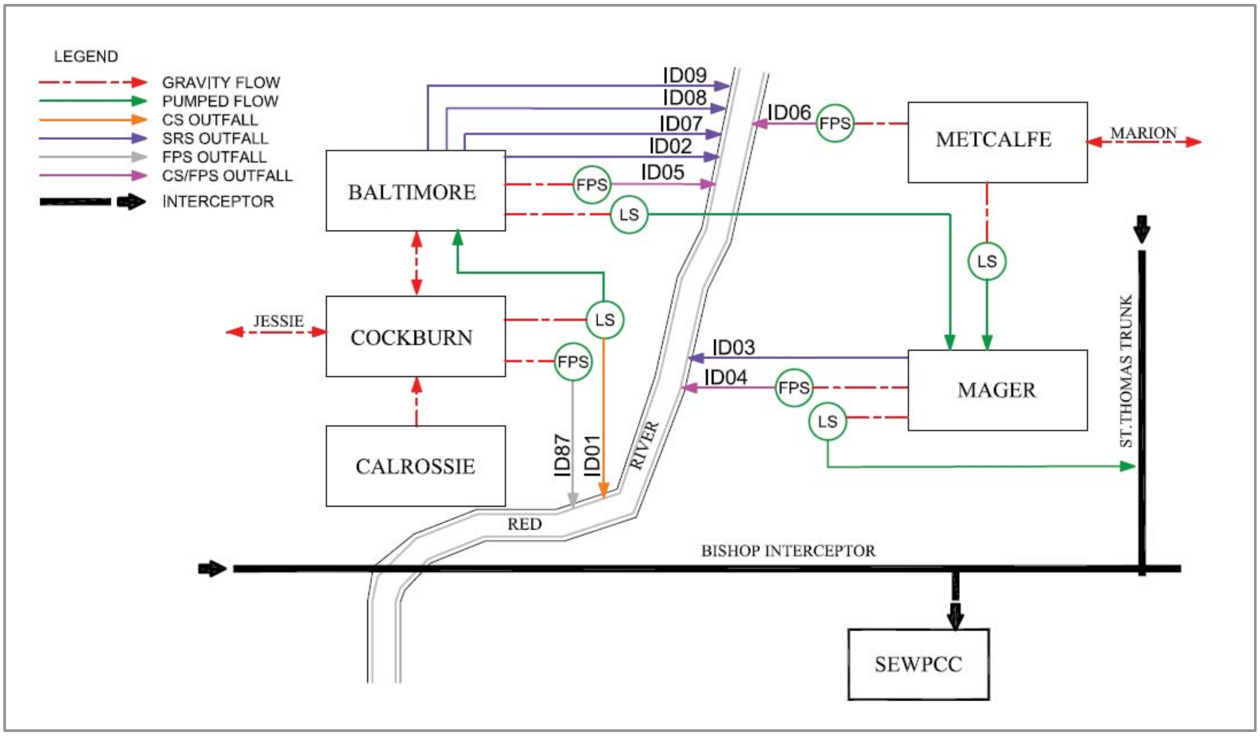

Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 06 and are listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID05)	S-RE60006416.1	S-MA60013599	1800 mm	Circular Invert: 222.74 m
Flood Pumping Outfall (ID05)	S-RE60006416.1	S-MA60013599	1800 mm	Circular Invert: 222.74 m
Other Overflows	N/A	N/A	N/A	

Main Trunk	S-CG00000778.1	S-MA70016827	1350 x 1800 mm	Invert: 223.16 m
SRS Outfalls (ID02, ID07, ID08, ID09)	324X0000064.1 S-CO70010585.1 S-CS00000430.1 S-CS00000442.1	S-MA70006325 S-MA70022370 S-MA70006655 S-MA70005806	1600 mm 750 mm 1200 mm 1600 mm	Invert: 221.34 m Invert: 223.03 m Invert: 221.89 m Invert: 221.47 m
SRS Interconnections	N/A	N/A	N/A	39 SRS - CS
Main Trunk Flap Gate	S-CG00001040.1	S-CG00001040	1525 mm	Invert: 223.48 m
Main Trunk Sluice Gate	S-TE70028161.1	S-CG00001040	1500 x 1500 mm	Invert: 223.48 m
Off-Take	S-MH60011694.1	S-MA70007637	750 mm	
Dry Well	N/A	N/A	N/A	
CS Lift Station Total Capacity	N/A	N/A	0.340 m^3/s	2 x 0.170 m^3/s
Lift Station ADWF	N/A	N/A	0.0408 m^3/s	
Lift Station Force Main	S-BE70018613.1	S-MA70051065	450 mm	To Mager district gravity system
Flood Pump Station Total Capacity	N/A	N/A	Min – 2.06 m^3/s Max – 2.60 m^3/s	Min – 2 x 0.47 m^3/s, 1.11 m^3/s Max – 0.55 m^3/s, 0.58 m^3/s, 1.46 m^3/s
Pass Forward Flow – First Overflow	N/A	N/A	0.343 m^3/s	

Notes:

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Baltimore – 223.74 Eccles – 223.74 Hay – 223.74 Osborne – 223.75
2	Trunk Invert at Off-Take	223.16
3	Top of Weir	223.51
4	Relief Outfall Invert at Flap Gate	Osborne SRS – 222.21 Eccles West SRS– 222.53 Eccles East SRS – 223.40 Hay – 221.69
5	Low Relief Interconnection (S-MH70002869)	225.21
6	Sewer District Low Interconnection (Cockburn)	228.82
7	Low Basement	227.17

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
8	Flood Protection Level (Baltimore)	230.01

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

A storm water management study (I.D. Engineering, 1993) was completed for Baltimore district in 1993. The study described the potential of implementing relief alternatives, and recommended alternatives to meet the 5-year and 10-year design level of service for basement flooding. Table 1-3 provides a summary of the district status in terms of data capture and study.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Baltimore CS District was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations have a combination of inflow and overflow level meters and flap gate inclinometers, if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Expected Completion
Baltimore	1993	Future Work-	2013	SRS system operational	N/A

1.5 Ongoing Investment Work

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Baltimore district. This consists of monthly site visits in confined entry spaces to ensure physical readings concur with displayed transmitted readings, and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Baltimore sewer district are listed in Table 1-4. The proposed CSO control projects will include latent storage, in-line storage via a control gate, and floatables management via screening. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	✓	-	-	✓	✓	-	-	-	✓	✓	✓

Notes:

- = not included
✓ = included

The existing CS and SRS systems are suitable for use of latent and in-line storage. These options will take advantage of the existing CS and SRS pipe networks for additional storage volume. The assessment completed as part of Phase 3 indicated that only the SRS system at Eccles would be suitable for implementation of latent storage system.

All primary overflow locations are to be screened under the current CSO control plan. Installation of a control gate will be required for the screen operation, and it will provide the mechanism for capture of the in-line storage.

Floatable control will be necessary to capture any undesirable floatables in the wastewater. Floatables will be captured with all implemented control options to some extent, but screening may be added as required to reach the desired level of capture. Screens will be installed only at the Baltimore CS outfall located on Baltimore Street.

GI and RTC will be applied within each district on a system wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Latent Storage

There are four SRS outfalls located in the Baltimore district and latent storage is proposed as a control option at only the Eccles West SRS Outfall. The latent storage level in the system is controlled by river level, and the resulting backpressure of the river level on the SRS outfall flap gate, as explained in Part 3C. The latent storage design criteria are identified in Table 1-5. The storage volumes indicated in design criteria table below are based on the NSWL river conditions for the 1992 representative year.

Table 1-5. Latent Storage Conceptual Design Criteria (Eccles West SRS)

Item	Elevation/Dimension	Comment
Invert Elevation	222.53 m	
NSWL	223.74 m	
Trunk Diameter	1200 mm	
Design Depth in Trunk	1210 mm	Eccles Latent storage is located from the Eccles West SRS flap gate
Maximum Storage Volume	317 m^3	Eccles twin SRS
Force Main	100 mm	Pipe diameter

Table 1-5. Latent Storage Conceptual Design Criteria (Eccles West SRS)

Item	Elevation/Dimension	Comment
Flap Gate Control	N/A	Flap Gate Control measures not required to provide level of latent storage required. NSWL alone provides sufficient backpressure.
Lift Station	Included	Off-line wet well
Nominal Dewatering Rate	0.01 m^3/s	Based on 24-hour emptying requirement
RTC Operational Rate	TBD	Future RTC / dewatering review on performance

Note:

TBD – To be determined
RTC = real time control
Latent storage at Hay SRS and Osborne not cost effective and not taken forward for latent storage control option

The addition of a latent storage pump station (LSPS) and force main that connects back to the CS system will be required for latent storage. A conceptual layout location of the LSPS and force main for the Eccles West SRS is shown in Figures 06-02. The LSPS will be installed near the existing gate chamber to avoid interference with nearby residential lands and disruption to existing sewers. The LSPS will transfer stored latent volume back into the CS system. The LSPS will operate to dewater the SRS system in preparation for the next runoff event, the requirement for the system to be ready for the next event within a 24-hour period after completion of the previous event. The proposed route for the latent force main along the ROW in Eccles Street already has three existing pipes, however, the existing SRS pipe within the west boulevard and the CS pipe in the eastern side of the street should have sufficient space that would allow a shallow force main pipe to be installed along the western edge of the street. The alternative potential location for force main discharge re-entry into the CS system at manhole ID S-MH60007438 could be achieved, although the existing CS sewer levels in this area indicate this pipe would include a negative gradient pipe. Further assessment of this would be recommended during the preliminary and detailed design of these recommendations.

As described in the standard details in Part 3C, wet well sizing will be determined based on the final pump selection, operation and dewatering capacity required. The interconnecting piping between the new gate chambers and the LSPS will be sized to provide sufficient flow to the pumps while all pumps are operating. Flap gate control was not deemed necessary for this control option. Flap gate control may be considered if additional storage is required or if the river level regularly drops below the SRS flap gate elevation. The SRS flap gate control is described further in the standard details in Part 3C.

1.6.3 In-Line Storage

In-line storage has been proposed as a CSO control option for the Baltimore district. The in-line storage will require the installation of a control gate at the CS outfall. The gate will increase the storage level in the existing CS to provide an overall higher volume capture. The control gate will also provide hydraulic head for screening operations as an additional benefit.

A standard design was assumed for the control gate, as described in Part 3C. A standard approach was used for conceptual gate sizing by assuming it to be the lesser of the height of half of the site-specific trunk diameter or the maximum height of the gate available. The design criteria for in-line storage are listed in Table 1-6.

Table 1-6. In-Line Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	223.16 m	Pipe invert upstream of primary weir
Trunk Diameter	1350 x 1800 mm	

Table 1-6. In-Line Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Gate Height	0.7 m	Gate height based on half trunk diameter assumption
Top of Gate Elevation	224.16 m	
Bypass Weir Height	224.06 m	
Maximum Storage Volume	400 m^3	
Nominal Dewatering Rate	0.340 m^3/s	Based on existing CS LS capacity
RTC Operational Rate	TBD	Future RTC / dewatering review on performance

Note:
TBD – to be determined

The proposed control gate will cause combined sewage to back-up in the collection system to the extent shown on Figure 06. Based on the available capacity of the sewers, the in-line storage will exist within nearby SRS and interceptor that run parallel to each other on Baltimore Road and the extent of the in-line storage and volume is related to the elevation of the bypass weir. The level of the top of the bypass side weir and adjacent control gate level are determined in relation to the critical performance levels in the system for basement flooding protection: when the system level increases above the bypass weir crest and proceeds above the top of the control gate during high flow events, the gate drops out of the way. At this point, the district will only provide its original interception capacity via the primary weir for the district, and all excess CS would flow over the weir and discharge to the river. After the sewer levels in the system drops back below the bypass side weir critical performance level, the control gate moves back to its original position to capture the receding limb of the WWF event. The CS LS will continue with its current operation while the control gate is in either position, with all DWF being diverted to the CS LS and pumped. The CS LS will further dewater the in-line storage provided during a WWF event as downstream capacity becomes available.

Figure 06-01 provides an overview of the conceptual location and configuration of the control gate, bypass weir, and screening chambers. The proposed control gate will be installed in a new chamber within the existing trunk sewer alignment near the existing CS LS and FPS. The dimensions of the chamber will be approximately 5.5 m in length and 3 m in width to accommodate the gate, with an allowance for a longitudinal overflow weir. The existing sewer configuration, including the 1350 mm by 1800 mm sewer trunk, may have to be modified to accommodate the new chamber. Further optimization of the gate chamber size may be provided if a decision is made not to include screening. Further optimization of the gate chamber size may be provided if a decision is made not to include screening. The existing sewer configuration may require the construction of an additional off-take pipe to be completed, if the future detailed design establishes that the proposed gate chamber cannot encompass the existing primary weir chamber. This will allow CS flows captured by the proposed control gate to be diverted to the Baltimore CS LS, ensuring that the system performs as per the existing conditions. The existing primary weir would remain in place to allow flow diversion to continue when the control gate is in its lowered position. The work required for the control gate construction is located within a residential street with minor disruptions expected.

The physical requirements for the off-take and station sizing for a modification to pumping capacity have not been considered in detail, but they will be required in the future as part of an RTC program or CS LS rehabilitation or replacement project.

The nominal rate for dewatering is set at the existing CS LS capacity. This allows dewatering through the existing interceptor system within 24 hours following the runoff event, allowing it to recover in time for a subsequent event. Additionally, for RTC, an initial estimate of two times the nominal dewatering rate has been selected. This allows individual districts to be dewatered within 12 hours, rather than within 24 hours. It will provide the ability to capture and treat more volume for localized storms by using the excess interceptor capacity where the runoff is less. Further assessment of the impact of the RTC/future dewatering arrangement will be necessary to review the downstream impacts (i.e., on Mager district).

1.6.4 Floatables Management

Floatables management will require installation of a screening system to capture floatable materials. Off-line screens will be proposed to maintain the current level of basement flooding protection.

The type and size of screens depend on the specific station configuration and the head available for operation. A standard design was assumed for screening and is described in Part 3C. The design criteria for screening, with an in-line control gate implemented, are listed in Table 1-7.

Table 1-7. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Top of Gate	224.16 m	
Bypass Weir Crest	224.06 m	
Normal Summer River Level	223.73 m	
Maximum Screen Head	0.33 m	
Peak Screening Rate	0.87 m^3/s	
Screen Size	1.5 m wide x 1 m high	Modelled Screen Size

The proposed side bypass overflow weir and screening chamber will be located adjacent to the proposed control gate and existing CS trunk, as shown on Figure 06-01. The screens will operate with the control gate in the raised position. A side bypass weir upstream of the gate will direct the flow to the screens located in the new screening chamber, with screened flow discharged to the downstream side of the gate to the river. The screening chamber will include screenings pumps with a discharge returning the screened material to the CS LS for routing to the SEWPCC for removal.

The dimensions for the screen chamber to accommodate influent from the side weir, the screen area, and the routing of the discharge p*i*ping downstream of the gate are 5 m in length and 3.5 m in width. The existing sewer configuration, including the 1350 mm by 1800 mm sewer trunk, may have to be modified to accommodate the new chamber.

1.6.5 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district will be reviewed to identify the most applicable GI controls.

Baltimore has been classified as a high GI potential district. The land usage is categorized as mainly residential, with the remainder of developed land identified as commercial along Osborne Street. This means the district would be an ideal location for bioswales, permeable paved roadways, cisterns/rain barrels, and rain gardens. There are a few flat roof commercial buildings in the north end of the district which make an ideal location for green roofs. The higher area of greenspace in Baltimore district is suitable for biorientation garden projects.

1.6.6 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

In-line storage will impact the existing sewer and may require the addition of a new chamber and a moving gate at the outfall. Lower velocities in the sewer may create additional debris deposition and require more frequent cleaning. Additional system monitoring, and level controls will be installed which will require regular scheduled maintenance. The control gate on the CS trunk would control the upstream levels for operation of the screens.

The latent storage will take advantage of the SRS infrastructure already in place; therefore, minimal additional maintenance will be required for the sewers. The proposed LSPS will require regular maintenance that would depend on the frequency of LSPS operation.

Floatable control with outfall screening will require the addition of another chamber with screening equipment installed. The chamber will be installed adjacent to the control gate chamber and will operate in conjunction with it. Screening operation will occur during WWF events that surpass the in-line storage control level. WWF will be directed from the main CS trunk, over the side weir in the control gate chamber and through the screens to discharge into the river. The screens will operate intermittently during wet weather events and will likely require operations review and maintenance after each event. The frequency of a screened event will correlate to the number overflows identified for the district. Having the screenings pumped back to the interceptor system via a small LS and force main will be required. Additional maintenance for the pumps will be required at regular intervals in line with typical lift station maintenance and after significant screening events.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. An individual model was created to represent the sewer system baseline as represented in the year 2013 and a second model was created for the CSO Master Plan evaluation purposes, with all the control options recommended for the district to meet Control Option 1 implemented in the year 2037. A summary of relevant model data is provided in Table 1-8.

Table 1-8. InfoWorks CS District Model Data

Model Version	Total Area (ha)[1]	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	221	221	7,124	41	N/A
2037 Master Plan – Control Option 1	221	221	7,124	41	IS, SC, Lat St

Note:

IS = In-line Storage
SC = Screening

Lat St = Latent Storage

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS records. Therefore, minor discrepancies in the area values in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-9 are for the hydraulic model simulations using the year-round 1992 representative year. This table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options, Table 1-9 also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-9. Performance Summary – Control Option 1

	Preliminary Proposal	Master Plan			
Control Option	Annual Overflow Volume (m^3)	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [b]
Baseline (2013)	69,611	72,575	-	26	0.296 m^3/s
Latent & In-Line Storage	60,144 [a]	66,599	5,976	21	0.435 m^3/s
Control Option 1	**60,144**	**66,599**	**5,976**	**21**	**0.435 m^3/s**

[a] Latent storage and in-line storage were not simulated independently during the Preliminary Proposal assessment

[b] Pass forward flows assessed on the 1-year design rainfall event

The percent capture performance measure is not included in Table 1-9, as it is applicable to the entire CS system and not for each district individually.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-10. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-10. Cost Estimates – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period)
Latent Storage	$4,760,000	$1,480,000	$55,000	$1,190,000
In-line Control Gate	N/A [a]	$2,360,000 [b]	$42,000	$900,000
Screening		$2,850,000 [c]	$52,000	$1,120,000
Subtotal	**$4,760,000**	**$6,690,000**	**$149,000**	**$3,210,000**
Opportunities	N/A	$670,000	$15,000	$320,000
District Total	**$4,760,000**	**$7,360,000**	**$164,000**	**$3,530,000**

[a] Solution developed as refinement to Preliminary Proposal work following submission of Preliminary Proposal costs. Costs for this control gate and screening work found to be $2,620,000 in 2014 dollars

b Costs associated with any revision to existing off-take, as required, to accommodate the control gate location and allow the intercepted CS flow to reach the existing Baltimore CS LS are not included.

[c] Cost for bespoke screenings return/force main not included in Master Plan as will depend on selection of screen and type of screening return system selected

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional cost for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014 dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019 dollar values:
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction, based on an assumed value of 3 percent per for construction inflation.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-11.

Table 1-11. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Latent Storage	PP had four latent storage control locations recommended; MP has one latent storage control location recommended.	Eccles West SRS Outfall
	Control Gate	A control gate was not included in the Preliminary Proposal estimate	Added for the MP to further reduce overflows
	Screening	Screening was not included in the Preliminary Proposal estimate	Added in conjunction with the Control Gate
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management approach.	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation.	Preliminary Proposal estimates were based on 2014-dollar values.	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, the future performance target is 98 percent capture for the representative year measured on a system-wide basis. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-12 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified for Control Option 1.

Overall the Baltimore district would be classified as low potential for implementation of complete sewer separation as the only feasible approach to achieve the 98 percent capture in the representative year future performance target. Increased volume capture from the review of the latent storage arrangements during a future modelling assessment could achieve additional flow capture, primarily via the implementation of either construction of additional interconnections between the CS and SRS systems for the Hay and Osborne systems or the reassessment of the performance of existing weir connections through survey confirmation work. Increases in the height of the control gate providing temporarily increased interception rates could be pursued and increase the in-line storage performance, so long as this does not impact the existing level of basement flooding protection. Off-line storage elements such as an underground tank or storage tunnel with associated dewatering pump infrastructure could also be utilized to provide additional volume capture. Finally, the focused use of green infrastructure at key locations would also be utilized to provide volume capture benefits to meet future performance targets.

Table 1-12. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Increased Latent Storage • Increased In-line Storage • Off-line storage (Tank/Tunnel) • Increased use of GI

The control options selected for the Baltimore district has been aligned for the 85 percent capture performance target based on the system wide basis. The expandability of this district to meet the 98 percent capture would be assessed based on a system wide basis. The listed migration options would be assessed as potential individual or combined solutions to achieve the percent capture target.

The cost for upgrading to meet an enhanced performance target depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-13.

Table 1-13. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	R	R	-	-	-	-	-	-
2	Existing Lift Station	-	R	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	-	-	-	-
4	Construction Disruption	-	-	-	-	-	-	-	-
5	Implementation Schedule	-	-	-	-	-	-	R	-
6	Sewer Condition	R	R	-	-	-	-	-	-
7	Sewer Conflicts	R	R	-	-	-	-	-	-
8	Program Cost	O	O	-	-	-	-	-	O
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	R	-	-	-	-	O	O	-
12	Operations and Maintenance	R	R	-	-	-	R	O	R
13	Volume Capture Performance	O	O	-	-	-	O	O	-
14	Treatment	R	R	-	-	-	O	O	R

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

I.D. Engineering Canada INC. 1993. *Baltimore Combined Sewer District Sewer Relief Study*. Prepared for the City of Winnipeg, Waterworks, Waste and Disposal Department. November.

LEGEND

Primary Weir	Inter-System Connection	District Boundary Crossing	Interceptor Sewer	District Boundary
Critical Elevation	SRS - CS	CS	Force Main	Watercourse
Decommissioned Outfall		LDS	Street	Greenspace
CSO Outfall		WWS	Railway	
Low CS Manhole				
Low SRS Connection				

CSO MASTER PLAN PROPOSED SOLUTIONS

- Proposed Control Gate
- Proposed SRS Latent Storage Pump
- Latent Storage Limit
- Latent Force Main
- Extent of In-line Storage

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 06
District Overview Map
Sewer District: Baltimore
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Manhole
- Flap Gate
- Sluice Gate
- Pump Location
- Force Main

Sewer By Type
- CS
- LDS
- SRS
- WWS

Control Structure Type
- Gate Chamber

Pump Station Type
- Flood Pump Station
- Lift Station

CSO MASTER PLAN PROPOSED SOLUTIONS
- Control Gate
- Screening

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

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WATER AND WASTE DEPARTMENT

FIGURE 06-01
Control Gate and Screening
Sewer District: Baltimore
City of Winnipeg
Combined Sewer Overflow Master Plan

LEGEND

Critical Elevation
CSO Outfall
Manhole
Flap Gate
Sluice Gate
Sewer By Type
CS
SRS
WWS
Control Structure Type
Gate Chamber
Land Parcel

CSO MASTER PLAN
PROPOSED SOLUTIONS

Proposed Latent Force Main
Latent Pump

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

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FIGURE 06-02
Latent SRS Control
Sewer District: Baltimore
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Bannatyne District Plan

August 2019

City of Winnipeg

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CSO Master Plan

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Document History and Status

Revision	Date	Description	By	Review	Approved
0	08/30/2018	DRAFT for City Comment	DT	SG	
1	15/02/2019	DRAFT 2 for City Review	MF	SG	MF
2	07/2019	Final Draft Submission	DT	MF	MF
3	08/19/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

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1. Bannatyne District

1.1 District Description

Bannatyne district is in the centre of the combined sewer (CS) area at the intersection of the Assiniboine and Red Rivers. Bannatyne is bounded by Arlington Street to the west, Notre Dame Avenue,Portage Avenue, and the Red River to the south, Elgin Avenue and Pacific Avenue to the north, and the Red River to the east.

Bannatyne has a wide variety of land uses across the district. The downtown area along Portage Avenue and Main Street includes a high density, multiple-use sector. The area west of Isabel Street includes a mix of commercial, educational and institutional, and residential land, where the residential areas are a mix of two- and multi-family homes. Commercial businesses are mainly located along Notre Dame Avenue and Isabel Street. The Health Sciences Centre is a major institution within the district, and consists of the City of Winnipeg's largest hospital, and a number of educational buildings. The Exchange District is located east of Isabel Street and covers a portion of the Bannatyne district. The Forks is another significant section of Bannatyne and includes a large commercial area, museum, hotel, several small parks, and riverbank sections that cover the southeastern area of the district. Approximately 17 ha of the district is classified as greenspace.

Portage Avenue, Main Street, and Notre Dame Avenue are regional transportation routes that pass through the Bannatyne district, with Portage and Main being the center of the City of Winnipeg and the CS area. The Canadian National Railway Mainline, which passes through Bannatyne parallel to the southern end of Main Street, separates the multiple-use sector from The Forks.

1.2 Development

Bannatyne district includes a significant portion of the downtown area, and the potential for redevelopment in the future is high. The OurWinnipeg development plan has prioritized the downtown for opportunities to create complete, mixed-use, higher density communities. Redevelopment within this area could impact the CS and will be investigated on a case-by-case basis for potential impacts to the combined sewer overflow (CSO) Master Plan. All developments within the CS districts are mandated to offset any peak combined sewage discharge by adding localized storage and flow restrictions, in order to comply with Clause 8 of the Environment Act License 3042.

A portion of Portage Avenue and Main Street are located within Bannatyne district. These streets are identified as Regional Mixed Use Corridors as part of the Our Winnipeg future development plans. As such, focused intensification along Portage Avenue and Main Street is to be promoted in the future.

Main Street, Pioneer Avenue, Princess Street, King Street, Donald Street, Smith Street, and Graham Street within the Bannatyne district have been identified as part of the potential routes for the Eastern Corridor of Winnipeg's Bus Rapid Transit. The work along these streets could result in additional development in the area. This could also present an opportunity to coordinate sewer separation works alongside the transit corridor development, providing further separation within the Bannatyne district. This would reduce the extent of the Control Options listed in this plan required.

1.3 Existing Sewer System

Bannatyne district covers an approximate land area of 257 ha[1] and includes a CS system, a storm relief sewer (SRS) system and a land drainage sewer (LDS) system. As shown in Figure 07, there is approximately 9 percent (23 ha) separated and 1 percent (3 ha) separation-ready areas.

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[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The CS system drains towards the Bannatyne outfall, located at the eastern end of Bannatyne Avenue at the Red River. At the outfall, combined sewage is diverted to the Main Interceptor pipe or the Bannatyne flood pumping station (FPS), or it may be discharged directly into the Red River. Sewage primarily flows through the 1500 mm main CS sewer trunk that extends along Bannatyne Avenue and receives all combined sewage from Bannatyne district west of Main Street. This CS runs from Sherbrook Street to Main Street and ties into the Bannatyne outfall upstream of the primary weir for the district. The area west of Main Street is serviced by a 1500 mm CS trunk extending along Bannatyne Avenue that runs from Sherbrook Street to Main Street. Finally, a 1125 mm sewer services the area north of Bannatyne Avenue ties into the Bannatyne outfall upstream of the primary weir for the district. A 1300 mm to 1050 mm CS runs north on Main Street from Portage Avenue that connects to the 1125 mm CS, servicing areas in south Bannatyne district. Other existing CS major collector pipes run along major roads, such as Williams Avenue and Notre Dame Avenue that each flow toward the main CS trunk on Bannatyne Avenue east of Main Street.

During heavy rainfall events, the SRS system provides relief to the CS system in the Bannatyne district. Most catch basins are still connected into the CS system, so the SRS acts as an overflow conduit for the CS. The SRS system discharges directly to the Red River through the McDermot dedicated SRS outfall. The McDermot SRS outfall is located at the eastern end of McDermot Avenue. A flap gate and sluice gate installed along the outfall pipe prevents river water from backing up into the SRS system under high river level conditions. Latent storage pumps are located upstream of the flap gate. Where high river levels keep the flap gate closed, the pumps keep the SRS dewatered following wet weather events. The pumps discharge upstream of the Bannatyne weir but are prevented from dewatering in the event of high levels in Bannatyne. The SRS system is installed throughout the majority of the district and connects to the CSs via interconnections with high overflow pipes and weirs.

There are also separation-ready sewers along John Hirsh Place consisting of a sustainable urban drainage system utilizing Green Infrastructure (GI). The street's drainage is diverted into underground soil storage cells which discharge back into the CS system on Bannatyne Avenue.

The area in the southeastern part of the district known as The Forks, contains a separate LDS system with two separate outfalls. These sewers discharge directly to the Red River and the Assiniboine River through separate LDS outfalls. A short segment of Waterfront Drive also has a separate LDS system, which connects = into the CS outfall on Bannatyne Avenue downstream of the primary weir.

The SRS does not receive dry weather flow (DWF); all DWF generated by the district is diverted by the primary weir within the main CS trunk, through a 1050 mm CS offtake pipe to flow by gravity back to the Main Interceptor on Main Street, and eventually on to the North End Sewage Treatment Plant (NEWPCC) for treatment. During wet weather flow (WWF), any flow that exceeds the diversion capacity overtops the primary weir in the Bannatyne CS outfall and is discharged through the gate chamber to the Red River. There is also a secondary CS outfall located at the eastern end of Lombard Avenue at the Red River. This secondary outfall is in place to relieve the CS system during WWF events, and discharges this excess CS directly to the Red River. Sluice gates are installed on both the Bannatyne and Lombard CS outfalls, with a flap gate on the Bannatyne CS outfall to restrict back-up from the Red River into the CS system under high river level conditions. When the river level is high such as this gravity discharge from the Bannatyne CS outfall is not possible. The excess flow under these conditions may be pumped by the Bannatyne FPS to reconnect to the CS outfall downstream of the flap gate, allowing gravity discharge to the river once more. Two weirs are located on either side of the FPS to restrict the DWF from entering the FPS.

The three outfalls to the Red River (two CSs and one SRS) are as follows:

- ID18 (S-MA70000991) – Bannatyne CS Outfall
- ID16 (S-MA70012338) – Lombard CS Outfall
- ID17 (S-MA20013332) – McDermot SRS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between the Bannatyne district and the surrounding districts. Each interconnection is shown on Figure 07. Interconnections include gravity and pumped flow from one district to another. The known district-to-district interconnections are identified as follows:

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

Alexander

The 1950 mm Main Interceptor pipe flows by gravity north on Main Street into Alexander district to carry sewage to the NEWPCC for treatment:

- Invert at Alexander district boundary 221.76 m (S-TE20005752)

1.3.1.2 Interceptor Connections – Upstream of Primary Weir

Assiniboine

The 1500 mm Main Interceptor pipe flows by gravity eastbound on Broadway from Assiniboine district into Bannatyne district:

- Invert at Bannatyne district boundary 224.28 m (S-TE70003462)

Despins

A 300 mm force main connects the Despins SPS to a 450-mm WWS in Bannatyne.

- River Crossing (S-MA70050831)

Dumoulin

A 300 mm force main connects the Dumoulin FPS / SPS to a 450-mm WWS in Bannatyne.

- River Crossing (S-MA70050829)

River

Two force mains, 600 mm and 500 mm, pump sewage across the Assiniboine River at Queen Elizabeth Way and Main Street:

- Invert at Queen Elizabeth Way in Bannatyne district, flowing from River district = 227.72 m (S-MH70001947)
- Invert at Queen Elizabeth Way in Bannatyne district, flowing from River district = 227.72 m (S-MH70001947)

1.3.1.3 District Interconnections

Cornish

<u>CS to CS</u>

A 1200 mm SRS flows by gravity into Cornish district from Bannatyne district on Wellington Avenue:

- Invert at Cornish district boundary 226.41 m (S-MA20018024)

A 300 mm CS flows by gravity west on Wellington Avenue and connects to the CS system in Cornish district:

- Invert at Bannatyne district boundary 229.48 m (S-MA20017998)

Assiniboine

CS to CS

A 1200 mm CS flowing by gravity connects to the diversion chamber at the Assiniboine CS outfall from Assiniboine district into Bannatyne district:

- Invert at Bannatyne district boundary on Main Street 225.83 m (S-MA70008096)

The 1350 mm CS flowing by gravity connects to the diversion chamber at the Assiniboine CS outfall from Bannatyne district into Assiniboine district:

- Invert at Bannatyne district boundary on Main Street 225.94 m (S-MA70016038)

- A 375 mm CS flows by gravity east on Broadway and connects to the CS system in Bannatyne district:
  - Invert at Bannatyne district boundary 226.35 m (S-MA20014317)

SRS to SRS

A 300 mm diversion SRS flows by gravity on Smith Street and connects to the Assiniboine SRS system at the intersection of Smith Street and Graham Avenue:

- Invert at Assiniboine district boundary 227.71 m (S-MA70087631)

A 525 mm SRS flows by gravity westbound into Assiniboine Avenue on Graham Avenue and connects to the SRS system in Assiniboine district:

- Invert at Assiniboine district boundary 227.50 m (S-MA20015767)

High sewer overflow:

- Smith Street and Graham Avenue – Invert at Bannatyne district boundary 229.08 m (S-MA70023072)
- Garry Street and Graham Avenue – Invert at Assiniboine district boundary 229.07 m (S-MA70001518)
- Fort Street and York Avenue – Invert at Bannatyne district boundary 229.31 m (S-MA20016068)

Aubrey

CS to CS

A CS flowing southbound on Lark Street flows by gravity into the manhole at the intersection of Lark Street and Bannatyne Avenue. From there, it is split into a 450 mm CS that flows eastbound on Bannatyne Avenue into Bannatyne district and a 375 mm CS that flows into Aubrey district:

- Bannatyne Avenue and Lark Avenue – 229.10 m (S-MH20016063)

A 300 mm CS flows by gravity southbound on Arlington Street from Bannatyne district into a manhole that connects with the Aubrey CS system at the intersection of Winnipeg Avenue and Arlington Street:

- Invert at Bannatyne district boundary 228.83 m (S-MA70062544)

A 1200 mm SRS flows by gravity southbound on Arlington Street from Bannatyne district into a manhole that connects with the Aubrey CS system at the intersection of Winnipeg Avenue and Arlington Street:

- Invert at Bannatyne district boundary 226.66 m (S-MA70062569)

A 1350 mm SRS flows into Bannatyne district from Aubrey receiving sewage from two high sewer overflows at the intersection of Notre Dame Avenue and Arlington Street:

- Invert at Aubrey district boundary 226.54 m (S-MA20018132)

A 375 mm SRS flows eastbound on Winnipeg Avenue in Aubrey district into the SRS system in Bannatyne district at the corner of Tecumseh Street and Winnipeg Avenue:

- Invert at Bannatyne district boundary 227.92 m (S-MA70062311)

High point manhole:

- William Avenue – 229.77 m (S-MH20017498)
- McDermot Avenue – 229.46 m (S-MH20016155)
- Notre Dame Avenue and Arlington Street – 229.43 m (S-MH20016156)

High sewer overflow:

- Notre Dame Avenue and Arlington Street – Invert at Bannatyne district boundary 229.92 m (S-MA20018078)
- Notre Dame Avenue and Arlington Street – Invert at Aubrey district boundary 229.53 m (S-MA20018082)
- Notre Dame Avenue and Home Street – Invert at Aubrey district boundary 229.44 m (S-MA20018115)

Alexander

CS to CS

A 375 mm CS flows northbound on Princess Street from Bannatyne district and connects to the CS system in Alexander district:

- Invert at Bannatyne district boundary 227.55 m (S-MA20019098)

A 450 mm CS flows by gravity north on Sherbrook Street. The manhole includes an interconnection to the Bannatyne SRS network with a 750 mm overflow SRS:

- Invert at Bannatyne district boundary 227.67 m (S-MA70026573)

A 450 mm SRS flows by gravity west on Ross Avenue to Tecumseh Street and connects to the SRS system in Alexander district:

- Invert at Alexander district boundary 227.43 mm (S-MA70062533)

A 1200 mm SRS flows by gravity along Tecumseh Street and into Bannatyne district at the intersection of Tecumseh Street and Elgin Avenue, serving a section of Alexander district. It connects to the SRS system on William Avenue:

- Invert at Alexander district boundary 227.03 m (S-MA70062503)

A 1050 mm SRS flows southbound by gravity on Sherbrook Street, while a 450 mm SRS flows westbound on Ross Avenue. Both SRSs flow from Alexander district, into a manhole at the intersection of Sherbrook Street and Ross Avenue and connect to the SRS system in Bannatyne district:

- Invert at Bannatyne district boundary on Sherbrook Street 226.03 m (S-MA70062761)
- Invert at Bannatyne district boundary on Ross Avenue 226.30 m (S-MA70062775)

A 1050 mm SRS flowing southbound into Bannatyne by gravity on Isabel Street connects to the SRS system on William Avenue. The SRS interconnects with the CS system in Alexander district flowing south from Logan Avenue into Bannatyne Avenue:

- Invert at Bannatyne district boundary 225.15 m (S-MA70069557)

A 900 mm SRS flows by gravity south on King Street from Alexander district and crosses into Bannatyne district at the intersection of King Street and Pacific Avenue:

- Invert at Bannatyne district boundary 224.42 m (S-MA70095935)

A 750 mm SRS flows from the SRS network in Alexander district into Bannatyne district by gravity on Ellen Street:

- Invert at Bannatyne district boundary 224.81 m (S-MA70066231)

- A CS flows north by gravity from Bannatyne district into the Alexander district CS system on Princess Street:
  - Invert at Bannatyne district boundary 227.55 m (S-MA20019098)

A 750 mm SRS consisting of a weir overflows during high rainfall events at the corner of Princess Street and Rupert Avenue and flows by gravity eastbound on Rupert Avenue to connect to the SRS system in Bannatyne district:

- Invert at Alexander district boundary 225.39 m (S-MA70096068) Weir height – 227.15 m

A 525 mm SRS flows southbound by gravity from Alexander district into the Bannatyne district SRS system on Arlington Street:

- Invert at Alexander district boundary 228.02 m (S-MA70062474)

High point CS manhole:

- Arlington Street – 229.54 m (S-MH20016288)

LDS to CS

A 525 mm LDS serves the National Microbiology Laboratory between Alexander Avenue and William Avenue. The LDS flows by gravity into Bannatyne and connects to the SRS network in Bannatyne at the corner of Tecumseh Street and Elgin Avenue:

- Invert at Bannatyne district boundary 229.23 m (S-MA70022812)

• A 300 mm LDS flows by gravity east into Bannatyne and connects to the SRS system in Bannatyne at the corner of Tecumseh Street and Elgin Avenue:

- Invert at Bannatyne district boundary 230.10 m (S-MA70022800)

A 450 mm LDS flows south into Bannatyne district at the intersection of Pacific Avenue and Waterfront Drive and is discharged to the main Bannatyne CS outfall:

- Invert at Bannatyne district boundary on Waterfront Drive 225.63 m (S-MA70037381)

Colony

CS to CS

A 450 mm CS flowing by gravity eastbound on Portage Avenue connects to the CS system in Bannatyne district at the intersection of Portage Avenue and Smith Street:

- Invert at Bannatyne district boundary 227.94 m (S-MA20015831)

A 300 mm CS flowing by gravity east on Ellice Avenue at Kennedy Street connects to the CS system in Bannatyne district from Colony district:

- Invert at Colony district boundary 228.60 m (S-MA70014619)

High point CS manhole:

- Victor Street – 229.62 m (S-MH20015805)
- Agnes Street – 229.30 m (S-MH20014738)
- McGee Street – 229.65 m (S-MH20015026)
- Maryland Street – 229.24 m (S-MH20015031)
- Young Street – 229.10 m (S-MH20015264)
- Cumberland Avenue and Balmoral Street – 229.02 m (S-MH20015291)
- Kennedy Street – 226.69 m (S-MH20015216)
- Qu'Appelle Avenue – 228.97 m (S-MH70040622)
- Carlton Street – 228.32 m (S-MH20014246)
- Toronto Street – 229.72 m (S-MH20016007)

High sewer overflow:

- Hargrave Street – 229.02 m (S-MA20015844)

A 1200 mm SRS flowing by gravity south and a 450 mm overflow SRS flowing by gravity east in Colony district connect to 1200 mm SRS on Ellice Avenue at Kennedy Street into Bannatyne district:

- Invert at Bannatyne district boundary on Kennedy Street 226.14 m (S-MA20016684)
- Invert at Colony district boundary 228.60 m on Ellice Avenue (S-MA20016685)

A 375 mm SRS flowing by gravity north on Donald Street connects to the SRS network in Bannatyne district at the intersection of Ellice Avenue and Donald Street:

- Invert at Bannatyne district boundary 227.76 m (S-MA70087485)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing system.

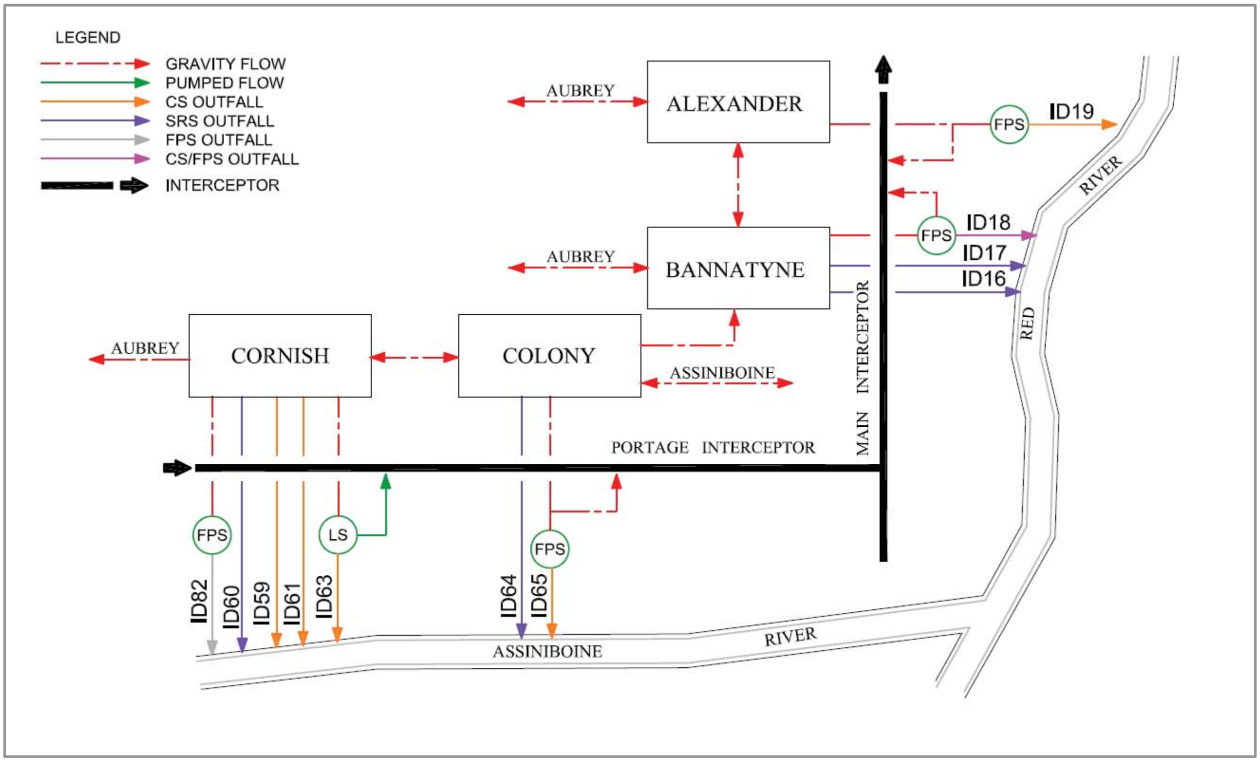


Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 07 and listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID18)	S-CO70000468.1	S-MA70000991	1100 x 1300 mm	Red River Invert: 222.10 m
Flood Pumping Outfall (ID18)	S-CO70000468.1	S-MA70000991	1100 x 1300 mm	Red River Invert: 222.10 m
Other Overflows (ID16)	S-MH70004946.1	S-MA70012338	900 mm	Red River Invert: 223.54 m
Main Trunk	S-TE70023567.1	S-MA70062289	1500 mm	Main CS that flows east on Bannatyne Avenue Circular

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
				Invert: 223.97 m
SRS Outfalls (ID17)	S-CO70010863.1	S-MA20013332	2700 mm	Invert: 221.29 m
SRS Interconnections	N/A	N/A	N/A	SRS - CS
Main Trunk Flap Gate	S-MH70006731.1	S-CG00000729	1525 mm	Invert: 223.81 m
Main Trunk Sluice Gate	S-CG00000728.1	S-CG00000728	1525 x 1525 mm	Invert: 223.57 m
Off-Take	N/A	S-MA70062293	N/A	Invert: 223.98 m
Dry Well	N/A	N/A	N/A	Diversion structure, no lift station force main as part of outfall.
Lift Station Total Capacity	N/A	S-MA70062266 (1)	1,050 mm (1)	2.59 m^3/s (1)
ADWF	N/A	N/A	0.0589 m^3/s	
Lift Station Force Main	N/A	N/A	N/A	Diversion structure, no lift station force main as part of outfall.
Flood Pump Station Total Capacity	N/A	N/A	2.82 m^3/s	2 x 0.97 m^3/s 1 x 0.64 m^3/s 1 x 0.24 m^3/s
Pass Forward Flow – First Overflow	N/A	N/A	0.443 m^3/s	

Notes:

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

(1) Gravity pipe replacing Lift Station as Bannatyne is a gravity discharge district

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Bannatyne – 223.72 McDermot – 223.73 Lombard – 223.73
2	Trunk Invert at Off-Take	N/A
3	Top of Weir	225.70
4	Relief Outfall Invert at Flap Gate (New McDermot Flap Gate) Relief Outfall Invert at Lombard Overflow (Lombard weir)	McDermot – 221.49 Lombard – 226.43
5	Low Relief Interconnection (S-MH20014313)	227.07
6	Sewer District Interconnection (Alexander district – S-TE20005752))	221.76
7	Low Basement	228.60
8	Flood Protection Level (Bannatyne, Alexander)	229.79

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed in Bannatyne was the *Alexander and Bannatyne Combined Sewer Districts Sewer Relief and CSO Abatement Study* (AECOM, 2009). The study's purpose was to identify and recommend sewer relief and CSO abatement options for the Alexander and Bannatyne districts. Sewer relief projects completed as part of the ongoing basement flood relief program were last completed in 2010. A SRS latent storage pump system was installed near the McDermot SRS outfall in 2014. The pumps were initially activated to dewater in winter periods but have been operating in summer periods from 2017.

A Sustainable Urban Drainage System with GI elements was installed along John Hirsh Place in 2016. The drainage system consists of soil storage cells which filter, provide attenuation and storage of surface runoff.

The City undertook an extensive district summer flow monitoring campaign in 2016 to collect observed flow monitoring data for the purpose of calibration of the City hydraulic model.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Bannatyne CS district was included as part of this program. Instruments installed at each of the primary CSO outfall locations has a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Expected Completion
7 – Bannatyne	2009	2016	2013	Complete	N/A

Source: Report on *Alexander and Bannatyne Combined Sewer Districts Sewer Relief and CSO Abatement Study*, 2009

1.5 Ongoing Investment Work

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Bannatyne district. This consists of monthly site visits in confined entry spaces to verify that physical readings concur with displayed transmitted readings, and replacing desiccants where necessary.

Specific to the McDermot SRS, an ongoing annual flow monitoring program (from 2019 to 2022), will be installed to assess the performance of the McDermot latent storage facility and the John Hirsh Place sustainable drainage system previously constructed.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The Bannatyne district has latent storage, gravity control, and floatable control projects proposed to meet CSO Control Option 1. Table 1-4 provides an overview of the control options included in the 85 percent capture in a representative year option.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage	Storage / Transport Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85% Capture in a Representative Year	✓	-	✓	-	-	-	-		✓	✓	✓

Notes:

- = not included
✓ = included

The existing SRS systems are suitable for use as latent storage. These control options will take advantage of the existing SRS pipe network for additional storage volume. Existing DWF from the collection system will remain the same, and overall district operations will remain the same. The SRS proposed latest storage option has been installed by the City during the assessment of the Preliminary Proposal.

The existing CS system has a high level primary weir already installed and therefore no proposed in-line storage is noted at this district.

Bannatyne district discharges to the interceptor by gravity; therefore, it will also require a method of gravity flow control to optimize and control the discharge rate to the interceptor for future dewatering Real Time Controls (RTCs).

Floatable control will be necessary to capture any undesirable floatables in the sewage. Floatables will be captured with all implemented control options to some extent, but screening is currently proposed for floatable management. Screens would be installed on the primary outfall located on the eastern end of Bannatyne Avenue.

GI and RTC will be applied within each district on a system-wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Latent Storage

Latent storage is a suitable control option for the Bannatyne district for the utilizing the McDermot SRS system. Latent storage has been recently installed in the district at the McDermot SRS outfall and has been included as part of the CSO Master Plan performance evaluation. The latent storage level in the system is controlled by the river level, and the resulting backpressure of the river level on the SRS outfall flap gate, as explained in Part 3C. The latent storage design criteria in which was utilized in the 2014 design are identified in Table 1-5. The storage volumes indicated in Table 1-5 are based on the NSWL river level conditions over the course of the 1992 representative year.

Table 1-5. Latent Storage Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	McDermot – 221.49 m	Flap Gate invert
NSWL	223.73 m	
Trunk Diameter	2700 mm	

Table 1-5. Latent Storage Design Criteria

Item	Elevation/Dimension	Comment
Design Depth in Trunk	2235 mm	
Maximum Storage Volume	4414 m^3	
Force Main	150 mm	
Flap Gate Control	N/A	
Lift Station	Yes	Within existing gate chamber
Nominal Dewatering Rate	0.050 m^3/s – proposed 0.032 m3/s (current rate installed in 2014)	Based on 24 hour emptying requirement between WWF events
RTC Operational Rate	TBD	Dependent on future RTC/dewatering control option assessment and recommendations

Note:
NSWL = normal summer water level
RTC = real time control

Latent storage is accessible and has lower risk than other storage types. In 2014, the City installed an in-line pump, removable weir, and interconnection to the 300-mm CS to pilot the SRS latent storage in this location. In order to facilitate an operational latent system, the existing McDermot latent pump station and interconnecting pipes will be operated and the monitoring program currently assessing the performance of the latent storage system will be reviewed at the completion of the monitoring collection period. This future review will allow the storage/dewatering pump capacity to ensure that the 24 hour emptying period is achieved by the current system. The operation of the submersible latent storage pump is dependent on the level meter at Bannatyne. If the level is greater than 225.4 m, the pump is switched off. When the level drops below 225.1 m at Bannatyne, the pump is allowed to operate. This arrangement is to ensure the dewatering pumps do not increase the volume or number of overflow events at the Bannatyne primary CS outfall.

As part of the CSO Master Plan, the details of the newly constructed outfall gate chamber and installation of the submersible pump and force main is shown on Figure 07-02. The submersible pump is located within the new gate chamber. The latent force main flows west and connect to the Bannatyne CS system on Ship Street, where it flows to the main Bannatyne CS outfall. The submersible pump empties the SRS system in preparation for the next runoff event based on the level meter at Bannatyne, as outlined previously.

The full details of the installed arrangement are covered in Bid Opportunity 912-2013.

1.6.3 Floatables Management

Floatables management will require installation of a screening system to capture floatable materials. The off-line screens would be proposed to maintain the current level of basement flooding protection. The existing arrangement at the Bannatyne CSO chamber has a high weir installed, and the standard arrangement of a side weir upstream of the existing weir would not work adequately in this location. The excess CS which overflows over the existing primary weir will be directed to the screens located in a new screening chamber, with screened flow discharged to the river.

The type and size of screens depend on the hydraulic head available for operation. A standard design was assumed for screening and is described in Part 3C. The design criteria for screening are listed in Table 1-6.

Table 1-6. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Top of Weir	225.7 m	Existing Static Weir Level
NSWL	223.73 m	
Maximum Screen Head	1.97 m	
Peak Screening Rate	1.95 m^3/s	Bypass to be installed to match district first flush peak flow rate
Screen Size	3.1 m x 5.7 m	

The proposed screening chamber will be located adjacent to the existing combined trunk sewer, as shown on Figure 07-01. The screen would operate once levels within the sewer surpassed the existing primary weir elevation. The overflow will continue to be directed to the outfall, with the screen located in the new screening chamber, with screened flow discharged to the upstream side of the gate to the river. The screening chamber would include screenings pumps with the discharge returning the screened material to the main sewer pipe for routing back to the interceptor and on to the NEWPCC for removal. A bypass would also be installed to limit the overflow volume to be screening to match that of the other proposed screening units in the system.

The dimensions for the screen chamber to accommodate influent from the screen area, and the routing of discharge downstream of the gate are 5.7 m in length and 3.1 m in width.

1.6.4 Gravity Flow Control

Bannatyne district does not include a lift station (LS) and discharges directly to the Main Interceptor by gravity. A flow control device will be required to control and monitor the diversion rate for future RTC and dewatering assessment. A standard flow control device was selected as described in Part 3C.

The controller will include flow measurement and a gate to control the discharge flow rate. This has been taken as part of the City's future vision to develop a fully integrated CS system network and will be needed to review flows during spatial rainfall WWF scenarios. The CSO Master Plan assessment utilized a uniform rainfall event, and no further investigative work has been completed within the CSO Master Plan.

The flow control would be installed at an optimal location on the connecting sewer between the existing weir and the Main Interceptor pipe on Bannatyne Avenue. Figure 07-01 identifies a conceptual location for flow controller installation. A small chamber or manhole with access for cleaning and maintenance will be required. The flow controller will operate independently and require minimal operation interaction. The diversion weir at the CS outfall may have to be adjusted to match the hydraulic performance of the flow controller.

A gravity flow controller has been included as a consideration in developing a fully optimized CS system as part of the City's long-term objectives. The operation and configuration of the gravity flow controller will have to be further reviewed for additional flow and rainfall scenarios.

1.6.5 Green Infrastructure

The North East Exchange District has undergone green infrastructure improvements within Bannatyne District. The improvements include watermain renewal, widening and lining sidewalks with trees and enhanced lighting were completed on John Hirsch Place, Lily Street, and Pacific Avenue, and green infrastructure work was piloted concurrently with these street upgrades. The green infrastructure involved utilizing sub-surface bioretention soil storage systems. This system utilizes plantings to absorb stormwater being directed to storage areas beneath the road, while for severe wet weather events the soil strata partial cleans excess water prior to being collected by the existing combined sewers. This bioretention GI was primarily completed on John Hirsch Place. The City will monitor the performance of this bioretention system to determine the operational requirements and measurable benefits.

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography, and soil classification for the district will be reviewed to identify applicable GI controls.

Bannatyne has been classified as a medium GI potential district. Bannatyne district is a mix of commercial, educational and institutional, and residential land. This district would be an ideal location for cisterns/rain barrels, and rain garden bioretention within the residential areas. There are a few commercial areas which may be suitable to green roofs and parking lot areas which would be ideal for paved porous pavement.

1.6.6 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 Systems Operations and Maintenance

Systems operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

The latent storage will take advantage of the SRS infrastructure already in place; therefore, minimal additional maintenance will be required for the sewers. The installed LS and dewatering pumps will require regular maintenance that would depend on the frequency of operation.

The flow controller will require the installation of a chamber and flow control equipment. Monitoring and control instrumentation will be required. The flow controller will operate independently and require minimal operation interaction. Regular maintenance of the flow controller chamber and appurtenances will be required.

Floatable control with outfall screening will require the addition of another chamber with screening equipment installed. The chamber will be installed downstream of the primary weir. Screening operation will occur during WWF events that surpass the in-line storage control level. WWF would be directed from the main outfall trunk and directly through the screens to discharge into the river. The screens will operate intermittently during wet weather events and will likely require operations review and maintenance after each event. The frequency of a screened event would correlate to the number overflows identified for the district. Having the screenings pumped back to the interceptor system via a small LS and force main will be required. The screenings return will require O&M inspection after each event to assess the performance of the return pump system.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. An individual model was created to represent the sewer system baseline as represented in the year 2013 and a model for the CSO Master Plan with the control options implemented in the year 2037. A summary of relevant model data is summarized in Table 1-7.

Table 1-7. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Mode
2013 Baseline	203	203	7,719	69	N/A
2037 Master Plan – Control Option 1	203	203	7,719	69	Lat St,

Notes:

Lat St = Latent Storage

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City Of Winnipeg GIS Records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-8 are for the hydraulic model simulations using the year-round 1992 representative year. This table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan – Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. Table 1-8 also includes overflow volumes specific to each individual control option: these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-8. Performance Summary – Control Option 1

Control Option	Preliminary Proposal	Master Plan			
	Annual Overflow Volume (m^3)	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [a]
Baseline (2013)	159,421	148,170	-	19	0.460 m^3/s
Latent Storage [b]	157,789	115,571	32,599	14	0.470 m^3/s
Latent and Off-line Storage	76,689	N/A [c]	N/A [c]	N/A [c]	N/A [c]
Control Option 1	**76,689**	**115,571** [b]	**32,599**	**14**	**0.470 m^3/s**

[a] Pass forward flows assessed on the 1-year design rainfall event.

[b] Latent storage pump and force main already installed within McDermot SRS system. Modelled as proposed pump capacity. Existing LSPS capacity to be assessed after monitoring collection period ended.

[c] Off-line storage originally recommended as part of Preliminary Proposal, but was not carried forward during the Master Plan assessment.

The percent capture performance measure is not included in Table 1-8, as it is applicable to the entire CS system and not for each district individually.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and

updated for the CSO Master Plan are identified in Table 1-9. The cost estimates are Class 5 planning level estimates with a level of accuracy of minus 50 to plus 100 percent.

Table 1-9. Cost Estimate – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period)
Latent Storage	$1,930,000	N/A [c]	N/A	N/A
Gravity Flow Control	N/A [a]	$1,300,000	$34,000	$740,000
Tunnel Storage	$6,480,000	N/A [d]	N/A	N/A
Screening	N/A [b]	$3,960,000 [e]	$50,000	$1,080,000
Off-line Storage	$15,040,000	N/A [d]	N/A	N/A
Subtotal	**$23,440,000**	**$5,260,000**	**$84,000**	**$1,820,000**
Opportunities	N/A	$530,000	$8,000	$180,000
District Total	**$23,440,000**	**$5,790,000**	**$92,000**	**$2,000,000**

Note:

[a] Gravity Flow Control not included in the Preliminary Proposal

[b] Screening solution developed as refinement to Preliminary Proposal work following submission of Preliminary Proposal costs. Costs for this item of work found to be $730,000 in 2014 dollars.

[c] McDermot SRS Latent Storage complete and operational in 2017. No additional cost allocated.

[d] Tunnel and Off-line Storage removed from Master Plan Control Options.

[e] Cost for bespoke screenings return pump/force main not included in Master Plan as will depend on selection of screen and type of screening return system selected

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional cost for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014 dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019 dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-10.

Table 1-10. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Gravity Flow Control	A control gate was not included in the preliminary estimate	Control gate added to Master Plan Control Options
	Screening	Screening was not included in the preliminary estimate	Screening added to Master Plan Control Options
	Latent Storage	Preliminary estimate did not include latent storage work.	Latent storage work completed in 2014 fully operational in 2017
	Off-line Storage	Not included in the Master Plan Control Options	Removed during marginal analysis process in Master Plan development.
	Tunnel Storage	Not included in the Master Plan Control Options	Removed during marginal analysis process in Master Plan development.
Opportunities	A fixed allowance of 10 percent has been included for program opportunities.	Preliminary Proposal estimate did not include a cost for GI opportunities.	
Lifecycle Costs	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation.	Preliminary Proposal estimates were based on 2014-dollar values.	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, the future performance target is 98 percent capture for the representative year measured on a system-wide basis. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-11 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified in Control Option 1.

Overall the Bannatyne district would be classified as a low potential for implementation of complete sewer separation as the only feasible approach to achieve the 98 percent capture in the representative year future performance target. However, opportunistic separation of portions of the district may be achieved with synergies with other major infrastructure work to address future performance targets. In addition, green infrastructure and off-line tank or tunnel storage may be utilized in key locations to provide additional storage and increase captured volume.

Table 1-11. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Opportunistic Sewer Separation • Increased use of GI • Off-Line Storage (Tank/Tunnel)

The control option for the Bannatyne district has been aligned to the primary outfalls being screened under the current CSO 85 percent capture control plan. The expandability of this district to meet the 98 percent capture would be based on the system wide basis. The applicability of the listed migration options will be stepped than full district solutions.

The cost for upgrading to meet an enhanced performance target depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-12.

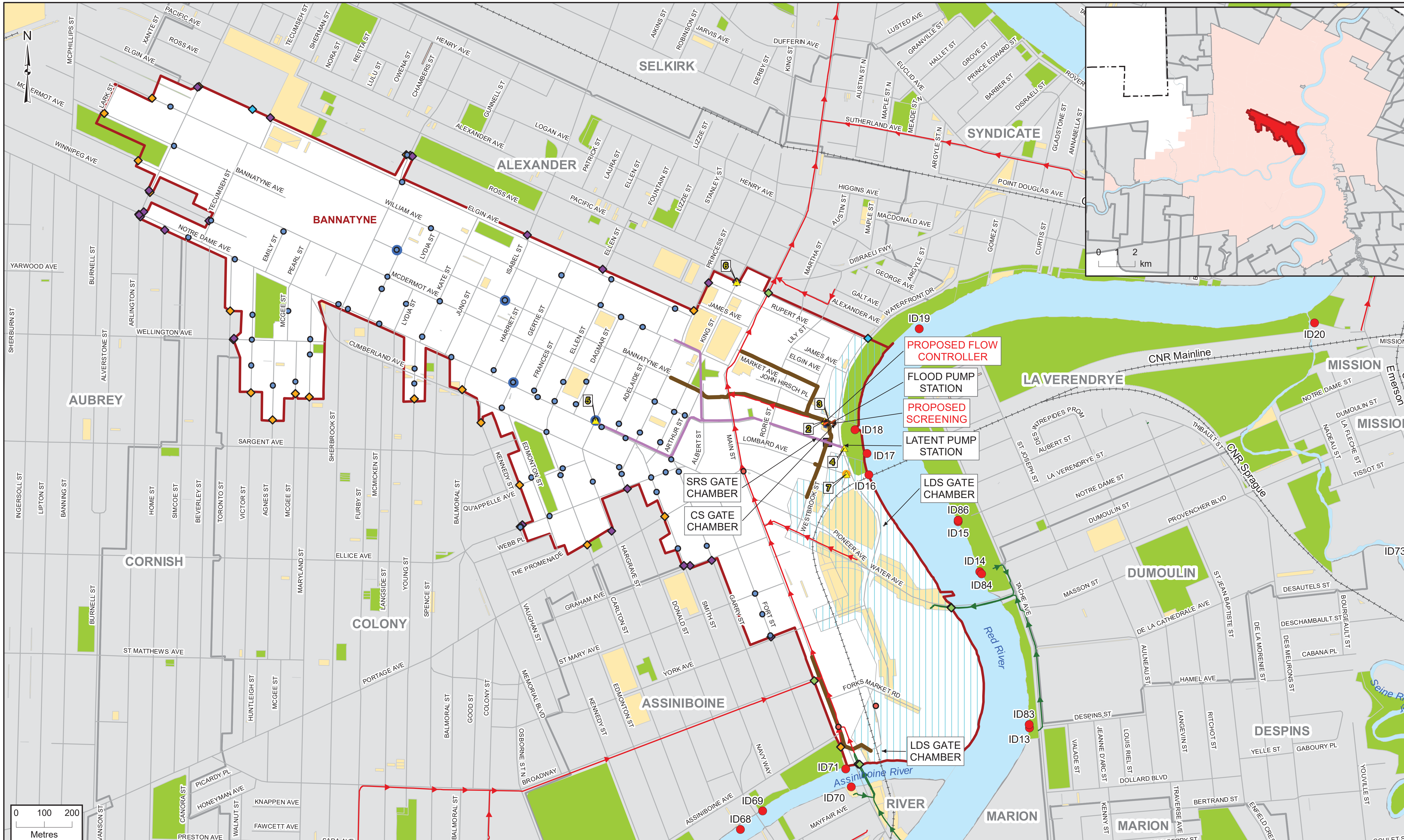
Table 1-12. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	R	-	-	-	-	-	-	-
2	Existing Lift Station	-	-	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	-	-	-	-
4	Construction Disruption	-	-	-	-	-	-	-	-
5	Implementation Schedule	-	-	-	-	-	-	R	-
6	Sewer Condition	R	-	-	-	-	-	-	-
7	Sewer Conflicts	R	-	-	-	-	-	-	-
8	Program Cost	O	-	-	-	-	-	-	O
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	R	-	-	-	-	O	O	-
12	Operations and Maintenance	R	-	-	-	-	R	O	R
13	Volume Capture Performance	O	-	-	-	-	O	O	-
14	Treatment	R	-	-	-	-	O	O	R

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

AECOM. 2009. *Alexander and Bannatyne Combined Sewer Districts Sewer Relief and CSO Abatement Study*. Prepared for the City of Winnipeg. April.



LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Low CS Manhole
- Low SRS Connection
- SRS Latent Storage Pump

Inter-System Connection
- CS - WWS
- SRS - CS

District Boundary Crossing
- CS
- LDS
- SRS
- WWS

- Existing Latent Storage Limit
- Extent of Existing In-line Storage
- Interceptor Sewer
- Force Main
- Street
- Railway

- District Boundary
- Watercourse
- Greenspace
- City Owned Land

CSO MASTER PLAN PROPOSED SOLUTIONS

- Sewer Separation - Complete

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 07
District Overview Map
Sewer District: Bannatyne
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Manhole
- Flap Gate
- Sluice Gate
- Pump Location

Sewer By Type
- CS
- LDS
- SRS

Control Structure Type
- Gate Chamber

Pump Station Type
- Flood Pump Station

CSO MASTER PLAN PROPOSED SOLUTIONS
- Screening
- Flow Controller

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 07-01
Screening and Flow Controller
Sewer District: Bannatyne
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- Critical Elevation
- CSO Outfall
- Manhole
- Sluice Gate

Sewer By Type
- CS
- LDS
- SRS
- WWS

Control Structure Type
- Gate Chamber

CSO MASTER PLAN
PROPOSED SOLUTIONS

ALL PROPOSED SOLUTIONS
SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 07-02
Latent SRS Control
Sewer District: Bannatyne
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Clifton District Plan

August 2019

City of Winnipeg

CSO Master Plan

Project No:	470010CH
Document Title:	Clifton District Plan
Revision:	03
Date:	August 16, 2019
Client Name:	City of Winnipeg
Project Manager:	John Berry
Author:	Stephen Godon
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Document History and Status

Revision	Date	Description	By	Review	Approved
0	08/2018	Version 1 DRAFT	SG	ES	
1	02/15/2019	DRAFT 2 for City Review	SB	SG	MF
2	07/2019	Final Draft Submission	DT	MF	MF
3	08/16/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

Tables

Figure

1. Clifton District

1.1 District Description

Clifton district is located towards the western edge of the combined sewer (CS) area. It stretches from Pacific Avenue West at the north to the Assiniboine River at the south. The most northern section of Clifton is split by Aubrey district. This section is bounded by Keewatin Street to the west, Pacific Avenue West to the north, Weston Street to the east, and Notre Dame Avenue to the south. The southern section of Clifton is bounded by the Midland Rail line to the west; Saskatchewan Avenue to the north; Downing, Goulding, and Clifton Streets to the east; and the Assiniboine River to the south. Omand's Creek runs north-south along the western side of the district boundary adjacent to the Tylehurst district and extends from Dublin Avenue to the Assiniboine River.

Many major transportation routes pass through the district. Ellice Avenue, Wellington Avenue, Sargent Avenue, Notre Dame Avenue, and Portage Avenue run horizontally through Clifton providing a corridor for small commercial businesses. Wall Street and Erin Street run parallel to each other providing access from Portage Avenue to Notre Dame Avenue. Clifton district also includes two rail lines:

- Canadian Pacific Railway (CPR) Lariviere
- CPR Spur SJ Industry

The Clifton area is primarily residential and industrial with an even distribution of general, light, and heavy manufacturing facilities located in the northern section of Clifton and along Erin and Wall Streets. Residential areas are located throughout the district and include mostly single- and two-family homes with a few apartment buildings. Approximately 30 ha of the district is classified as greenspace.

1.2 Development

A portion of Portage Avenue is located within the Clifton District. Portage Avenue is identified as a Regional Mixed Use Corridor as part of the OurWinnipeg future development plans. As such, focused intensification along Portage Avenue is to be promoted in the future.

1.3 Existing Sewer System

Clifton district encompasses an area of 371 ha[1] and includes both a CS system and a storm relief sewer (SRS) system. As shown in Figure 08, there is no LDS already separated areas and 2 percent (7 ha) of the total district is considered separation ready.

The Clifton sewer system includes a flood pump station (FPS), CS lift station (LS), and a CS outfall gate chamber located adjacent to the Assiniboine River at Clifton Street and Wolseley Avenue. The sewage LS is located beside the flood pumping station (FPS) with an independent outfall to the river.

CS flows south through a 2970 by 2300 mm main egg-shaped trunk sewer that runs along Clifton Street. A 600 mm collector pipe collects sewage from four residential blocks south of Portage Avenue and ties into the Clifton trunk sewer immediately upstream of the Clifton CS outfall. CS from the northern section of Clifton district flows through the 1025 by 1325 mm egg-shaped trunk on Clifton Street and flows south towards the CS outfall. There is an extensive SRS pipe network in both the northern and southern sections of Clifton. The majority of these SRS pipes drain towards a dedicated SRS outfall at the southern end of Strathcona Street.

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and In Section 1.8 Performance Estimate may occur.

During dry weather flow (DWF), the SRS is not utilized, and all sanitary sewage is diverted by the primary weir through the 500 mm off-take pipe to the Clifton CS LS, where it is pumped to the Portage interceptor pipe where it flows by gravity east along Wolseley Avenue and on to the North End Sewage Treatment Plant (NEWPCC) for treatment.

During wet weather flow (WWF), any flow that exceeds the diversion capacity of the primary weir then overtops the weir and is discharged to the river. Sluice and flap gates are installed on the Clifton CS outfall and are utilized to restrict back-up from the Assiniboine River into the CS system during high river level conditions. When the Assiniboine River level is high like this however gravity discharge is not possible due to the flap gate. The excess flow under these conditions is instead pumped by the Clifton FPS to discharge into a dedicated FPS outfall. There are no flap or sluice gates installed on this FPS outfall, and allows for gravity discharge to the river regardless of river level conditions.

During WWF as well, the SRS system provides relief to the CS system in the Clifton district by diverting CS into the SRS system via high point overflow connections between the CS and SRS systems. Portions of this SRS divert CS from the CS system at one point, but then ties back into the CS system at a point further downstream. The majority of SRS for the Clifton district flow by gravity to a dedicated SRS outfall on Strathcona Street. Flap and positive gates are installed on the Strathcona SRS outfall pipe to prevent river water from backing up into the Clifton SRS under river level conditions. The Strathcona SRS outfall discharges into Omand’s Creek.

The outfalls to for the Clifton District are as follows:

- ID54 (S-MA70008731) – Clifton CS Outfall
- ID81 (S-MA70042741) – Clifton FPS Outfall
- ID72 (S-MA20011477) – Clifton SRS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Clifton and the surrounding districts. Each interconnection is shown on Figure 08 and shows gravity and pumped flow from one district to another. Each interconnection is listed as follows:

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

Aubrey

- A 1200 mm WWS Main interceptor flows eastbound by gravity at the district boundary between Clifton and Aubrey and on to the North End Sewage Treatment Plant (NEWPCC) for treatment:
  - Invert at manhole on Wolseley Avenue at Clifton district boundary – 226.69 m (S-MA70017830)

1.3.1.2 Interceptor Connections – Upstream of Primary Weir

Tylehurst

- A 600 mm WWS Main interceptor flows eastbound by gravity through the siphon at the district boundary between Clifton and Tylehurst and on to the North End Sewage Treatment Plant (NEWPCC) for treatment:
  - Invert at manhole on Portage Avenue at Clifton district boundary – 228.11 m (S-MH20009684)

1.3.1.3 District Interconnections

Tylehurst

CS to CS

- A 200 mm CS sewer from Tylehurst district into the Clifton CS system:
  - Sargent Avenue and Sanford Street – 228.92 m (S-MH20009103)

Aubrey

CS to CS

- High Point Manhole:
  - Midland Street – 230.72 m (S-MH20010625)
  - Notre Dame Street – 230.28 m (S-MH20010674)
  - Wall Street (near Wall Street East) – 229.04 m (S-MH20009426) (also to SRS)
  - Wolseley Avenue – 230.22 m (S-MH70039558)
  - Pacific Avenue West and Quelch Street – 228.87 m (S-MH20011789)
  - Alexander Avenue and Quelch Street – 228.57 m (S-MH20010968)
  - Portage Avenue and Clifton Street – 227.24 m (S-MH20010003)
- A 750 mm pipe directs excess flow from the Clifton district to the Aubrey district at the intersection of Roy Avenue and Cecil Street:
  - Cecil Street – 227.88 m (S-MH20010899)
- A 750 mm bifurcation pipe from Aubrey flows southbound on Quelch Street and excess flows connect to the CS system south in the Clifton district on Logan Avenue:
  - Logan Avenue – 227.03 m (S-MH20010965)

CS to SRS

- High Point Manholes:
  - Minto Street – 227.56 m (S-MH20008769)
  - Goulding Street – 229.9 m (S-MH20008710)
  - Goulding Street – 229.53 m (S-MH20008700)
  - Wolseley Avenue and Basswood Place – 229.65 m (S-MH70005332)
- A 450 mm SRS overflow pipe connects from the Aubrey district to the SRS system in Clifton district at Keewatin Street and Alexander Avenue:
  - Alexander Avenue – 228.27 m (S-MH20011401)
- A 300 mm SRS overflow pipe connects into the SRS system in Clifton district to reduce sewage back-up of the CS network in Aubrey on Pacific Avenue West:
  - Pacific Avenue West – 227.84 m (S-MH20011392)
- A 300 mm diversion pipe provides relief to the CS on Sprague Street and flows from a high point manhole into the Clifton district flowing eastbound on Wolseley Avenue:
  - Wolseley Avenue – 229.42 m (S-MH20010522)

SRS to SRS

- A 2700 mm SRS trunk conveys flow by gravity southbound on Midland Street from Aubrey district into Clifton district to Clifton's SRS outfall:
  - Midland Street – 225.53 m (S-TE20003059)
- A 2250 mm SRS trunk flows by gravity from northern Clifton into Aubrey district at the intersection of Notre Dame Avenue and Flint Street. It also connects to a SRS coming eastbound from Aubrey and then it connects to the SRS that flows south on Midland Street:
  - Flint Street and Notre Dame Avenue – 225.68 m (S-MH20011539)
- A 1650 mm SRS flows by gravity from northern Clifton collecting overflow from the CS system, into Aubrey district on Notre Dame Avenue. It then connects the SRS that flows south on Midland Street:
  - Notre Dame Avenue – 227.22 m (S-MH20010742)
- A 1350 mm SRS flows by gravity from the Aubrey district into Clifton district along Quelch Street at Logan Avenue:
  - Logan Avenue – 226.91 m (S-MH20010964)
- A 1350 mm SRS pipe flows by gravity from the Aubrey district into Clifton along Worth Street:
  - Worth Street – 226.94 m (S-TE20003936)

<u>SRS to CS</u>

- A 600 mm SRS overflow pipe from Aubrey's CS system flows into Clifton district on Notre Dame Avenue near Clifton Street North:
  - Notre Dame Avenue – 228.5 m (S-MH20011679)
- A 375 mm SRS overflow pipe from Aubrey's CS system flows into Clifton district on Logan Avenue near Wiens Street and connects to the SRS along Logan Avenue:
  - Logan Avenue – 228.83 m (S-MH20011446)

<u>WWS to CS</u>

- A 250 mm WWS pipe flows westbound from the Aubrey district on Pacific Avenue into the Clifton CS system:
  - Pacific Avenue – 227.92 m (S-MH20011757)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing district.

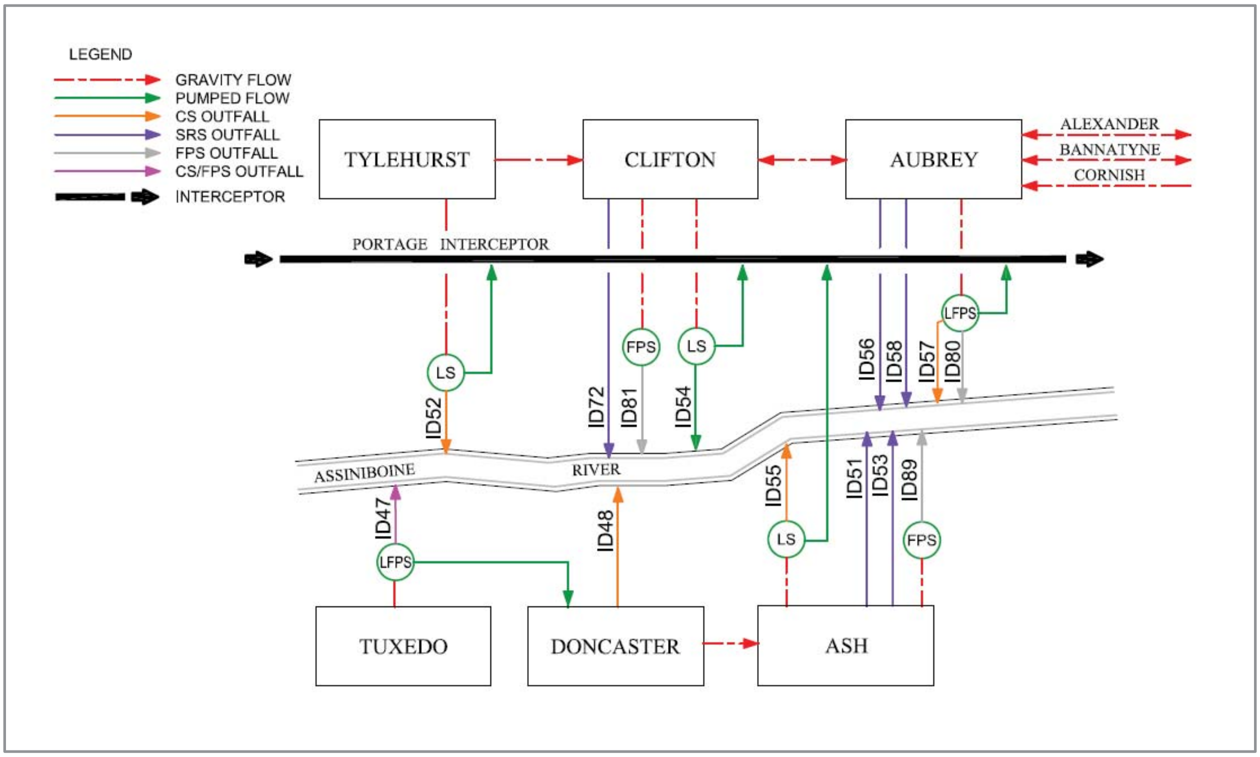

Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 08 and are listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID54)	CLIFTON_GC2.1	S-MA70008731	2500 mm	Circular Invert: 223.50 m
Flood Pumping Outfall (ID81)	S-AC70016634.1	S-MA70042741	2100 mm	Circular Invert: 224.75 m
Other Overflows	N/A	N/A	N/A	
Main Trunk	S-CG00000937.1	S-MA70008732	2970 x 2300 mm	Egg-shaped Invert: 223.82 m
SRS Outfalls (ID72)	S-MH70004527.1	S-MA20011477	2700	Circular Invert: 223.68 m
SRS Interconnections	N/A	N/A	N/A	60 SRS-CS
Main Trunk Flap Gate	CLIFTON_WEIR.1	S-CG00000762	2100 mm	Invert: 224.05 m
Main Trunk Sluice Gate	CLIFTON_GC1.1	S-CG00000763	1800 x 2400 mm	Invert: 224.03 m
Off-Take	S-TE70008194.1	S-MA70017712	500 mm	Circular Invert: 223.80 m
Dry Well	N/A	N/A	N/A	
Lift Station Total Capacity	N/A	N/A	0.250 m^3/s	1 x 0.150 m^3/s 1 x 0.100 m^3/s
Lift Station ADWF	N/A	N/A	0.066 m^3/s	

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Lift Station Force Main	S-AC70008191.1	S-MA70017710	300 mm	Invert: 226.65 m (Note downstream gravity Interceptor 1066 mm diameter with peak flow capacity of 0.791 m^3/s)
Flood Pump Station Total Capacity	N/A	N/A	5.64 m^3/s	4 x 1.41 m^3/s
Pass Forward Flow – First Overflow	N/A	N/A	0.456 m^3/s	

Note:
ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Clifton – 223.86 Strathcona – 223.86
2	Trunk Invert at Off-Take	223.80
3	Top of Weir	224.80
4	Relief Outfall Invert at Flap Gate	223.70
5	Low Relief SRS Interconnection (S-TE20003352)	225.2
6	Sewer District Interconnection (Aubrey)	225.35
7	Low Basement	229.97
8	Flood Protection Level	230.30

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

A summary of the previous work in the Clifton district has been included in Table 1-3, and provides a summary of the district status in terms of data capture and study. The most recent study completed in Clifton was in 1979 with the *Conceptual Design Report for the Clifton Combined Sewer Relief Project* (James F. Maclaren Limited, 1979). The purpose of the conceptual design was to examine various alternatives to provide sewer relief for Clifton district, as well as considering pollution control for CSOs to the Assiniboine River.

An extensive SRS system was constructed within the Clifton district, as well as covering the adjacent Aubrey and Tylehurst districts, over an approximate length of 14 km between 1979 and 2013 (the majority was constructed in 1981). The SRS system is classified as the Strathcona SRS discharging to the Assiniboine river via a 2700 mm diameter outfall pipe.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Clifton Combined Sewer District was included as part of this program. Instruments installed at each of the

39 primary CSO outfall locations has a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Planned Completion
8 - Clifton	1979 - Conceptual	Future Work	2013	Study Complete	N/A

1.5 Ongoing Investment Work

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Clifton district. This consists of monthly site visits in confined entry spaces to verify that physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Clifton sewer district are listed in Table 1-4. The proposed CSO control projects will include in-line storage via control gate, floatable management via screening, and latent storage with flap gate control. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85% Capture in a Representative Year	✓	✓	-	✓	✓	-	-	-	✓	✓	✓

Notes:

- = not included
✓ = included

The existing CS system is suitable for use as in-line and latent storage. These control options would take advantage of the existing CS pipe network for additional storage volume. Existing DWF from the collection system would remain the same, and overall district operations would remain the same, although additional WWF will be collected from the SRS and transferred to the existing CS system and forwarded to the NEWPCC for treatment.

All primary overflow locations are to be screened under the current CSO control plan. The installation of a control gate at the primary CS outfall will be required for the screen operation. The control gate installation will also provide the mechanism for capture of additional in-line storage.

GI and RTC will be applied within each district on a system-wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Latent Storage

Latent storage is proposed as a control option for the Clifton district. The latent storage level is partially controlled by the resulting backpressure of the river level on the Strathcona SRS outfall flap gate. However, the level of the Strathcona SRS outfall is sufficiently above the river level that insufficient volume capture is achieved from the latent storage provided by the flap gate only. Therefore, flap gate control has been recommended with this control option, to provide the additional latent storage volume desired. The latent storage design criteria are identified in Table 1-5.

Table 1-5. Latent Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	223.70 m	
NSWL	223.86 m	
Trunk Diameter	2,700 mm	
Design Depth in Trunk	160 – 1740 mm	1.74 m for 1-year design event (depth varies with rainfall)
Maximum Storage Volume	23 - 6,740 m^3	Varies depending on rainfall, 6,740m^3 with 1-year design event. 23 m^3 provided with no flap control (single rainfall event modelled value)
Force Main	125 mm diameter	
Flap Gate Control	Yes	
Lift Station	Yes	
Nominal Dewatering Rate	0.040 m^3/s	Based on 24-hour emptying requirement between WWF events
RTC Operational Rate	TBD	Dependent on future RTC control option requirement and recommendation

Notes:

NSWL = normal summer water level
TBD = to be determined

The addition of a latent storage pump station (LSPS) and force main that connect to the CS system are necessary for the latent storage. The purpose of the LSPS is to transfer stored latent volume back into the CS system. The LSPS will operate to dewater the SRS system in preparation for the next runoff event, the requirement for the system to be ready for the next event within a 24-hour period after completion of the previous event. A conceptual layout for the LSPS and force main is shown on Figure 08-02. The pump station would be located to the east of the existing SRS outfall chamber within public land. The latent force main will route through city-owned land and connect to the interceptor sewer on Raglan Road and into the manhole (S-MH20010465). The pump station and force main construction would cause minimal disruption to local residents within the surrounding area.

As mentioned above, flap gate control for the SRS system is proposed to fully utilize the latent storage available in the SRS system. The operation of this flap control will be tied to the lowering of the control gate on the CS system. As soon as the control gate drops out of the way, resulting from the increasing level in the CS system to the critical elevation, the flap control allows full capacity outflow in the SRS system through the SRS outfall and flap gate. The actual levels in the SRS system at these times will vary depending on the rainfall characteristics.

Figure 08 identifies the extent of the SRS system within the Clifton district that would be used for latent storage. The extent shown on the figure is relative to the NSWL as the controlling elevation. The maximum storage level is related to the NSWL, flap gate control and the size and depth of the SRS system. Once the level in the SRS exceeds the river level or the control set point of the flap gate control, the flap gate opens, and the CS is discharged to the river. The lowest interconnection between the combined sewer and relief pipe is higher than the proposed latent and in-line storage control levels, as a result the additional storage contained within the two systems via in-line and latent storage would function independently.

As described in the standard details in Part 3C wet well sizing will be determined based on the final pump selection, operation and dewatering capacity required. The interconnecting piping between the new gate chamber and the pump station would be sized to provide sufficient flow to the pumps while all pumps are operating. Th flap gate control function is also described in the standard details in Part 3C.

1.6.3 In-Line Storage

In-line storage has been proposed as a CSO control for the Clifton district. The in-line storage will require the installation of a control gate at the CS outfall. The control gate will primarily be use to maximize the available hydraulic head in the district CS system, such that screening can be effectively operated. The gate will also provide a minor increase in the storage level in the existing CS to provide an increase to the volume capture. Should screening no longer be required for floatables management in this district, ultimately the in-line storage arrangements recommended in this sub-section should not be pursued.

A standard design was assumed for the control gate, as described in Part 3C. A standard approach was used for conceptual gate sizing by assuming it to be the lesser of the height of half of the site-specific trunk diameter or the maximum height of the gate available. The design criteria for the in-line storage are listed in Table 1-6.

Table 1-6. In-Line Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	223.82 m	Downstream invert of pipe at weir
Trunk Diameter	2300 x 2970 mm	
Gate Height	0.59 m	Gate height based on half trunk diameter assumption
Top of Gate Elevation	225.40 m	
Bypass Weir Height	225.20 m	
Maximum Storage Volume	2,397 m^3	
Nominal Dewatering Rate	0.25 m^3/s	Based on existing sewage LS capacity
RTC Operational Rate	TBD	Future RTC / dewatering review on performance

The proposed control gate will cause combined sewage to back-up within the collection system to the extent shown on Figure 08. The extent of the in-line storage and volume is related to the top elevation of the bypass side weir. The level of the top of the bypass side weir and adjacent control gate level are determined in relation to the critical performance levels in the system for basement flooding protection: when the system level increases above the bypass weir crest and proceeds above the top of the control gate during high flow events, the gate drops out of the way. At this point, the district will only provide its original interception capacity via the primary weir for the district, and all excess CS would flow over the weir and discharge to the river. After the sewer levels in the system drops back below the bypass side weir critical performance level, the control gate moves back to its original position to capture the receding limb of the WWF event. The CS LS will continue with its current operation while the control gate is in either position, with all DWF being diverted to the CS LS and pumped to the Main Interceptor pipe on Wolseley Avenue. The CS LS will further dewater the in-line storage provided during a WWF event as downstream capacity becomes available.

Figure 08-01 provides an overview of the conceptual location and configuration of the control gate and screening chambers. The control gate would be installed in a new chamber within the trunk sewer alignment and located north of the CS LS. The dimensions of a new chamber to provide an allowance for a side weir for floatables control are 5.0 m in length and 3.6 m in width. The existing sewer configuration including the construction of an additional off-take, and force main modifications may have to be completed accommodate the new control gate chamber. This will be confirmed in future design assessments. This construction will be within city owned land as this is adjacent to the existing FPS and CS LS structures. The construction is expected to be minimal from a traffic aspect due to the location proposed being located off of a residential street, although construction traffic will be present in the local street area.

The physical requirements for the off-take and station sizing for a modification to pumping capacity have not been considered in detail, but they will be required in the future as part of an RTC program or FPS rehabilitation or replacement project.

The nominal rate for dewatering is already set at the existing pipe capacity as the district is a gravity discharge district. Any future considerations, for RTC improvements, would be completed with spatial rainfall as any reduction to the existing pipe capacity/operation for large events will adversely affect the overflows at this district. This future RTC control will provide the ability to capture and treat more volume for localized storms by using the excess interceptor capacity where the runoff is less.

1.6.4 Floatables Management

Proposed floatables management will require installation of a screening system to capture floatable materials. The off-line screens will be designed to maintain the current level of basement flooding protection.

The type and size of screens depend on the specific station configuration and the hydraulic head available for operation. A standard design was assumed for screening and is described in Part 3C. The design criteria for screening, with an in-line control gate implemented, are listed in Table 1-7.

Table 1-7. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Top of Gate	225.40 m	
Bypass Weir Crest	225.20 m	
NSWL	223.86 m	
Maximum Screen Head	1.34 m	
Peak Screening Rate	0.76 m^3/s	
Screen Size	1.5 m wide x 1 m high	Modelled Screen Size

The proposed side bypass overflow weir and screening chamber will be located adjacent to the existing combined trunk sewer, as shown on Figure 08-01. The screens will operate once levels within the sewer surpass the bypass weir elevation. The side bypass weir upstream of the gate will direct initial overflow to the screens located in the new screening chamber, with screened flow discharged to the downstream side of the gate to the river. The screening chamber may include screenings pumps with a discharge returning the screened material to the LS for routing back to the interceptor and on to the NEWPCC for removal. The provision of screening pumps is dependent on final level assessment within the existing infrastructure and the Clifton trunk. This will be confirmed during future assessment stage.

The dimensions for the screen chamber to accommodate influent from the side bypass weir, the screen area, and the routing of discharge piping downstream of the gate are 3.6 m in length and 3.1 m in width. The location of the screen will provide minimal interference with local private residencies although possible disruption from construction processes is possible. All land utilized has been determined to City-owned, as per the current zoning boundary maps.

1.6.5 Green Infrastructure

The approach to GI is described in more detail in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography, and soil classification for the district will be reviewed to identify applicable GI controls.

Clifton has been classified as a medium GI potential district. Land use in Clifton is mainly industrial and residential, the south end of the district is bounded by the Assiniboine River. Bioswales and green roofs may be suitable to the industrial areas while cisterns/rain barrels, and rain garden bioretention are suitable for the residential areas. Parking lots located in commercial areas are ideal for paved porous pavement.

1.6.6 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

In-line storage will impact the existing sewer and will require the addition of a new chamber and a moving gate at the outfall. In-line storage dewatering will be controlled with the existing Clifton CS LS, which will require more frequent and longer duration pump run times. Lower velocities will occur in the CS trunk in the vicinity of the control gate due to lower pass forward flows, and may create additional debris deposition requiring cleaning. Additional system monitoring, and level controls will be installed, which will require regular scheduled maintenance.

Floatable control with outfall screening will require the addition of another chamber with screening equipment installed. The chamber will be installed adjacent to the control gate chamber and will operate in conjunction with it. Screening operation will occur during WWF events that surpass the in-line storage control level. WWF will be directed from the main CS trunk, over the side weir in the control gate chamber and through the screens to discharge into the river. The screens will operate intermittently during wet weather events and will likely require operations review and maintenance after each event. The frequency of a screened event will correlate to the number overflows identified for the district. Having the screenings pumped back to the interceptor system via a small LS and force main will be required. The screenings return will require O&M inspection after each event to assess the performance of the return pump system.

The latent storage would take advantage of the SRS infrastructure already in place, therefore, minimal additional maintenance will need to be anticipated. The proposed latent LSPS will require regular maintenance that would depend on the frequency of operation. The flap control gate will require maintenance inspection for continued assurance that the flap gate would open during WWF events.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. Two versions of the sewer system model were created and used to measure system performance. The 2013 Baseline model represents the sewer system baseline in the year 2013 and the 2037 Master Plan – Control Option 1 model, which includes the proposed control options in the year 2037. A summary of relevant model data is provided in Table 1-8.

Table 1-8. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	403	384	8,160	46	N/A
2037 Master Plan – Control Option 1	403	384	8,160	46	Lat St, FGC, IS, SC

Notes:

Lat St = Latent Storage

FC = Flap Gate Control
IS = In-line Storage
SC = Screening

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district.

City Of Winnipeg Hydraulic Model relied upon for area statistics. The Hydraulic model representation may vary slightly from the City Of Winnipeg GIS Records. Therefore minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-9 are for the hydraulic model simulations using the year-round 1992 representative year. This table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options, Table 1-9 also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-9. District Performance Summary – Control Option 1

Control Option	Preliminary Proposal Annual Overflow Volume (m^3)	Master Plan Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [c]
Baseline (2013)	153,921	114,875	-	41	0.456 m^3/s
In-line Storage		97,059 [b]	17,816	41	0.296 m^3/s
Latent Storage	153,619 [a]	113,932 [b]	943	15	0.296 m^3/s
Flap Gate Control		104,302 [b]	10,573	15	0.292 m^3/s
Control Option 1	**153,397**	**88,392**	**26,483**	**15**	**0.292 m^3/s**

[a] In-line and latent storage not modelled separately in the Preliminary Proposal assessment. Flap gate control not considered in PP assessment.

[b] Assessment completed with individual district models and reductions attributed to full model impact overflows provided

[c] Pass forward flows assessed on the 1-year design rainfall event

The selection of a flap gate control for the latent storage was not considered during the Preliminary Proposal, although further assessment of the level interaction between the SRS outfall and NSWL resulted in this being reconsidered during the CSO Master Plan phase.

The percent capture performance measure is not included in Table 1-9, as it is applicable to the entire CS system and not for each district individually.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-10. The cost estimates are a Class 5 planning level estimate with a level of accuracy of minus 50 to plus 100 percent.

Table 1-10. Cost Estimates – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance (Over 35-year period)
Latent Storage	N/A [a]	$2,410,000	$87,000	$1,860,000
Latent Flap Gate Control		$2,420,000	$42,000	$900,000
In-line Storage	$7,740,000 [b]	$2,730,000 [c]	$42,000	$900,000
Screening		$2,730,000 [d]	$48,000	$1,040,000
Subtotal	**$7,740,000**	**$10,290,000**	**$219,000**	**$4,700,000**
Opportunities	N/A	$1,030,000	$22,000	$470,000
District Total	**$7,740,000**	**$11,320,000**	**$241,000**	**$5,170,000**

[a] Latent Storage and flap gate control not included in the Preliminary Proposal 2015 costing. Solution developed as refinement to Preliminary Proposal work following submission of Preliminary Proposal costs. Costs for the Latent Storage item of work found to be $1,530,000 in 2014 dollars

[b] Solution developed as refinement to Preliminary Proposal work following submission of Preliminary Proposal costs. Costs for this item of work found to be $3,000,000 in 2014 dollars

[c] Cost associated with new off-take construction, as required, to accommodate control gate location and allow intercepted CS flow to reach existing Clifton LS not included

[d] Cost for bespoke screenings return/force main not included in Master Plan as will depend on selection of screen and type of screening return system selected

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the Mast Plan cost estimate includes the following:

- Capital costs and O&M are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional cost for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014 dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019 dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.

- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The difference identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-11 below.

Table 1-11. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Control Gate	Preliminary estimate was based on a standard cost per district, which has been updated to a site-specific cost estimate	The change may result in significant changes to individual districts, but balances over the entire CS area
	Screening	Preliminary estimate was based on a standard cost per district, which has been updated to a site-specific cost estimate	The change may result in significant changes to individual districts, but balance out over the entire CS area
	Latent Storage	Not included in the Preliminary Proposal cost submission, modelled as part of Preliminary Proposal refinements.	Add to Master Plan recommended solutions.
	Flap Gate Control	Not included in the Preliminary Proposal. Determined as necessary to fully take advantage of available latent storage.	Added in conjunction with Latent Storage
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Costs	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation	Preliminary Proposal estimates were based on 2014-dollar values	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, the future performance target is 98 percent capture for the representative year measured on a system-wide basis. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-12 provides a description of how the target adjustment could be met by building off proposed work identified in Control Option 1.

Overall the Clifton district would be classified as a low potential for implementation of complete sewer separation as the only feasible approach to meet future performance targets. However, opportunistic sewer separation within a portion of the district may be completed in conjunction with other major infrastructure work to address future performance targets. In addition, green infrastructure and off-line tank or tunnel storage may be utilized in key locations to provide additional storage and increase capture volume to meet future performance targets.

Table 1-12. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Opportunistic separation • Off-line storage (Tank/Tunnel) • Increased use of GI

The control options for the Clifton district has been aligned for the 85 percent capture performance target based on the system wide assessment. The expandability of the district to the future 98 percent capture target will be restricted depending on the interaction of the system wide performance.

The cost for upgrading to meet an enhanced performance target depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-13.

Table 1-13. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	R	R	-	-	O	-	-	-
2	Existing Lift Station	-	R	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	O	-	-	-
4	Construction Disruption	-	-	-	-	-	-	-	-
5	Implementation Schedule	-	-	-	-	-	-	R	-
6	Sewer Condition	R	R	-	-	-	-	-	-
7	Sewer Conflicts	R	R	-	-	-	-	-	-
8	Program Cost	O	O	-	-	-	-	-	O
9	Approvals and Permits	-	-	-	-	-	R	-	-

Table 1-13. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	R	-	-	-	-	O	O	-
12	Operations and Maintenance	R	R	-	-	-	R	O	R
13	Volume Capture Performance	O	O	-	-	-	O	O	-
14	Treatment	R	R	-	-	-	O	O	R

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

James F. Maclaren Limited. 1979. *Conceptual Design Report for the Clifton Combined Sewer Relief Project*. Prepared for the City of Winnipeg Water and Waste Department. January.

LEGEND

Primary Weir	Inter-System Connection	District Boundary Crossing	Interceptor Sewer	District Boundary
Critical Elevation	CS - LDS	CS	Force Main	Watercourse
CSO Outfall	CS - WWS	SRS	Street	Green Space
Low CS Manhole	SRS - CS	WWS	Railway	
Low SRS Connection	SRS - WWS			

CSO MASTER PLAN PROPOSED SOLUTIONS

- Proposed Control Gate
- Proposed SRS Latent Storage Pump
- Latent Storage Limit
- Extent of In-line Storage
- Latent Force Main
- Sewer Separation - Ready

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 08
District Overview Map
Sewer District: Clifton
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Manhole
- Flap Gate
- Sluice Gate
- Pump Location
- Force Main

Sewer By Type
- CS
- SRS
- WWS

Control Structure Type
- Gate Chamber

Pump Station Type
- Flood Pump Station
- Lift Station

CSO MASTER PLAN PROPOSED SOLUTIONS
- Control Gate
- Screening

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

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WATER AND WASTE DEPARTMENT

FIGURE 08-01
Control Gate and Screening
Sewer District: Clifton
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- Critical Elevation
- CSO Outfall
- Manhole
- Flap Gate
- Sluice Gate

Sewer By Type
- CS
- LDS
- SRS
- WWS

Control Structure Type
- Gate Chamber

- Land Parcel

CSO MASTER PLAN PROPOSED SOLUTIONS
- Proposed Latent Force Main
- Latent Pump

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 08-02
Latent SRS Control
Sewer District: Clifton
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Cockburn and Calrossie Districts Plan

August 2019

City of Winnipeg

CSO Master Plan

Project No:	470010CH
Document Title:	Cockburn and Calrossie Districts Plan
Revision:	04
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0	08/2018	DRAFT – Template Development	SG	ES	
1	11/2018	Version 1 DRAFT	SG	ES / JB / DT	
2	12/2018	Version 2 DRAFT	SG	ES / MF	
3	05/2019	Final Draft Submission	SG	MF	MF
4	08/18/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

Tables

Figure

1. Cockburn and Calrossie Districts

1.1 District Description

The Cockburn and Calrossie sewer districts are located at the southern limit of the combined sewer area. Cockburn is bounded by Grant Avenue on the north, Daly Street on the east, Jubilee and Parker Avenues on the south, and Cambridge Street on the west. Calrossie is a small separated sewer district located south of Jubilee Avenue between Pembina Highway and the Red River, extending south to Calrossie Boulevard. Figure 09 provides an overview of the sewer district and the location of the proposed Combined Sewer Overflow (CSO) Master Plan control options.

The Canadian National Railway (CNR) Mainline and CNR Letellier rail lines run through Cockburn and split it into two distinct parts; in terms of the combined sewer (CS) area, these are subsequently referred to as Cockburn East and Cockburn West. Cockburn East includes the Lord Roberts area, which developed as residential in the early 1900s, while the residential portion of Cockburn West was developed between the 1940s and 1960s.

Pembina Highway is a major regional roadway that runs parallel to the rail lines in a north-south direction; it intersects with Grant Avenue and Taylor Avenue, which are major regional streets that extend from Pembina Highway to the west.

Cockburn East is primarily residential, except for the railway corridor that originally contained the Fort Rouge Yards. The railway yards are in the process of being abandoned and replaced with the Southwest Rapid Transitway (SWRT), a new bus rapid transit roadway.

A portion of Cockburn West between Grant Avenue and Taylor Avenue is primarily residential, with single-family residential areas and multi-family apartment buildings along Grant and Taylor Avenues. Grant Avenue includes Grant Park shopping centre, Grant Park School, and Pan Am Pool. Taylor Avenue includes two commercial developments: Grant Park Pavilions and Grant Park Festival. Approximately 22 ha of the district is classified as greenspace, which includes multiple parcels spread throughout the district.

Calrossie is primarily a single-family residential area with some commercial properties along Pembina Highway.

1.2 Development

A significant level of development is ongoing within the Cockburn district. This includes the Fort Rouge Yards, the Taylor Lands, and the Parker Lands. Each of these areas have designated as Major Redevelopment Sites as part of the Complete Communities direction strategy within OurWinnipeg. The lands adjacent to the SWRT along the former Fort Rouge Yards are in the process of being developed into multi-family residential housing. The area south of Taylor Avenue and west of Pembina Highway is actively under development, as follows:

- The second phase of the SWRT is being constructed from the underpass at Pembina Highway and Jubilee Avenue in a westward direction parallel to Parker Avenue, before turning south to the University of Manitoba.
- Large commercial developments are taking place on the Taylor and Parker Lands. The Taylor Lands development has been zoned for commercial development and is proceeding. High-density residential development has been proposed for Parker Lands. Both development areas will be served by the new land drainage sewer (LDS) system, which is being installed as part of the basement flooding relief.
- The Pembina-Jubilee underpass is being widened to a six-lane underpass. The current design includes use of a dry pond to temporarily store stormwater with gradual release back into the CS system.

A portion of Pembina Highway is located within the Cockburn and Calrossie Districts. Pembina Highway is identified as Regional Mixed Use Corridor as part of the OurWinnipeg future development plans. As such, focused intensification along Pembina Highway is to be promoted in the future.

1.3 Existing Sewer System

The Cockburn district has an approximate area of 327[1] ha based on the district boundary. There is approximately 1 percent (4 ha) separated and no separation-ready areas. Separation work is ongoing with areas west and north of the rail line planned for LDS separation.

The Calrossie district has a drainage area of 16 ha and was originally a small CS district; it has since been completely separated through the addition of an LDS system. An LDS outfall is located in Toilers Memorial Park, near the intersection of Riverside Drive and Byng Place. In 2014, the LDS outfall was reconnected to the upstream side of the LDS gate chamber installed for the Cockburn West sewer separation project. The original CSs for Calrossie continue to discharge separate wastewater into the Cockburn CS system at the intersection of Jubilee Avenue and Riverside Drive.

The CS system includes a flood pump station (FPS), CS lift station (LS), one CS outfall, and one FPS outfall. All domestic wastewater and CS flows collected in Cockburn and Calrossie districts are routed to Cockburn Avenue, where the CS LS and outfall are located.

During dry weather flow (DWF), sewage flows are directed by the primary weir to the Cockburn CS LS and pumped to the Baltimore interceptor sewer. From Baltimore district, flows are pumped across the Red River to a gravity sewer flowing to the Mager CS LS. The Mager CS LS then pumps to the south end interceptor system, which flows by gravity to the South End Sewage Treatment Plant (SEWPCC). During wet weather flow (WWF), any flow that exceeds the diversion capacity of the primary weir is discharged into the Cockburn outfall, where it flows to the Red River by gravity. Sluice and flap gates are installed on the CS outfall to prevent back-up of the Red River into the CS system under high river level conditions.

Under these high river level conditions and when gravity discharge through the Cockburn CS outfall is not possible, the excess flow is pumped by the Cockburn FPS to a separate outfall adjacent to the CS outfall, where it will the discharge by gravity to the Red River. There are no sluice or flap gates on this FPS outfall.

The two CS outfalls to the Red River are as follows:

- ID1 (S-MA60012037) – Cockburn CS Outfall
- ID87 (S-MA60012037) – Cockburn FPS Outfall

1.3.1 District-to-District Interconnections

There are several sewer system interconnections between this district and the adjacent districts; see Figure 09. Interconnections include gravity and pumped flow from one district to the other. Each interconnection is listed in the following subsections:

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

Baltimore

- The Cockburn CS LS discharges through a 250 mm force main into the Baltimore Interceptor, a gravity sewer beginning at Cockburn Street and Rosedale Avenue that flows through the Baltimore district to the Baltimore CS LS.

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

1.3.1.2 District Interconnections

Calrossie

WWS to CS

- A 200 mm WWS pipe from Calrossie flows into the Cockburn CS system at the intersection of Jubilee Avenue and Riverside Drive. (S-MH60010185)

Jessie

CS to CS

- High Point Manhole (flow is directed into both districts from this manhole)
  - Ebby Avenue and Wentworth Street – 228.93 m (S-MH60010140)
- A 300 mm CS sewer acts as an overflow pipe from the Cockburn CS system into the Jessie CS system.
  - Jackson Avenue and Stafford Avenue – 229.29 m (S-MH60010066)

LDS to LDS

- A 1350 mm LDS trunk conveys flow from the Fort Rouge Yards development area within Cockburn to an LDS outfall discharging to the Red River and located in the Jessie sewer district.

Baltimore

CS to CS

- High Point Manholes (flow is directed into both districts from these manholes)
  - Montague Avenue and Nassau Street South – 228.83 m (S-MH60010528)
  - McNaughton Avenue and Nassau Street South – 228.82 m (S-MH60010544)
  - Churchill Drive – 229.71 m (S-MH60010728)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing district.

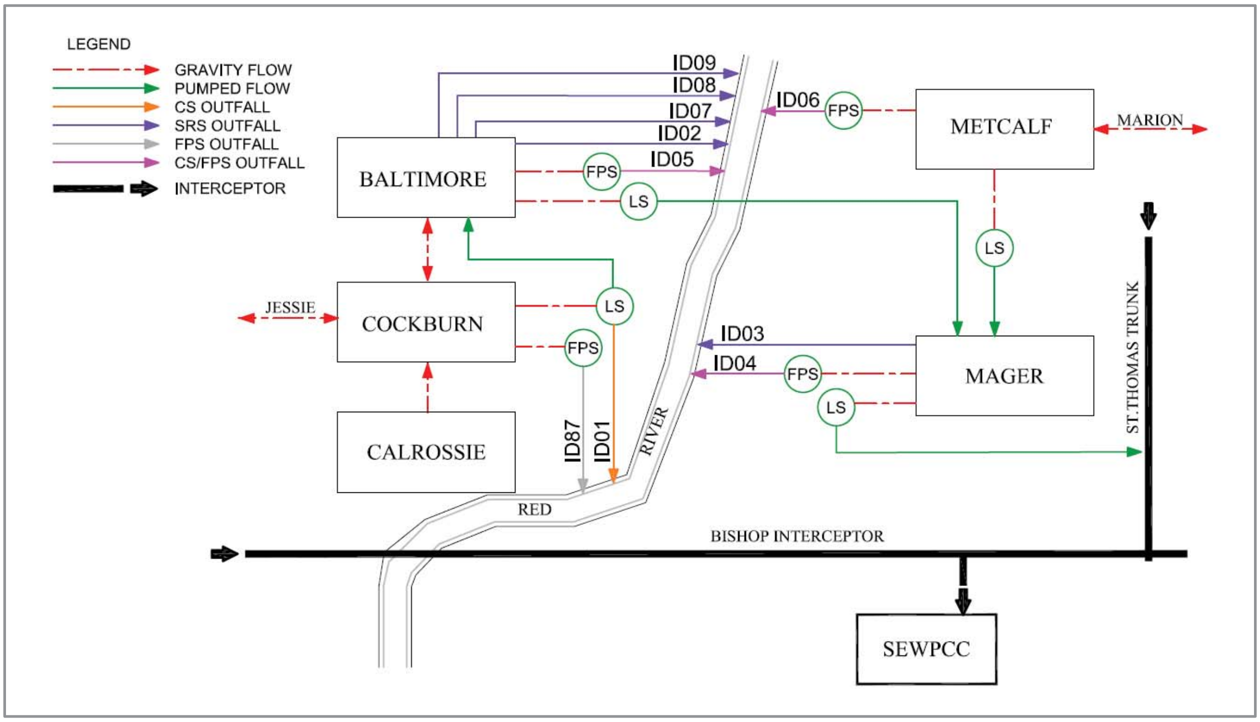


Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 09 and are listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID1)	S-CS00000475 DS.1	S-MA60012037	1675 mm	Red River Invert: 222.66 m
Flood Pumping Outfall (ID87)	S-TE70028256.1	S-MA60012037	1524 mm	Red River Invert: 221.93 m
Other Overflows	N/A	N/A	N/A	
Main Sewer Trunk	N/A	S-MA60012153	2800 x 2100 mm	Invert: 223.07 m
Storm Relief Sewer Outfalls	N/A	N/A	N/A	
Storm Relief Sewer Interconnections	N/A	N/A	N/A	
Main Trunk Flap Gate	S-CS00000475.1	S-CG00000764	2000 mm	Invert: 223.21 m
Main Trunk Sluice Gate	S-CG00000765.1	S-CG00000765	1810 mm	Invert: 223.03 m
Off-Take	S-TE70008629.2	S-MA70018505	406 mm	Invert 223.00 m
Wet Well	S-MH70006766.1	S-MA70018509	14 m x 2.3 m	
Lift Station Total Capacity	N/A	N/A	0.098 m^3/s	1 x 0.035 m^3/s 1 x 0.063 m^3/s pumps
Lift Station ADWF	N/A	N/A	0.017 m^3/s	

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Lift Station Force Main	S-BE70003227.1	S-MA70018509	250 mm	Discharge Invert 230.10 m
Flood Pump Station Total Capacity	N/A	N/A	2.380 m^3/s	3 pumps at 0.851 m^3/s
Pass Forward Flow – First Overflow	N/A	N/A	0.052 m^3/s	

Notes:

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	223.75
2	Trunk Invert at Off-Take	223.00
3	Top of Weir	223.38
4	Relief Outfall Invert at Flap Gate	N/A
5	Low Relief Interconnection	N/A
6	Sewer District Low Interconnection (Baltimore)	228.28
7	Low Basement	229.73
8	Flood Protection Level	230.16

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Calrossie district was completely separated in 2010. The work included construction of a new LDS with reconnection of the catch basins to collect all road drainage and surface runoff. The original CS now serves as a WWS, with collection of foundation drainage and any flows from downspouts that may still be connected to the separate system.

A basement flooding relief (BFR) preliminary design report (KGS, 2015) was completed for Cockburn and the southeastern portion of the Jessie sewer district in 2015. Separation of a portion of the Jessie sewer district is included with Cockburn BFR, with separated stormwater collected through Cockburn West and the sanitary system continuing to be collected by Jessie district through the original CSs. Southeast Jessie relief was not included when the rest of the Jessie district was relieved in the 1970s and was added to the Cockburn district relief study because of proximity.

The study included creation of a drainage hydraulic model, flow monitoring for model calibration, and evaluation of BFR alternatives and associated cost estimates. Work to date has included a LDS trunk across the CNR, a stormwater retention basin on Parker Lands, and a land drainage trunk to the outfall at Toilers Memorial Park into the Red River. Table 1-3 provides a summary of the district status in terms of data capture and study.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Cockburn district was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations have a combination of inflow and overflow level meters and flap gate inclinometers, if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Expected Completion
Cockburn	2015 – Preliminary Design	Yes	2013	Under Construction	TBD
Calrossie	N/A	No	2013	Separation Complete	N/A
Southeast Jessie	2015 – Preliminary Design	Yes	2013	Under Construction	TBD

Note:
TBD = to be determined

1.5 Ongoing Investment Work

The Cockburn BFR program work began in 2013 with construction of a new LDS outfall and trunk sewer. Once completed, the LDS system will provide complete road drainage separation of Cockburn West and southeast Jessie.

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Cockburn district. This consists of monthly site visits in confined entry spaces to verify that physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Cockburn sewer district are listed in Table 1-4. The proposed CSO control projects will include sewer separation, in-line storage with screening, and floatable management. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	-	-	-	✓	✓	-	-	✓	✓	✓	✓

Notes:

- = not included
✓ = included

The Cockburn sewer district is identified as a priority, because it was previously identified as needing basement flooding relief. The BFR program was well underway at the time of the CSO Master Plan development, and a decision had been previously made to separate Cockburn West, while deferring Cockburn East until more information became available under the CSO Master Plan.

The marginal evaluation indicated that in-line storage for Cockburn East will be more economical than continuing with full separation of the district and will provide a high level of CSO control. In-line storage is lower in cost and will be effective because of the reduced inflows resulting from partial separation and the subsequent large volume of storage available in the existing CS.

All primary overflow locations are to be screened under the current CSO control plan. Installation of a control gate will be required for the screen operation, and it will provide the mechanism for capture of the in-line storage.

Floatable control will be necessary to capture floatables in the sewage. Floatables will be captured with all implemented control options to some extent, but screening may be added as required to reach the desired level of capture.

GI and RTC will be applied within each district on a system-wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Sewer Separation

The sewer separation project for Cockburn West will provide immediate benefits to the CSO program when complete. The work includes installation of an independent LDS system to collect road drainage. Collected stormwater runoff will be routed through a new stormwater retention pond to an outfall discharging to the Red River at Toilers Memorial Park, located in the Calrossie sewer district. The approximate area of sewer separation is shown on Figure 09.

The flows to be collected after Cockburn West separation will be as follows:

- DWF will remain the same for Cockburn district (and for southeast Jessie).
- Cockburn West WWF will consist of sanitary sewage combined with foundation drainage.
- Cockburn East will remain as combined sewage.

This will result in a significant reduction in combined sewage flow received at Cockburn CS LS after the separation project is complete. The separation project by itself will provide a partial reduction of overflows and must be accompanied by in-line storage at the Cockburn diversion.

In addition to BFR and reducing the CSO volume, the benefits of Cockburn West separation include making storage volume available in the CS system for in-line storage and reducing the amount of flood pumping required at the Cockburn FPS.

1.6.3 In-line Storage

In-line storage has been proposed as a CSO control for Cockburn district. The in-line storage will require the installation of a control gate at the CS outfall. The gate will increase the storage level in the existing CS to provide an overall higher volume capture and will provide additional hydraulic head for screening operations.

A standard design was assumed for the control gate, as described in Part 3C. A standard approach was used for conceptual gate sizing by assuming it to be the lesser of the height of half of the site-specific trunk diameter or the maximum height of the gate available. The design criteria for in-line storage are listed in Table 1-5.

Table 1-5. In-Line Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	223.07 m	
Trunk Height	2700 x 2075 mm	
Gate Height	1.35 m	Based on half pipe height
Top of Gate Elevation	224.42 m	
Bypass Weir Height	224.32 m	
Maximum Storage Volume	2,600 m^3	
Nominal Dewatering Rate	0.098 m^3/s	Based on existing CS LS capacity
RTC Operational Rate	TBD	Future RTC / dewatering review on performance

The proposed control gate will cause combined sewage to back-up in the collection system to the extent shown on Figure 09. The extent of the in-line storage and volume is related to the top elevation of the bypass side weir. The level of the bypass side weir and adjacent control gate level area determined in relation to the critical performance levels in the system for basement flooding protection: when the system level increases above the bypass weir crest and proceeds above the top of the control fate during high flow events, the control gate drops out of the way. At this point, the district will only provide its original interception capacity via the primary weir for the district, and all excess CS would flow over the weir and discharge to the river. After the sewer levels in the system drops back below the bypass side weir critical performance level, the control gate moves back to its original position to capture the receding limb of the WWF event. The CS LS wil continue with its current operation while the control gate is in either position, with all DWF being diverted to the CS LS and pumped. The CS LS will further dewater the in-line storage provided during a WWF event as downstream capacity becomes available.

Figure 09-01 provides an overview of the conceptual location and configuration of the control gate, bypass weir, and screening chambers. The proposed control gate will be installed in a new chamber within the existing trunk sewer alignment near the existing CS LS and FPS. The dimensions of the chamber will be 6 m in length and 3.5 m in width to accommodate the gate, with an allowance for a longitudinal overflow weir. The existing sewer configuration including the off-take, the 900 mm CS sewer along Churchill Drive, and the force main may have to be modified to accommodate the new chamber. Further optimization of the gate chamber size may be provided if a decision is made not to include screening.

The physical requirements for the off-take and station sizing for a modification to pumping capacity have not been considered in detail, but they will be required in the future as part of an RTC program or LS rehabilitation or replacement project.

The nominal rate for dewatering is set at the existing CS LS station capacity. The dewatering rate includes both the DWF and WWF components of the district flows. This allows dewatering through the existing interceptor system within 24 hours following the runoff event, allowing it to recover in time for a subsequent event. Any future considerations, for RTC improvements, would be completed with spatial rainfall as any reduction to the existing capacity for large events will adversely affect the overflows at this district. . This future RTC will provide the ability to capture and treat more volume for localized storms by using either the district in-line storage or the excess interceptor capacity where the runoff volume is less. Further assessment of the impact of the RTC and future dewatering arrangement will be necessary to review the impacts on downstream districts such as the Baltimore and Mager districts.

1.6.4 Floatables Management

Floatables management will require installation of a screening system to capture floatable materials. The off-line screens will be proposed to maintain the current level of basement flooding protection.

The type and size of screens depend on the specific station configuration and the hydraulic head available for operation. A standard design was assumed for screening and is described in Part 3C. The design criteria for screening, with an in-line control gate implemented, are listed in Table 1-6.

Table 1-6. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Top of Gate	224.55 m	
Bypass Weir Crest	224.40 m	
Normal Summer River Level	223.75 m	
Maximum Screen Head	0.65 m	
Peak Screening Rate	0.52 m^3/s	
Screening Size	1.5 m wide x 1 m high	Modelled Screen Size

The proposed side bypass overflow weir and screening chamber will be located adjacent to the proposed control gate and existing CS trunk, as shown on Figure 09-01. The screens will operate with the control gate in the raised position, diverting flows to the bypass weir. A side bypass weir upstream of the gate will direct the flow to the screens located in the new screening chamber, with screened flow discharged to the downstream side of the gate to the river. The screening chamber will include screenings pumps with a discharge returning the screened material to the CS LS for routing to the SEWPCC for removal.

The dimensions for the screen chamber to accommodate influent from the side weir, the screen area, and the routing of the discharge piping downstream of the gate are 4 m in length and 3 m in width. The existing sewer configuration including the off-take, the 900 mm CS sewer along Churchill Drive, and the LS force main may have to be modified to accommodate the new chamber.

1.6.5 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district will be reviewed to identify the most applicable GI controls.

Cockburn has been classified as a high GI potential district. A portion of Cockburn West between Grant Avenue and Taylor Avenue is primarily residential, with single-family residential areas and multi-family apartment buildings along Grant and Taylor Avenues. This means the district would be an ideal location for bioswales, permeable paved roadways, cisterns/rain barrels, and rain gardens. The higher area of greenspace in Cockburn district is suitable for biorientation garden projects. The commercial buildings along Taylor Avenue, Grant Avenue, and Pembina Highway are ideal locations for green roof projects.

1.6.6 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

Sewer separation will include the installation of additional sewers that will require inspection, cleaning and rehabilitation. This will result in additional maintenance costs over the long term, but operational costs will be minimal. The existing larger CS pipes within the district may also receive insufficient flows with the separation work for proper scouring velocities in the sewer pipes. This could result in solids settling within the sewers and requiring more frequent cleaning operations. However, the WWF flows from the non-separated east Cockburn area will offset part of this concern. The impacts of the reduced flows in larger CS pipes will be evaluated as part of the sewer separation design for the district. The stormwater retention pond and LDS gate chamber at Toilers Memorial Park are included as part of routine LDS operation.

In-line storage will impact the existing sewer and will require the addition of a new chamber and a moving gate at the outfall. In-line storage dewatering will be controlled with the existing Cockburn LS, which will require more frequent and longer duration pump run times. Lower velocities will occur in the CS trunk in the vicinity of the control gate due to lower pass forward flows, and may create additional debris deposition requiring cleaning. Additional system monitoring, and level controls will be installed, which will require regular scheduled maintenance. However, the sewer separation will remove storm runoff flows that will lower the duration and frequency of the pump run times.

Floatable control with outfall screening will require the addition of another chamber with screening equipment installed. The chamber will be installed adjacent to the control gate chamber and will operate in conjunction with it. Screening operation will occur during WWF events that surpass the in-line storage control level. WWF will be directed from the main CS trunk, over the side weir in the control gate chamber and through the screens to discharge into the river. The screens will operate intermittently during wet weather events and will likely require operations review and maintenance after each event. The frequency of a screened event will correlate to the number overflows identified for the district. Having the screenings pumped back to the interceptor system via a small LS and force main will be required. Additional maintenance for the pumps will be required at regular intervals in line with typical lift station maintenance and after significant screening events.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. An individual model was created to represent the sewer system baseline as represented in the year 2013 and a second model was created for the CSO Master Plan evaluation purposes, with all the control options recommended for the district to meet Control Option 1 implemented in the year 2037. A summary of relevant model data is provided in Table 1-7.

Table 1-7. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	336	336	5,584	27	N/A
2037 Master Plan – Control Option 1	323	312	5,584	19	SEP, IS, SC

Notes:

SEP = Separation
IS = In-line Storage
SC = Screening

Table 1-7. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-8 are for the hydraulic model simulations using the year-round 1992 representative year. The table lists the results for the Baseline, for each individual control option, and for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. Table 1-8also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-8. District Performance Summary – Control Option 1

Control Option	Preliminary Proposal	Master Plan			
	Annual Overflow Volume (m^3)	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [b]
Baseline (2013)	164,713	188,459	0	22	0.075 m^3/s
Cockburn West Separation	12,297 [a]	14,541	173,918	15	0.087 m^3/s
In-Line Storage + Cockburn West Separation		6,183	182,276	4	0.126 m^3/s
Control Option 1	**12,297**	**6,183**	**182,276**	**4**	**0.126 m^3/s**

[a] Separation and In-line Storage were not simulated independently during the Preliminary Proposal assessment

[b] Pass forward flows assessed on the 1-year design rainfall event.

The percent capture performance measure is not included in Table 1-8above, as it is applicable to the entire CS system and not for each district individually.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-9. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-9. Cost Estimates – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance (Over 35-year period)
Sewer Separation	$89,370,000 [a]	$56,280,000 [c]	$30,000	$720,000
In-line Storage		$2,650,000	$40,000	$890,000

Table 1-9. Cost Estimates – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance (Over 35-year period)
Screening	N/A [b]	$2,250,000 d	$30,000	$730,000
Subtotal	**$89,370,000**	**$61,180,000**	**$110,000**	**$2,340,000**
Opportunities	N/A	$6,120,000	$10,000	$230,000
District Total	**$89,370,000**	**$67,300,000**	**$120,000**	**$2,570,000**

[a] Solution development as refinement to Preliminary Proposal costs. Revised cost for this sewer separation work found to be $47,490,000 in 2014 dollars

[b] Solution development as refinement to Preliminary Proposal costs. Revised costs for these items of work found to be $4,400,000 in 2014 dollars

[c] Cockburn separation is approximately 20% complete and at the time of CSO Master Plan development. An adjustment to the total capital cost estimate has been included in the Master Plan cost to account for this

[d] Cost for bespoke screenings return pump/force main not included in Master Plan as will depend on selection of screen and type of screening return system selected

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional cost for RTC.
- The Preliminary Proposal capital cost is in 2014 dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019 dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019. Each of these values include equipment replacement and O&M costs.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of alternative plans for the entire system, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-10.

Table 1-10. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Separation	Unit costs were updated Cockburn West area removed from estimate. The percent separation was adjusted to account for construction completed.	

Table 1-10. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
	In-line Storage	A control gate was not included in the Preliminary Proposal estimate	Added for the Master Plan to further reduce overflows
	Screening	Screening was not included in the Preliminary Proposal estimate	Added in conjunction with the Control Gate
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation.	Preliminary Proposal estimates were based on 2014-dollar values.	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, the future performance target is 98 percent capture for the representative year measured on a system-wide basis. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-11 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified for Control Option 1.

Overall the Cockburn district would be classified as a high potential for implementation of complete sewer separation as the feasible approach to achieve the 98 percent capture in the representative year future performance target. The non-separation measures recommended as part of this district engineering plan to meet Control Option 1, specifically in-line storage and floatables management via off-line screening, are therefore at risk of becoming redundant and unnecessary when the measures to achieve future performance targets are pursued. As a result, these measures should not be pursued until the requirements to meet future performance targets are more defined. Should it be confirmed that complete separation is the recommended solution to meet future performance targets, then complete separation will likely be pursued to address Control Option 1 instead of implementing the non-separation measures. This will be with the understanding that while initial complete separation is less cost-effective to meet Control Option 1, it is the most cost effective solution to meet the future performance target and removes the capital costs on short term temporary solutions. Focused use of green infrastructure, and reliance on said green infrastructure as well can provide volume capture benefits and could be utilized to meet future performance targets.

Table 1-11. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Separation of remainder of Cockburn district • Increased use of GI

The control options selected for the Cockburn district has been aligned with the City's committed projects for the BFR program. The expandability of this district to meet the 98 percent capture would be based on a system wide assessment. The cost for upgrading to meet an enhanced performance target depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-12.

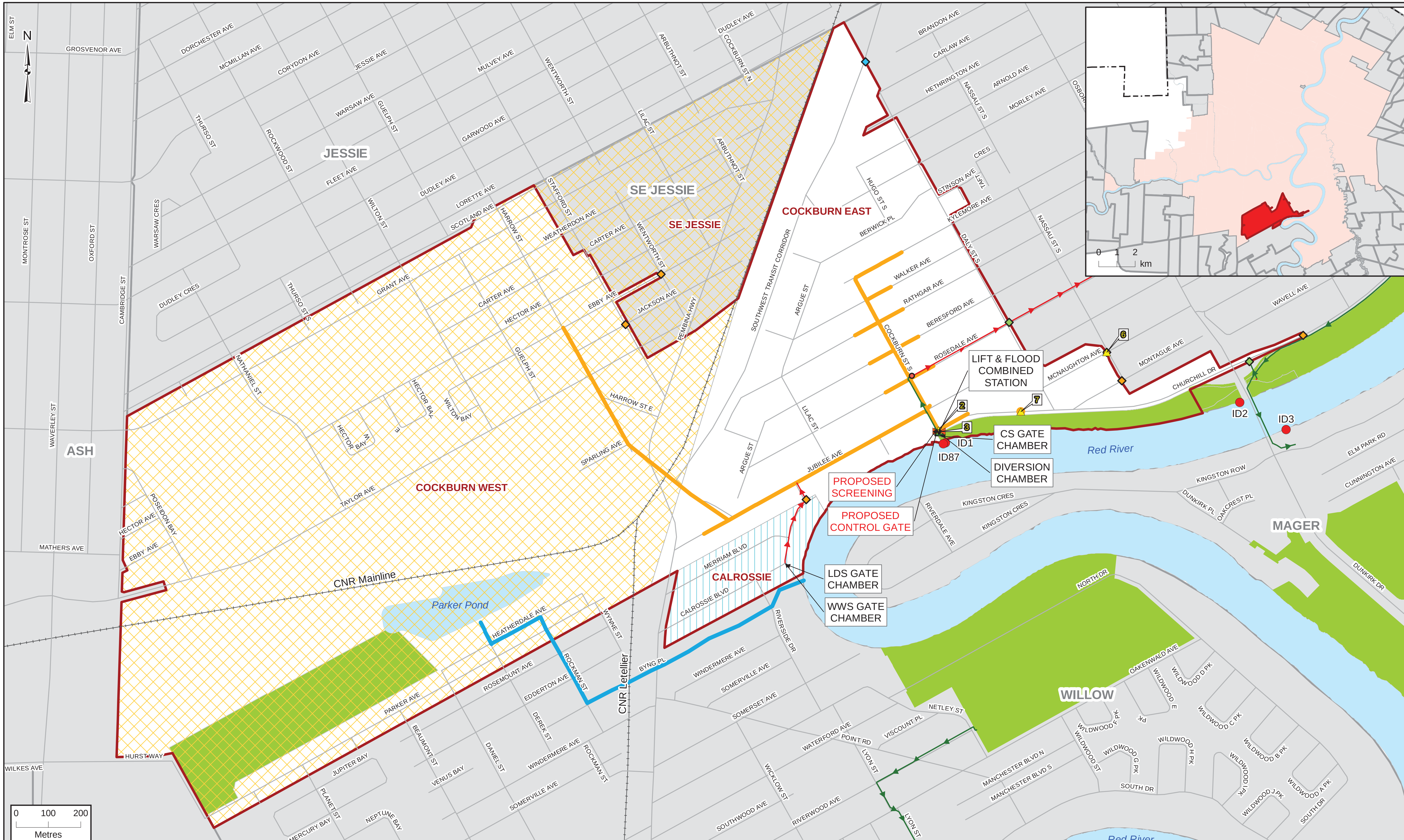
Table 1-12. Control Option 1 Significant Risks and Opportunities

ID Number	Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	R	-	-	O	-	-	-
2	Existing Lift Station	-	R	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	O	-	-	-
4	Construction Disruption	-	-	-	-	R	-	-	-
5	Implementation Schedule	-	-	-	-	R	-	R	-
6	Sewer Condition	-	R	-	-	-	-	-	-
7	Sewer Conflicts	-	R	-	-	R	-	-	-
8	Program Cost	-	R/O	-	-	R	-	-	O
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	-	-	-	-	O	O	O	-
12	Operations and Maintenance	-	R	-	-	R / O	R	O	R
13	Volume Capture Performance	-	O	-	-	-	O	O	-
14	Treatment	-	R	-	-	O	O	O	R

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

KGS Group. 2015. *Cockburn and Calrossie Combined Sewer Relief Works Preliminary Design Report.* Prepared for the City of Winnipeg, Waterworks, Waster and Disposal Department. June.



LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Low CS Manhole

Inter-System Connection
- CS - WWS

District Boundary Crossing
- CS
- LDS
- WWS

- Interceptor Sewer
- Force Main
- Street
- Railway

- District Boundary
- Watercourse
- Greenspace

CSO MASTER PLAN PROPOSED SOLUTIONS

- Proposed Control Gate
- Cockburn LDS Trunk
- Extent of In-line Storage
- Sewer Separation - Underway
- Sewer Separation - Complete

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 09
District Overview Map
Sewer District: Cockburn
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Manhole
- Flap Gate
- Sluice Gate
- Pump Location
- Force Main

Sewer By Type
- CS
- LDS
- WWS

Control Structure Type
- Gate Chamber

Pump Station Type
- Diversion Chamber
- Lift & Flood Combined Station

CSO MASTER PLAN
PROPOSED SOLUTIONS
- Control Gate
- Screening

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 09-01
Control Gate and Screening
Sewer District: Cockburn
City of Winnipeg
Combined Sewer Overflow Master Plan

CSO Master Plan

Colony District Plan

August 2019

City of Winnipeg

CSO Master Plan

Project No:	470010CH
Document Title:	Colony District Plan
Revision:	04
Date:	August 18, 2019
Client Name:	City of Winnipeg
Project Manager:	John Berry
Author:	Scott Begg
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Document History and Status

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0	08/2018	Version 1 DRAFT	SG	ES	
1	12/2018	Version 2 DRAFT	SB	MF / ES / DT	
2	06/2019	Final Draft Submission	SB/JT	MF	SG
3	07/2019	Revised Final Draft Submission	SB/JT	MF	MF
4	08/18/2109	Final Submission For CSO Master Plan	MF	MF	SG

Contents

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Figures

1. Colony District

1.1 District Description

Colony district is located along the northern bank of the Assiniboine River and west of the Red River. It is near the centre of the combined sewer area, towards the western edge of the City of Winnipeg's (City's) 'downtown'. Colony is bounded by Notre Dame Avenue on the north, Kennedy and Osborne Streets on the east, the Assiniboine River on the south, and Toronto and Maryland Streets on the west. Portage Avenue runs east-west through the centre of the district, extending the district slightly more towards the Portage Avenue and Main Street intersection. The three districts that border Colony are Assiniboine to the east, Bannatyne to the north, and Cornish to the west.

The district contains a mix of residential, commercial, and institutional land usage that includes a portion of downtown, the University of Winnipeg, the Misericordia Health Centre, and the Winnipeg Art Gallery. The area outside of downtown is mostly multi-family, with commercial areas built up along major transportation routes. The available land use and green space is minimal due to the density of existing residential and commercial developments. Approximately 7 ha of the district is classified as greenspace.

1.2 Developments

There is limited land area available for development within Colony district, so no significant developments that could impact the Combined Sewer Overflow (CSO) Master Plan are expected. Some redevelopment is underway by the University of Winnipeg, but no impact to the CSO Master Plan is anticipated.

A portion of Portage Avenue is located within the Colony district. Portage Avenue is identified as Regional Mixed Use Corridor as part of the OurWinnipeg future development plans. As such, focused intensification along Portage Avenue is to be promoted in the future.

1.3 Existing Sewer System

The Colony district covers an approximate land area of 237 hectares (ha)[1] and includes a combined sewer (CS) system and a storm relief sewer (SRS) system. This district does not include any areas that may be identified as separated. Of the total district area, 6.8 percent (16 ha) is considered separation ready. The CS system was mostly constructed between 1880 and 1950. The SRS system was added in the 1960s to relieve the CS system. Further upgrades to the SRS to separate road drainage from the CS system were completed in the 1990s.

The CS system includes a diversion chamber, flood pump station (FPS) and CS outfall gate chamber. The Colony district does not contain an independent lift station (LS) for dry weather flow (DWF). The Colony FPS and CS outfall are located next to the Assiniboine River at the end of Colony Street and Granite Way. The diversion chamber and off-take pipe are set further north from the CS outfall between Broadway Avenue and Granite Way along Colony Street.

During wet weather flow (WWF), any flow that exceeds the diversion capacity overtops the weir and is discharged through the gate chamber to the Colony CS outfall to the Assiniboine River. Sluice and flap gates are installed on the CS outfall to prevent back-up of the Assiniboine River into the CS system. When the Assiniboine River levels are particularly high, the flap gate prevents gravity discharge from the Colony CS outfall. Under these conditions, the excess flow is pumped by the Colony FPS to a point downstream of the flap gate, where it can be discharged to the river.

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The SRS system is installed throughout most of the district and connects to the CS system via various interconnections which consist of overflow pipes and weirs. During runoff events, the SRS system provides relief to the CS system. Most catch basins are still connected into the CS system, so no partial separation has been completed and the SRS system acts as an overflow conduit for the CS to prevent basement surcharge. The SRS system discharges directly to the Assiniboine River through the Spence SRS outfall located at the south end of Spence Street. A flap gate and sluice gate are installed on the outfall pipe to control backflow into the SRS system under high river level conditions. The SRS flows into and CS flows from the Cornish district along the western edge of the Colony district.

During DWF, the SRS system is not required; sanitary sewage is diverted by the weir located on the main sewer trunk, through a 680 mm off-take pipe to the 680 mm Colony secondary interceptor pipe and back to the Portage Interceptor by gravity and on to the North End Sewage Treatment Plant (NEWPCC) for treatment.

The two outfalls to the Assiniboine River are as follows:

- ID65 (S-MA20014505) – Colony CS and FPS Outfall
- ID64 (S-MA70103641) – Colony SRS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Colony and the surrounding three districts. They are shown on Figure 10 and show gravity and pumped flow from one district to another. Each interconnection is listed in the following subsections:

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

Assiniboine

- A 1500 mm intercepted WWS flows by gravity from the Colony district into the Assiniboine district and on to the NEWPCC for treatment.
  - Broadway Avenue at Memorial Boulevard interceptor invert - 223.72 m (S-MH20013425)

1.3.1.2 Interceptor Connections – Upstream of Primary Weir

Cornish

- A 450 mm intercepted WWS flows from the Cornish district into the Colony district and to the NEWPCC for treatment.
  - Furby Street and Cornish Avenue interceptor invert - 225.48 m (S-TE20012409)
- A 1500 mm intercepted WWS flows from the Cornish district into the Colony district and on to the NEWPCC for treatment.
  - Wolseley Avenue and Maryland Street Interceptor invert - 225.46 m (S-TE20012409)

1.3.1.3 District Interconnections

Assiniboine

<u>SRS to SRS</u>

- A 450 mm SRS overflow pipe diverts flow from Assiniboine district SRS system at Edmonton Street and Graham Avenue, and then flows by gravity northbound along Edmonton Street and flows into Colony district CS system.
  - Graham Avenue and Edmonton Street overflow invert into 450 SRS - 227.18 m (S-TE20005333)

CS to CS

- A 300 mm SRS overflow pipe diverts flow form Assiniboine district CS system at Carlton Street near Portage Avenue, and then flows by gravity northbound along Carlton Street and flows into Colony district CS system.
  - Portage Avenue and Carlton Street overflow invert CS - 227.61 m (S-MH20014163)

CS to SRS

- A 1050 mm SRS overflow pipe diverts flow from Colony district CS system at Portage Avenue and Donald Street, and then flows by gravity southbound along Donald Street and flows into Assiniboine district SRS system.
  - Graham Avenue and Donald Street SRS overflow invert into 1050 SRS - 225.43 m (S-MA70023000)
- A 1350 mm SRS overflow pipe diverts flow from Colony district CS system at Portage Avenue and Kennedy Street and then flows by gravity southbound along Kennedy Street and flows into Assiniboine SRS system.
  - Graham Avenue and Kennedy Street SRS overflow invert into 1350 SRS - 225.54 m (S-MA20015634)
- A 450 mm SRS overflow pipe diverts flow from Colony district CS system at Vaughan Street and Mary Avenue and flows by gravity eastbound along St. Mary Avenue and flows into Assiniboine district SRS system.
  - St. Mary Avenue and Kennedy Street SRS overflow invert into 450 SRS - 225.38 m (S-MA70022895)

Bannatyne

CS to CS

- High point CS manholes (flow is directed into both districts from this manhole):
  - Victor Street invert - 229.33 m (S-MA20017614)
  - Agnes Street invert - 229.30 m (S-MA20016379)
  - McGee Street invert - 229.65 m (S-MA20016714)
  - Maryland Street invert - 229.24 m (S-MA20016720)
  - Young Street invert - 229.10 m (S-MA20016919)
  - Cumberland Avenue and Balmoral Street invert - 229.02 m (S-MA20016981)
  - Kennedy Street invert - 229.69 m (S-MA20016934)
  - Qu`Appelle Avenue invert - 228.97 m (S-MA20016817)

CS to SRS

- High point SRS manhole: A 250 mm SRS overflow pipe diverts flow from Bannatyne district CS system near Hargrave Street and Portage Avenue and flows by gravity southbound along Hargrave Street and flows into Colony CS system.
  - Hargrave Street and Portage Avenue SRS overflow invert into 250 mm SRS – 229.02 m (S-MA20015844)
- A 525 mm SRS overflow pipe diverts flow from Colony district CS system at Vaughan Street and Webb Place and flows by gravity northbound and then turns eastbound along Ellice Avenue and flows into Bannatyne SRS system.

  - Ellice Avenue and Kennedy Street SRS overflow invert into 1200 mm SRS - 226.14 m (S-MH20016684)
- A 450 mm SRS overflow pipe diverts flow from Colony district CS system near Donald and Ellice Avenue and flows by gravity northbound along Donald Street and flows into Bannatyne SRS.
  - Donald Street and Ellice Avenue SRS overflow invert into 375 mm SRS - 227.76 m (S-MA70087485)

CS to CS

- A 250 mm CS pipe flows northbound by gravity from Colony to Bannatyne district at Ellice Avenue and Kennedy Street
  - Ellice Avenue and Kennedy Street CS invert into 250 mm CS - 228.54 m (S-MH20016689)
- A 369 mm CS pipe flows southbound by gravity from Colony to Bannatyne district at Ellice Avenue and Kennedy Street
  - Ellice Avenue and Kennedy Street CS invert into 369 mm CS – 228.48 m (S-MH70003125)
- A 450 mm CS pipe flows eastbound by gravity along Portage Avenue that flows out of Colony CS into Bannatyne CS system.
  - Portage Avenue and Smith Street CS invert CS outfall - 227.94 m (S-MA20015831)

Cornish

CS to CS

- A 300 mm high point CS manhole (flow is directed into both districts from this manhole):
  - Toronto Street – 229.72 m (S-MA20017892)
- A 450 mm CS pipe high level overflow that flows by gravity from Cornish into Colony CS system.
  - Honeyman Avenue and Canora Street CS overflow invert – 225.63 m (S-MA20015466)

CS to SRS

- A 1245 mm SRS overflow pipe diverts flow from Cornish district CS system at Toronto Street and St. Matthews Avenue and flows by gravity eastbound into the Colony SRS system.
  - St. Matthews Avenue and Toronto Street SRS invert - 226.55 m (S-MA20015548)
- A 200 mm SRS overflow pipe diverts flow from Cornish district CS system at Toronto Street and St. Matthews Avenue and flows by gravity westbound and then southbound into the Colony SRS system.
  - St. Matthews Avenue and Toronto Street SRS invert - 226.68 m (S-MA20023073)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing district.

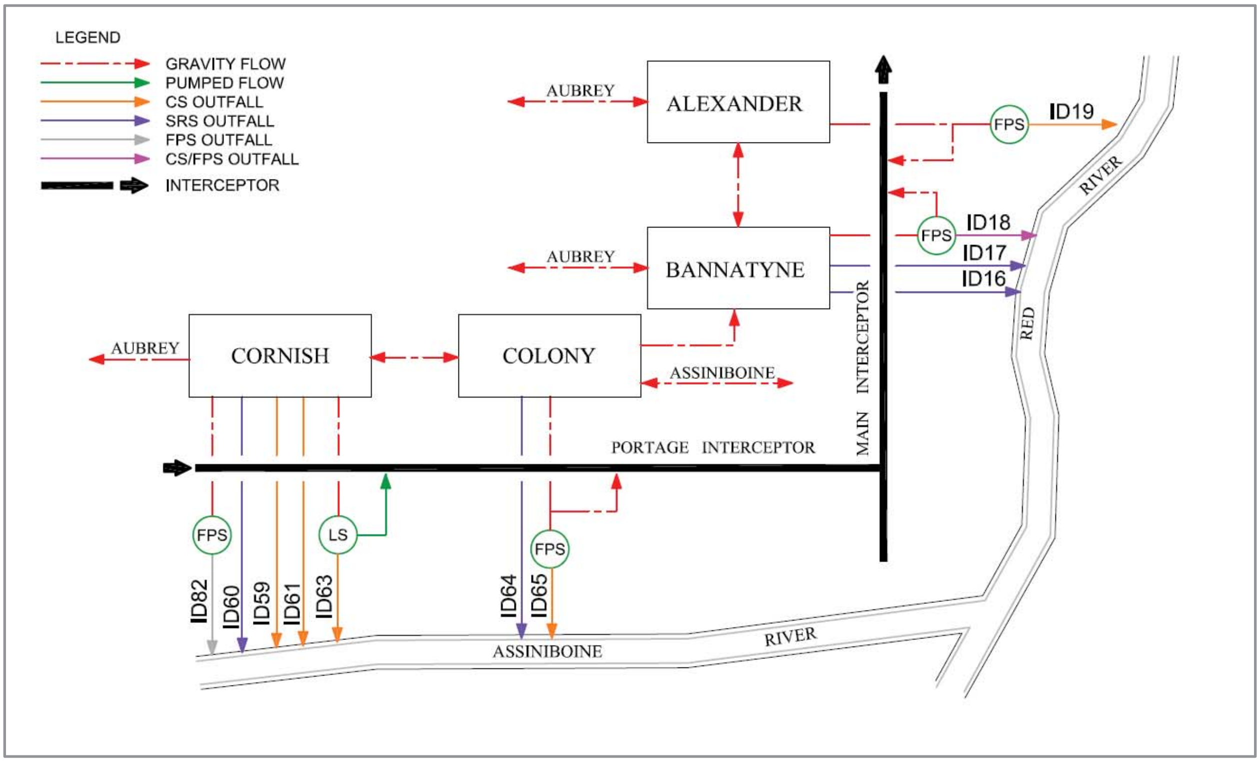


Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 10 and are listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID65)	S-AC70016494.1	S-MA20014505	1800 mm	Circular
Flood Pumping Outfall (ID65)	S-AC70016494.1	S-MA20014505	1800 mm	Circular
Other Overflows (ID#)	N/A	N/A	N/A	
Main Trunk	S-MH20013353.1	S-MA20014788	1350 x 1800 mm	Egg-shaped
SRS Outfalls (ID64)	S-CG00001168 DS.1	S-MA70103641	2750 mm	Spence Street
SRS Interconnections	N/A	N/A	N/A	61
Main Trunk Flap Gate	S-TE70018683.1	S-CG00001169	1520 mm	Invert: 223.51 m
Main Trunk Sluice Gate	COLONY_GC.1	S-CG00001041	750 x 1000 mm	Invert: 223.21 m
Off-Take	COLONY_WEIR.1	S-MA20014797	680 mm	No Pumping Station
Dry Well	N/A	N/A	N/A	No Pumping Station
Lift Station Total Capacity	N/A	S-MA20014797 (1)	680 mm (1)	1.716 m^3/s (1) (D/s pipe pff 0.281 m^3/s)
Lift Station ADWF	N/A	N/A	0.107 m^3/s	2.75 x ADWF – 0.193 m^3/s
Lift Station Force main	N/A	N/A	N/A	

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Flood Pump Station Total Capacity	N/A	N/A	2.34 m^3/s	1 x 1.32 m^3/s 1 x 1.02 m^3/s
Pass Forward Flow – First Overflow	N/A	N/A	0.400 m^3/s	

Notes:

(1) – Gravity pipe replacing Lift Station as Colony is a gravity discharge district

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	District – 223.84
2	Trunk Invert at Off-Take	224.73
3	Top of Weir	225.76
4	SRS Outfall Invert at Flap Gate (Upstream of First Gate Chamber)	221.58
5	Low SRS Relief Interconnection (S-MH70007916)	226.12
6	Sewer District Interconnection (Interceptor Inverts at Colony District Boundary)	Assiniboine –223.15 Cornish (Furby Street and Cornish Avenue) – 224.70 Cornish (Wolseley Avenue and Maryland Street) – 225.80
7	Low Basement	228.60
8	Flood Protection Level	229.98

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

The Colony district has most recently undergone storm relief sewer work in 1998. This work included implementing a 5-year basement flood relief design level by disconnecting street inlets from the CS pipes and connecting them to the SRS pipes to regain capacity in the CS system. The inlet redirections, plus outfall improvements to increase the outfall capacity, are the most recent upgrades made to the district sewer system. A more detailed description can be found in the Colony 1998 report prepared by Dillon Consulting Limited and Sprenger & Associates Inc. (Sprenger/Dillon, 1998).

In 2011, the City installed an off-line underground storage facility at the University of Winnipeg between Young and Langside Streets beneath the Richardson Green Corridor as a pilot study for future CSO projects. The storage system consists of a series of manholes with sluice gates that operate to direct storm water runoff into four 1500 mm diameter high-density polyethylene pipes. The total length of the pipes is approximately 240 m, which amounts to a storage volume of approximately 420 m^3. Water from the storage facility is released back into a 300 mm diameter CS, which then connects back into the sewer system.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Colony Combined Sewer District was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations has a combination of inflow and overflow level meters and flap gate inclinometers if available.

No further relief projects are planned for the district. Table 1-3 provides a summary of the district status in terms of data capture and study.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Planned Completion
10 - Colony	1998	Future Work	2013	Study Complete	N/A

1.5 Ongoing Investment Work

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Colony district. This consists of monthly site visits in confined entry spaces to verify physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Colony sewer district are listed in Table 1-4. The proposed CSO control projects will include latent storage, gravity flow control, control gate, in-line storage and floatable management. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	✓	-	✓	✓	✓	-	-	-	✓	✓	✓

Notes:

- = not included
✓ = included

The existing CS and SRS systems are suitable for use as in-line and latent storage. These control options will take advantage of the existing CS and SRS pipe networks for additional storage volume. Existing

DWF from the collection system would remain the same, and overall district operations would remain the same, although additional WWF will be collected from the SRS and transferred to the existing CS system and forwarded to the NEWPCC for treatment.

A gravity flow controller is proposed on the CS system to monitor and confirm the dewatering rate from the district back into the Main Street interceptor.

All primary overflow locations are to be screened under the current CSO control plan, Installation of a control gate will be required for the screen operation, and it will provide the mechanism for capture of the in-line storage.

Floatable control will be necessary to capture any floatables in the sewage. Floatables will be captured with all implemented control options to some extent, but screening may be added as required to reach the desired capture level.

GI and RTC will be applied within each district on a system wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Latent Storage

Latent storage is proposed as a control option for Colony district. The latent storage level in the system is controlled by river level, and the resulting backpressure of the river level on the SRS outfall flap gate, as explained in Part 3C. The latent storage design criteria are identified in Table 1-5. The storage volumes indicated in Table 1-5 are based on the NSWL river conditions.

Table 1-5. Latent Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	221.58 m	
NSWL	223.84 m	
Trunk Diameter	2550 mm	
Design Depth in Trunk	2253 mm	
Maximum Storage Volume	4,380 m^3	
Force main	150 mm	
Flap Gate Control	N/A	
Pump Station	Yes	
Nominal Dewatering Rate	0.045 m^3/s	Based on 24 hour emptying requirement
RTC Operational Rate	TBD	Future RTC/ dewatering assessment

Notes:

RTC = real time control

NSWL = normal summer water level

The addition of a pump and force main that connects back to the CS system will be required for latent storage. A conceptual layout for the latent storage pump station (LSPS) and force main is shown on Figure 10-02. The LSPS will be located adjacent to the existing gate chamber on Spence Street to avoid interference with nearby residential lands and disruption to existing sewers. The latent force main will pump north to the nearby 300 mm CS sewer and into the manhole (S-MH20013095) south of the intersection of Balmoral Street and Scotia Street. The pump station will operate to dewater the SRS system in preparation for the next runoff event, the requirement for the system to be ready for the next event within a 24-hour period after completion of the previous event.

The LSPS would connect to the SRS outfall chamber and discharge back to the CS system once capacity allows. Figure 10 identifies the extent of the SRS system within Colony district that would be used for latent storage. The maximum storage level is directly related to the NSWL and the size and depth of the SRS system. Once the level in the SRS exceeds the NSWL river level, the flap gate opens, and the combined sewage is discharged to the river.

The river level will keep the SRS flap gate closed and system level maintained at the NSWL for the representative year assessment. This level utilizes 88 percent of the SRS pipe height and, therefore, additional flap gate control was not recommended as part of the 85 percent capture target assessment. The lowest interconnection between the combined sewer and relief pipe is higher than the proposed latent and in-line storage control levels, meaning that the two systems would function independently.

As described in the standard details in Part 3C wet well sizing will be determined based on the final pump selection, operation and dewatering capacity required. The interconnecting piping between the existing gate chamber and the pump station would be sized to provide sufficient flow to the pumps while all pumps are operating.

1.6.3 In-line Storage

In-line storage has been proposed as a CSO control for Colony district. The in-line storage will require the installation of a control gate at the CS outfall. The gate will increase the storage level in the existing CS to provide an overall higher volume capture and provide additional hydraulic head for screening operations.

A standard design was assumed for the control gate, as described in Part 3C. A standard approach was used for conceptual gate sizing by assuming it to be the lesser of the height of half of the site-specific trunk diameter or the maximum height of the gate available. The design criteria for in-line storage are listed in Table 1-6.

Table 1-6. In-Line Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	224.52 m	
Trunk Diameter	1350 x 1800 mm	
Gate Height	0.75 m	Gate height based on half trunk diameter assumption (flood assessment included)
Top of Gate Elevation	225.86 m	
Bypass Weir Level	225.76 m	
Maximum Storage Volume	284 m^3	
Nominal Dewatering Rate	0.40 m^3/s	Minimum pass forward rate for gravity discharge district
RTC Operational Rate	TBD	Future RTC/dewatering review on assessment

Note:
RTC = Real Time Control
TBD = to be determined

The proposed control gate will cause combined sewage to back-up in the collection system to the extent shown on Figure 10. The extent of the in-line storage and volume is related to the top elevation of the bypass side weir. The level of the top bypass side weir and adjacent control level gate are determined in relation to the critical performance levels in the system for basement flooding protection: when the system level increases above the bypass weir crest and proceeds above the top of the control gate during high flow events, the gate drops out of the way. At this point, the district will only provide its original interception capacity via the primary weir for the district, and all excess CS would flows over the weir and discharge to the river. After the sewer levels in the system drops back below the bypass side weir critical performance level, the control gate moves back to its original position to capture the receding limb of the WWF event. The existing gravity pipe pass forward flow will continue its current operation while the control gate is in either position, with all DWF being diverted to the existing gravity pipe.

Figure 10-01 provides an overview of the conceptual location and configuration of the control gate, bypass weir and screening chambers. The proposed control gate will be installed in a new chamber within the existing trunk sewer alignment near the existing FPS. The dimensions of the chamber will be 5.0 m in length and 2.5 m in width to accommodate the gate, with an allowance for a longitudinal overflow weir. The existing sewer configuration may have to be modified to accommodate the new chamber. This will be confirmed in future design assessments.

The physical requirements for the off-take and station sizing for a modification to pumping capacity have not been considered in detail, but they will be required in the future as part of an RTC program or FPS rehabilitation or replacement project.

The nominal rate for dewatering is already set at the existing pipe capacity as the district is a gravity discharge district. Any future considerations, for RTC improvements, would be completed with spatial rainfall as any reduction to the existing pipe capacity/operation for large events will adversely affect the overflows at this district. This future RTC control will provide the ability to capture and treat more volume for localized storms in other districts by using the excess interceptor capacity made available by restricting the pass forward flows through the control device where the runoff is less.

1.6.4 Gravity Flow Control

Colony district does not include a LS and discharges to the Portage Interceptor by gravity. A flow control device will be required to control the diversion rate for future RTC and dewatering. The controller will include flow measurement and a gate to control the discharge flow rate. A standard flow control device was selected as described in Part 3C.

The flow control would be installed at an optimal location on the connecting sewer between the proposed in-line control and existing diversion chamber. A small chamber or manhole with access for cleaning and maintenance will be required. The flow controller will operate independently and require minimal operation interaction.

A gravity flow controller has been included as a consideration in developing a fully optimized CS system as part of the City's long-term objective. The operation and configuration of the gravity flow controller will have to be further reviewed for additional flow and rainfall scenarios.

1.6.5 Floatables Management

Floatables management will require installation of a screening system to capture floatable materials. The off-line screens will be designed to maintain the current level of basement flooding protection.

The type and size of screens depend on the specific station configuration and the head available for operation. A standard design was assumed for screening and is described in Part 3C. The design criteria for screening, with an in-line control gate implemented, are listed in Table 1-7.

Table 1-7. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Top of Gate	225.86 m	
Bypass Weir Crest	225.76 m	
Normal Summer River Level	223.84 m	
Maximum Screen Head	1.92 m	

Table 1-7. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Peak Screening Rate	0.82 m^3/s	
Screen Size	1.5 m x 1.0 m	Modelled Screen Size

The proposed side bypass overflow weir and screening chamber will be located adjacent to the proposed control gate and existing CS trunk, as shown on Figure 10-01. The screens will operate with the control gate in its raised position. A side bypass weir upstream of the gate will direct the flow to the screens located in the new screening chamber, with screened flow discharged to the downstream side of the gate to the river. The screening chamber will include screenings pumps with a discharge returning the screened material to the CS system for routing to the NEWPCC for removal.

The dimensions for the screen chamber to accommodate influent from the side weir, the screen area, and the routing of the discharge piping downstream of the gate are 3.2 m in length and 3.1 m in width. The existing sewer configuration may have to be modified to accommodate the new chamber.

1.6.6 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography, and soil classification for the district will be reviewed to identify applicable GI controls.

Colony has been classified as a medium GI potential district. Land use in Colony is mix of residential, commercial, and institutional, the south end of the district is bounded by the Assiniboine River. This district would be an ideal location for cisterns/rain barrels, and rain garden bioretention within the residential areas. There are a few commercial areas which may be suitable to green roofs and parking lot areas which would be ideal for paved porous pavement.

1.6.7 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

In-line storage will impact the existing sewer and will require the addition of a new chamber and a moving gate at the outfall. In-line storage dewatering will be controlled with the existing Clifton CS LS, which will require more frequent and longer duration pump run times. Lower velocities will occur in the CS trunk in the vicinity of the control gate due to lower pass forward flows, and may create additional debris deposition requiring cleaning. Additional system monitoring, and level controls will be installed, which will require regular scheduled maintenance.

The flow controller will require the installation of a chamber and flow control equipment. Monitoring and control instrumentation will be required. The flow controller will operate independently and require minimal operation interaction. Regular maintenance of the flow controller chamber and appurtenances will be required.

Floatable control with outfall screening will require the addition of another chamber with screening equipment installed. The chamber will be installed adjacent to the control gate chamber and will operate in conjunction with it. Screening operation will occur during WWF events that surpass the in-line storage control level. WWF will be directed from the main CS trunk, over the side weir in the control gate chamber and through the screens to discharge into the river. The screens will operate intermittently during wet weather events and will likely require operations review and maintenance after each event. The frequency of a screened event will correlate to the number overflows identified for the district. Having the screenings pumped back to the interceptor system via a small LS and force main will be required. The screenings return will require O&M inspection after each event to assess the performance of the return pump system.

The latent storage would take advantage of the SRS infrastructure already in place, therefore, minimal additional maintenance will need to be anticipated. The proposed latent LSPS will require regular maintenance that would depend on the frequency of operation. The flap control gate will require maintenance inspection for continued assurance that the flap gate would open during WWF events.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. Two versions of the sewer system model were created and used to measure system performance. The 2013 Baseline model represents the sewer system baseline in the year 2013 and the 2037 Master Plan – Control Option 1 model, which includes the proposed control options in the year 2037. A summary of relevant model data is provided in Table 1-8.

Table 1-8. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	230	230	15,636	52	N/A
2037 Master Plan – Control Option 1	230	230	15,636	52	IS, Lat St, SC

Notes:

Total area is based on the model subcatchment boundaries for the district.

IS = In-line Storage
Lat St = Latent Storage
SC = Screening

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-9 are for the hydraulic model simulations using the year-round 1992 representative year. The table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. The table also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-9. Performance Summary – Control Option 1

Control Option	Preliminary Proposal	Master Plan			
	Annual Overflow Volume (m^3)	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [a]
Baseline (2013)	89,783	163,833	-	20	0.347 m^3/s
Latent Storage	-[b]	126,058	37,775	20	0.354 m^3/s
In-Line Storage	82,693	108,985	54,848	20	0.354 m^3/s
Latent & In-line & Offline Storage	14,196 [c]	N/A	N/A	N/A	N/A
Control Option 1	**14,196**	**108,985**	**54,848**	**20**	**0.354 m^3/s**

[a] Pass forward flows assessed on the 1-year design rainfall event

[b] Latent Storage, In-Line Storage and Off-line Storage Tank solutions not modelled as single options for the Preliminary Proposal assessment. Each was modelled together and it's impact assessed.

[c] Preliminary Proposal included offline storage tank within this district to achieve the 85 percent capture target in the Master Plan re-assessment

The CSO Master Plan assessment did not require the selection of an off-line tank to achieve the 85 percent capture target in the representation year. As part of the refinements during the CSO Master Plan assessment, it was found that the cumulative 85 percent target was achieved prior to needing the benefits provided by the off-line tank. As the off-line tank is considered the highest marginal cost solution in comparison to the in-line and latent storage options recommended, it was removed from the recommendations for this district. Note however that the inclusion of off-line storage has been considered as one of the recommendations to meet future performance targets; see Section 1.10 below.

The percent capture performance measure is not included in Table 1-9, as it is applicable to the entire CS system and not for each district individually.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-10. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-10. Cost Estimate – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance (Over 35-year period)
Latent Storage	$1,680,000	$2,340,000	$76,000	$1,640,000
In-Line Storage	$7,740,000 [a]	$2,360,000 [c]	$44,000	$940,000
Screens		$2,790,000 [d]	$54,000	$1,170,000
Gravity Flow Control	N/A [b]	$1,280,000	$34,000	$740,000

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance (Over 35-year period)
Off-line Storage Tank	$8,950,000	N/A [e]	N/A [e]	N/A [e]
Subtotal	**$18,360,000**	**$8,770,000**	$209,000	**$4,490,000**
Opportunities	N/A	$880,000	$21,000	$450,000
District Total	**$18,360,000**	**$9,650,000**	**$230,000**	**$4,940,000**

[a] In-Line storage and screening costs not separated during the Preliminary Proposal

[b] Gravity Flow Control not included in the Preliminary Proposal

[c] Cost associated with new off-take construction, as required, to accommodate control gate location and allow intercepted CS flow to reach the Portage Interceptor not included.

[d] Cost for bespoke screening return/force main not included in Master Plan as will depend on selection of screen and type of screening return system selected.

[e] Offline storage tank found to not be required to meet 85 Percent Capture target and was removed during Master Plan assessment.

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional cost for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014-dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019-dollar values.
- The 2019 Total Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of alternative plans, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-11.

Table 1-11. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	In-line Storage	Unit cost updates Separation of screening and in-line	In-line and Screening included as combined cost in Preliminary Proposal

Table 1-11. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
	Screening	Unit cost updates Separation of screening and in-line	In-line and Screening included as combined cost in Preliminary Proposal
	Gravity Flow Control(	A flow controller was not included in the preliminary estimate	Added for the Master Plan to further reduce overflows and control in-line
	Removal of Off-line Storage	Not included in the Master Plan	Removed through marginal analysis
	Latent Storage	Unit cost updates	
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation	Preliminary estimates were based on 2014-dollar values	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, the future performance target is 98 percent capture for the representative year measured on a system-wide basis. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-12 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified for Control Option 1.

Overall the Colony district would be classified as a low potential for implementation of complete sewer separation as the only feasible approach to achieve the 98 percent capture future performance target in the representative year. Opportunistic sewer separation within portions of the district may be completed in conjunction with other major infrastructure work to address future performance targets. In addition, green infrastructure and off-line tank or tunnel storage may be utilized in key locations to provide additional storage and increase capture volume.

Table 1-12. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Opportunistic Separation • Off-Line Storage (Tank/Tunnel) • Increased GI

The control options for the Colony district has been aligned for the 85 percent capture performance target based on the system wide assessment. The expandability of the district to the future 98 percent capture target will be restricted depending on the interaction of the system wide performance.

The cost for upgrading to meet an enhanced performance target depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of

master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-13Table 1-13.

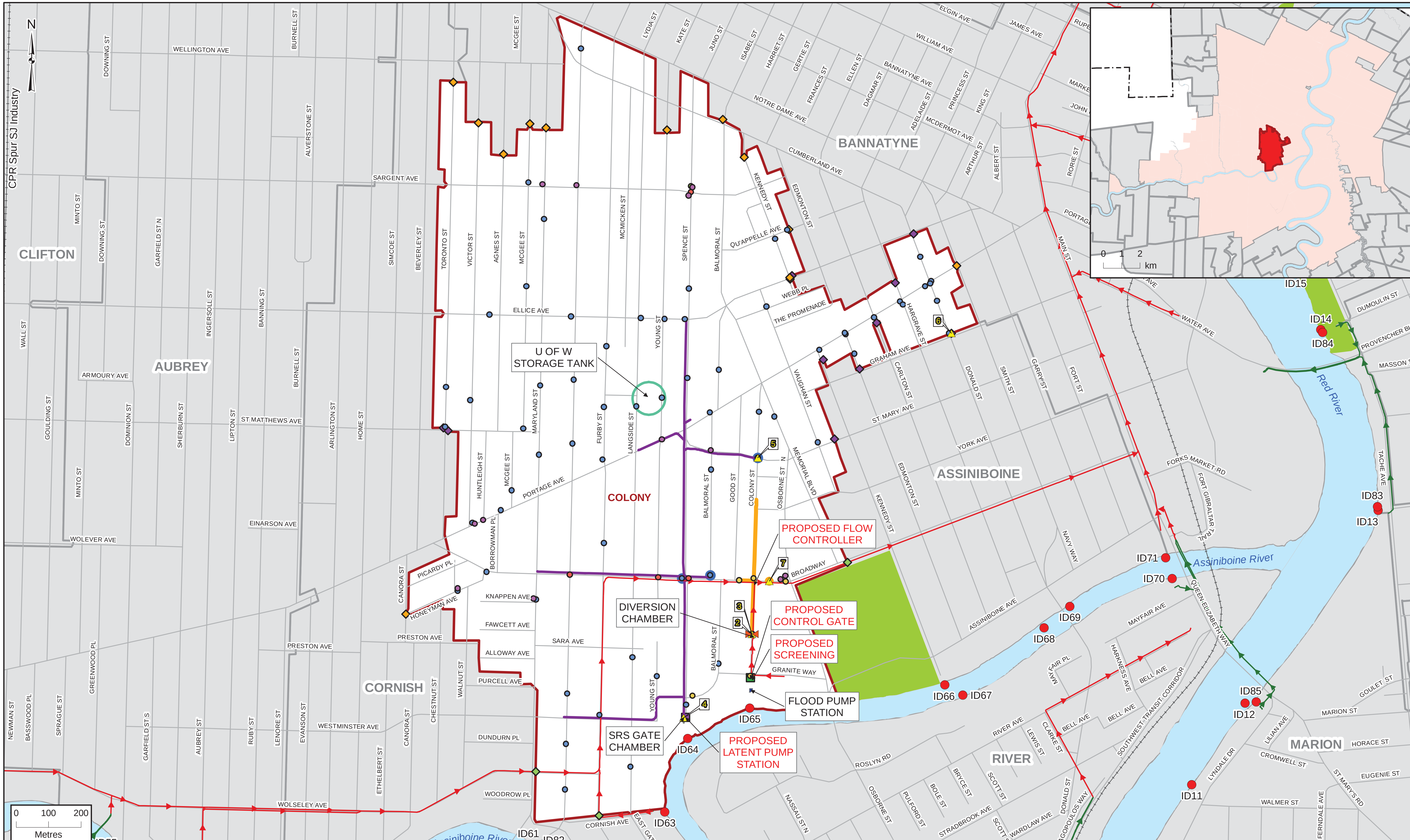
Table 1-13. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	R	R	-	-	-	-	-	-
2	Existing Lift Station	-	R	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	-	-	-	-
4	Construction Disruption	-	-	-	-	-	-	-	-
5	Implementation Schedule	-	-	-	-	-	-	R	-
6	Sewer Condition	R	R	-	-	-	-	-	-
7	Sewer Conflicts	R	R	-	-	-	-	-	-
8	Program Cost	O	O	-	-	-	-	-	O
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	R	-	-	-	-	O	O	-
12	Operations and Maintenance	R	R	-	-	-	R	O	R
13	Volume Capture Performance	O	O	-	-	-	O	O	-
14	Treatment	R	R	-	-	-	O	O	R

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

Sprenger & Associates Inc. and Dillon Consulting Limited (Sprenger/Dillon). 1998. *Independent Review of the Colony Combined Sewer Relief Report.* Prepared for the City of Winnipeg, Water and Waste Department. September.



LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Low CS Manhole
- Low SRS Connection

District Boundary Crossing
- CS
- SRS
- WWS

Inter-System Connection
- CS - LDS
- CS - WWS
- SRS - CS
- SRS - LDS
- SRS - WWS

- Interceptor Sewer
- Force Main
- Street
- Railway
- District Boundary
- Watercourse
- Greenspace

CSO MASTER PLAN PROPOSED SOLUTIONS
- Proposed Control Gate
- Proposed SRS Latent Storage Pump
- Latent Storage Limit
- Extent of In-line Storage

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 10
District Overview Map
Sewer District: Colony
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- CSO Outfall
- Manhole
- Flap Gate
- Sluice Gate
- Pump Location

Sewer By Type
- CS
- LDS
- SRS
- WWS

Pump Station Type
- Flood Pump Station

- Land Parcel

CSO MASTER PLAN PROPOSED SOLUTIONS

- Control Gate
- Screening

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

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WATER AND WASTE DEPARTMENT

FIGURE 10-01
Control Gate and Screening
Sewer District: Colony
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- Critical Elevation
- Manhole
- Sluice Gate

Sewer By Type
- CS
- LDS
- SRS

Land Parcel

CSO MASTER PLAN PROPOSED SOLUTIONS

- Proposed Latent Force Main
- Latent Pump

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

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WATER AND WASTE DEPARTMENT

FIGURE 10-02
Latent SRS Control
Sewer District: Colony
City of Winnipeg
Combined Sewer Overflow Master Plan

LEGEND

- Critical Elevation
- Manhole

Sewer By Type
- CS
- LDS
- SRS
- WWS

Land Parcel

CSO MASTER PLAN
PROPOSED SOLUTIONS

Flow Controller

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 10-03
Gravity Flow Control
Sewer District: Colony
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Cornish District Plan

August 2019

City of Winnipeg

JACOBS

CSO Master Plan

Project No: 470010CH
Document Title: Cornish District Plan
Revision: 03
Date: August 18, 2019
Client Name: City of Winnipeg
Project Manager: John Berry
Author: Danny Tinker
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Document History and Status

Revision	Date	Description	By	Review	Approved
0	08/30/2018	Version 1 DRAFT	DT	SB / MF / SG	
1	02/15/2019	DRAFT 2 for City Review	SB / MF	SG	MF
2	06/2019	Final Draft Submission	DT	MF	MF
3	08/18/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

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Figure

1. Cornish District

1.1 District Description

Cornish district is located in the central portion of the combined sewer (CS) area along the northern edge of the Assiniboine River. Cornish is bounded by Toronto and Maryland Streets to the east; Lenore, Burnell, Arlington, and Simcoe Streets to the west; Notre Dame Avenue to the north; and the Assiniboine River to the south.

Land use within Cornish district includes a mix of commercial and residential, with the majority being two-family residential. Commercial property is located along the major roadways including Portage Avenue, Notre Dame Avenue, Ellice Avenue, Sargent Avenue, and Arlington Street, which are also the regional transportation routes within the district. There is approximately 18 ha of greenspace in the district. Greenspace is limited due to the high makeup of multi-family and commercial land use. Vimy Ridge Park, located on Portage Avenue, is the only significant greenspace within the district.

1.2 Development

A portion of Portage Avenue is located within the Cornish District. Portage Avenue is identified as Regional Mixed Use Corridor as part of the Our Winnipeg future development plans. As such, focused intensification along Portage Avenue is to be promoted in the future.

1.3 Existing Sewer System

Cornish district has an approximate area of 141 ha[1] based on the GIS district boundary information and includes CS and storm relief sewer (SRS) systems. This district does not include any areas that may be identified as separated or separation-ready. The CS system drains toward the Cornish outfall, located at the eastern end of Cornish Street where combined sewage is pumped to the Main Interceptor along Wolseley Avenue.

The CS system includes a flood pump station (FPS), CS lift station (LS), one CS primary outfall, two CS secondary outfalls, one SRS outfall and one FPS outfall. All domestic wastewater and CS flow collected in Cornish district is routed to the east end of Cornish Avenue, where the CS LS and primary CS outfall (Cornish East CS Outfall) are located.

There is a single main CS trunk sewer that collects the flow from the district. This main CS trunk changes in shape and size several times before reaching the Assiniboine River. North of Portage Avenue is serviced by a 300 mm to 750 mm CS along Simcoe Street that flows southbound from Notre Dame Avenue to Portage Avenue. From Portage Avenue, the trunk runs south on Canora Street, Walnut Street, and Maryland Street to eventually reach Cornish Avenue. The trunk sewer previously along Simcoe Street turns into a 1200 mm by 1550 mm egg-shaped CS on Canora Street and continues south, then east on Preston Avenue. The areas south of Preston Avenue are serviced by a series of laterals that collect combined sewage from the residential areas and connect to the CS collector on Westminster Avenue, which eventually connects to a 900 mm CS collector located in the southern section of Walnut at Purcell Avenue that connects to the trunk sewer for the district. Collected sewage eventually flows into a 1500 mm sewer trunk that connects into the Cornish Avenue gate chamber and CS LS at the eastern end of Cornish Avenue, as part of the primary CS outfall.

A flap gate and sluice gate are located in the Cornish east outfall pipe to prevent river water from backing up into the CS system during high river levels along the Assiniboine River. The FPS is located at the western end of Cornish Avenue upstream from the CS LS. The FPS has a separate outfall directly to the

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

Assiniboine River located near the Maryland bridge, and allows the CS system to discharge to the river when the flap gate remains closed during these high river level conditions. When the river level is high and gravity discharge is not possible, the excess flow is pumped by the Cornish FPS to the dedicated FPS outfall allowing gravity discharge to the river. There is no flap or sluice gate installed on the dedicated FPS outfall.

During wet weather flow (WWF) events, the SRS system provides relief to the CS system in Cornish district. The SRS system extends throughout the district and has multiple interconnections with the CS system. The SRS system in Cornish also receives SRS flow from parts of the neighboring Aubrey, Colony and Bannatyne districts. Most catch basins are still connected to the CS system in Cornish, so no partial separation has been completed. There is a main SRS trunk within the Cornish district which runs along Simcoe Street north of Portage Avenue, and then Canora Street south of Portage Avenue. The SRS system within this Simcoe/Canora trunk discharges directly to the Assiniboine River by gravity through the SRS outfall at the southern end of Canora Street. A sluice gate is located on this outfall pipe to prevent river water from backing up into the SRS system during high river levels along the Assiniboine River.

During dry weather flow (DWF), the SRS system is not required; sanitary sewage flow is diverted by the primary weir at the Cornish outfall, and is intercepted through the 450 mm off-take to the Cornish SPS, where it is pumped to the interceptor pipe along Wolseley Avenue and eventually reaches to the North End Sewage Treatment Plant (NEWPCC) for treatment. During wet weather flow (WWF), any flow that exceeds the diversion capacity overtops the primary weir and is discharged to the river through the Cornish East outfall.

There are also two secondary CS outfalls within the Cornish district, which provide relieve to the CS in the district under wet weather flow events and allow direct discharge to the Assiniboine River at different points, relieving the system and reducing the possibility of localized basement flooding. The Arlington CS secondary outfall is located at Palmerston and Arlington: when the capacity of the sewer laterals along Palmerston Ave and Arlington Street are exceeded, the outfall will overflow to the Assiniboine River. The Cornish West secondary outfall is located adjacent to the Maryland Bridge, near the Cornish FPS outfall. If the WWF exceeds the capacity of the Cornish East Primary CS outfall, then the Cornish West weir will overflow to the Assiniboine River. Sluice gate protection is provided on the Arlington secondary outfall, and both sluice and flap gate protection is provided on the Cornish West secondary outfall, to restrict back-up from the Assiniboine River into the CS system under high river level conditions along the Assiniboine River.

In total, there are five outfalls to the Assiniboine River (three CSs, one SRS, and one FPS) as follows:

- ID63 (S-MA70033535) – Cornish East Primary CS Outfall
- ID83 (S-MA70017433) – Cornish FPS Outfall
- ID61 (S-MA20013630) – Cornish West Secondary CS Outfall
- ID59 (S-MA70053466) – Arlington Secondary CS Outfall
- ID60 (S-MA70017866) – Canora SRS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between the Cornish district and the surrounding districts. Each interconnection is shown on Figure 11 and shows locations where gravity and pumped flow can cross from one district to another. The known district-to-district interconnections are identified as follows:

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

Colony

- A 450 mm carries intercepted CS flows from the Cornish district into the Colony district and to the NEWPCC for treatment.
  - Furby Street and Cornish Avenue interceptor invert - 225.48 m (S-TE20012409)
- A 1500 mm interceptor flows by gravity through the Cornish district into the Colony district and on to the NEWPCC for treatment. This interceptor carries intercepted CS from the districts upstream of the Cornish district, and does not interact with the Cornish CS system.
  - Wolseley Avenue and Maryland Street Interceptor invert - 225.46 m (S-TE20012409)

1.3.1.2 Interceptor Connections – Upstream of Primary Weir

Aubrey

- Two 1200mm interceptor gravity sewers discharge into the Cornish district from the Aubrey district and carries sewage to the NEWPCC for treatment:
  - Wolseley Avenue – 226.20 m (S-MH20012549)
  - Wolseley Avenue – 226.04 m (S-TE20004698)

1.3.1.3 District Interconnections

Aubrey

CS to CS

- High Point Manhole (flow can be directed into both districts from this manhole):
  - Portage Avenue – 229.09 m (S-MH20013779)

CS to SRS

- A 600 mm SRS diverts from the CS flowing southbound on Home Street into Cornish district on Wellington Avenue:
  - Wellington Avenue – 226.59 m (S-MA20018010)

Bannatyne

CS to CS

- A 375 mm CS flows by gravity northbound on Toronto Street and connects to the CS system in Bannatyne district:
  - Toronto Street – 229.12 m (S-MH20016131)
- A 450 mm CS acts as an overflow pipe from the Bannatyne district to the Cornish district:
  - Wellington Avenue and Toronto Street – 229.76 m (S-MH70028187)

SRS to SRS

- A 1200 mm SRS flows by gravity into Cornish district from Bannatyne district on Wellington Avenue:
  - Wellington Avenue and Toronto Street – 226.54 m (S-MA20018024)

Colony

CS to CS

- High Point Manhole (flow can be directed into both districts from this manhole):
  - Toronto Street – 229.72 m (S-MH20016007)
- A 450 mm CS sewer acts as an overflow pipe from the Cornish CS system into the Colony CS system.
  - Honeymoon Avenue – 228.61 m (S-MH20013931)

SRS to SRS

- Two connections that flow via gravity at the intersection of St. Matthews Avenue and Toronto Street:
  - St. Matthews Avenue SRS invert at district boundary that flows from Cornish into Colony district into SRS outfall on Spence Street = 226.31 m (S-MA20015548)
  - Toronto Street SRS invert at district boundary that flows from Cornish into Colony district into SRS outfall on Spence Street = 226.68 m (S-MA70023075)

A district interconnection schematic is included as Figure **1-1**. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing district.

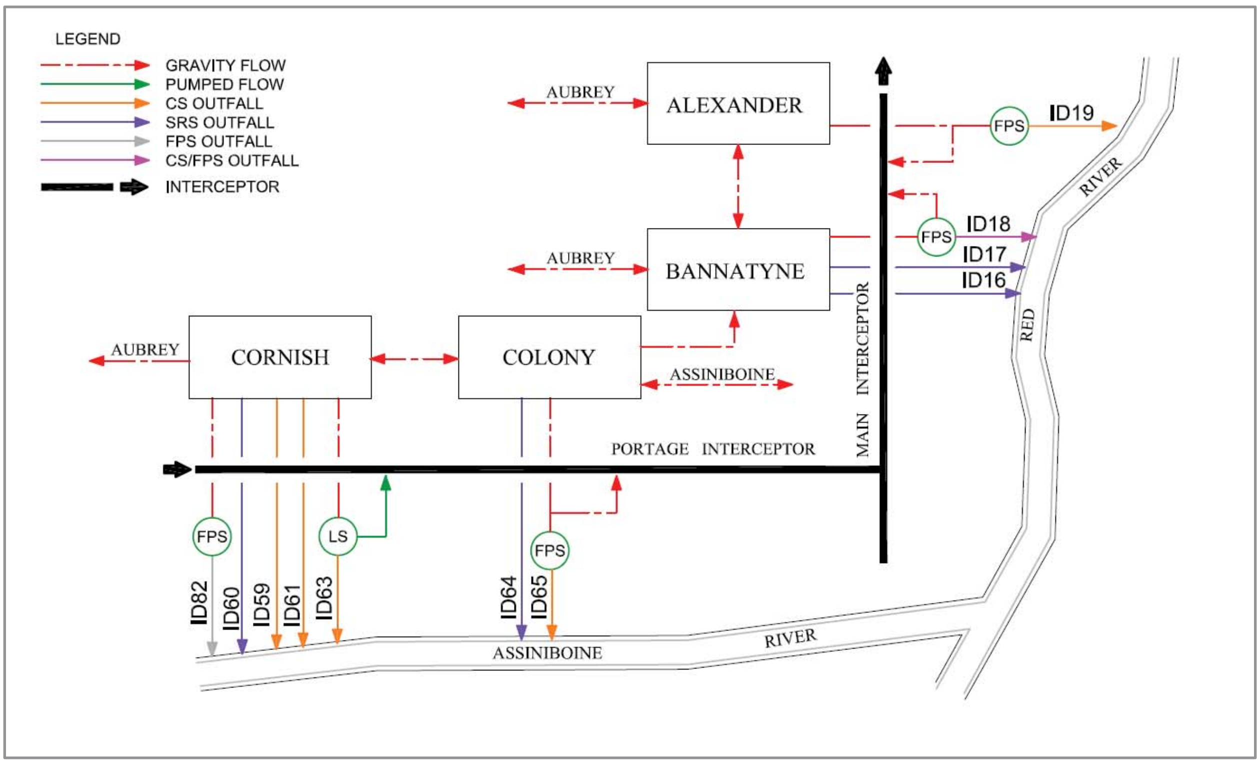


Figure 1-1. **District Interconnection Schematic**

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 11 and listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID63)	S-MH70011815.1	S-MA70033535	1600 x 1450 mm	Assiniboine River Invert: 223.3 m
Flood Pumping Outfall (ID83)	S-AC70008049.1	S-MA70017433	1670 mm	Assiniboine River Invert: 223.29 m
Other Overflows (ID59 & ID61)	S-MH20012348.1 S-RE70014978.1	S-MA20013630 S-MA70053466	750 mm 400 mm	Invert: 223.38 m Invert: 224.20 m
Main Trunk	S-RE70008047.1	S-MA70017431	1450 mm	Circular Invert: 223.8 m
SRS Outfalls (ID60)	S-CO70008272.1	S-MA70017866	1980 mm	Invert: 222.1 m
SRS Interconnections	N/A	N/A	N/A	35 SRS - CS
Main Trunk Flap Gate	CORNISH_EAST_GC.1	S-CG00000755	1375 mm	Invert: 224 m
Main Trunk Sluice Gate	S-MH70011814.2	S-CG00001131	1500 x 1500 mm	Invert: 223.61 m
Off-Take	S-MH20012427.2	S-MA70017421	450 mm	Circular Invert: 223.84 m
Dry Well	N/A	N/A	N/A	
Lift Station Total Capacity	N/A	N/A	0.148 m^3/s	1 x 0.059 m^3/s 1 x 0.089 m^3/s
Lift Station ADWF	N/A	N/A	0.059 m^3/s	
Lift Station Force Main	S-MH20012408.1	S-MA20013697	200 mm	Invert: 226.17 m
Flood Pump Station Total Capacity	N/A	N/A	1.87 m^3/s	1 x 0.72 m^3/s 1 x 0.29 m^3/s 1 x 0.86 m^3/s
Pass Forward Flow – First Overflow	N/A	N/A	0.151 m^3/s	

Notes:

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Cornish East – 223.84 Cornish West – 223.84 Arlington – 223.85 Canora – 223.85
2	Trunk Invert at Off-Take	223.84
3	Top of Weir	224.44
4	Relief Outfall Invert at Flap Gate	Canora SRS Outfall – 221.18
5	Low Relief Interconnection (S-MH20013588)	225.88
6	Sewer District Interconnection (Colony)	226.55

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
7	Low Basement	228.60
8	Flood Protection Level	230.04

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

The most recent study completed in Cornish was the 1986 Basement Flood Relief study (Girling, 1986). No other work has been completed to evaluate the district sewer system since that time. Table 1-3 provides a summary of the district status in terms of data capture and study.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Cornish CS district was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations has a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Planned Completion
11 – Cornish	1986	Future Work	2013	Study Complete	N/A

1.5 Ongoing Investment Work

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Cornish district. This consists of monthly site visits in confined entry spaces to verify that physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

Future upgrades to the Outfall Gate Structure for the Canora SRS outfall are anticipated to take place in the next five to ten years. This work will include the addition of a flap gate to the Canora SRS outfall. Additional work including the installation of the necessary pumps to begin to implement the latent storage control solution recommended in this district plan may also be packaged with this flap gate installation work. This work is to be prioritized along with the other SRS outfalls requiring gate structure upgrade work.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected for the Cornish district to meet Control Option 1 – 85 Percent Capture in a Representative Year are listed in Table 1-4. The proposed CSO control options will include in-line storage via control gate, latent storage, and floatables management via screening. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85% Capture in a Representative Year	✓	-	-	✓	✓	-	-	-	✓	✓	✓

Notes:

- = not included
✓ = included

The existing CS system is suitable for use as latent storage. These control options will take advantage of the existing CS pipe network for additional storage volume. Existing DWF from the collection system will remain the same, and overall district operations will remain the same.

The primary CS overflow for the district is to be screened under the current CSO control plan to address the floatables management requirements. The installation of a control gate at the primary CS outfall will be required for the screen operation in the Cornish district. This control gate installation will also be providing the mechanism for capture of minor additional in-line storage. It should be noted however that in-line storage for the Cornish district is not a cost effective solution specifically for additional volume capture. The control gate installation is recommended primarily to provide the necessary hydraulic head for screen operations. Should screening no longer be required in the Cornish district to address the floatables management requirements, it is recommended that alternative measures such as off-line storage be investigated in the Cornish district to provide the additional volume capture in a more cost effective manner.

All primary overflow locations are to be screened under the current CSO control plan. Installation of a control gate will be required for the screen operation, and additionally it will provide the mechanism for capture of the in-line station. GI and RTC will be applied within each district on a system wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Latent Storage

Latent storage is a suitable control option for the Cornish district. There is one SRS system and SRS outfall that will provide additional storage volume. The latent storage level is controlled by river level and resulting backpressure of the river level on the proposed Canora SRS outfall flap gate, as explained in Part 3C. The storage volumes indicated in the design criteria table below is based on the river level condition of NSWL (normal summer water level) during the 1992 representative year at the outfall location.

Latent storage is accessible and has a lower risk than other storage types. A latent pump station, flap gate, and interconnecting pipes will be required to access the storage. The latent storage design criteria are identified in Table 1-5. The storage volumes indicated in design criteria table below are based on the NSWL river conditions.

Table 1-5. Latent Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	Canora – 222.18 m	Existing Sluice Gate invert.

Table 1-5. Latent Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
NSWL	223.85 m	
Trunk Diameter	1975 mm	
Design Depth in Trunk	1667 mm	
Maximum Storage Volume	1471 m3	
Force Main	125 mm	
Flap Gate Control	N/A	
Lift Station	Yes	
Nominal Dewatering Rate	0.025 m^3/s	Based on 24 hour emptying requirement
RTC Operational Rate	TBD	Future RTC/dewatering assessment

Note:
TBD – to be determined
RTC – Real Time Control

The addition of a latent storage pump station (LSPS) and force main that connect to the CS system are necessary for the latent storage to be dewatered. A conceptual layout for the LSPS and force main is shown on Figure 11-02 for the Canora SRS outfall. The LSPS will be located to the northwest of the SRS outfall chamber to avoid interference with nearby private residential lands. It is expected that the structure (large manhole chamber) will be situated within the street and provide minor disruption to the street and adjacent streets will provide alternative access. The latent force main will be routed north on Palmerston Avenue and connect to the Cornish CS system at the manhole on Wolseley Avenue and Canora Street. The LSPS will operate to dewater the SRS system in preparation for the next runoff event, the requirement for the system to be ready for the next event within a 24-hour period after completion of the previous event.

As described in Section 1.5 above, much of this latent storage work may be pursued in conjunction with the critical flap gate installation work. This work is prioritized to occur within the Canora SRS outfall within the next five to ten years.

As described in the standard details in Part 3C, wet well sizing will be determined based on the final pump selection, operation and dewatering capacity required. The interconnecting piping between the new gate chambers and the LSPS will be sized to provide sufficient flow to the pumps while all pumps are operating.

Flap gate control was not deemed necessary for this control option. Flap gate control may be considered if additional storage is required or if he river level regularly drops below the SRS flap gate elevation. The SRS flap gate control is described in the standard details in Part 3C.

1.6.3 In-Line Storage

In-line storage has been proposed as a CSO control for the Cornish district. The in-line storage will require the installation of a control gate at the CS outfall. The gate will primarily be used to provide additional hydraulic head for screening operations. The gate will also provide a secondary benefit in increasing the storage level in the existing CS to provide an overall higher volume capture, which is evaluated in further detail in this section. It is noted that the existing Cornish West secondary outfall will need to be monitored as any increases to the primary weir may adversely affect the performance at Cornish West secondary outfall. Assessment modelling did not indicate that additional overflows occur at the secondary outfall after implementation of the in-line storage arrangements described below.

A standard design was assumed for the control gate, as described in Part 3C. A standard approach was used for conceptual gate sizing by assuming it to be the lesser of the height of half of the site-specific trunk diameter or the maximum height of the gate available. The design criteria for in-line storage are listed in Table 1-6.

Table 1-6. In-Line Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	223.80 m	Downstream invert of pipe at weir
Trunk Diameter	1450 mm	
Gate Height	0.72 m	Gate height based on half truck diameter assumption
Top of Gate Elevation	224.63 m	
Bypass Weir Height	226.53 m	
Maximum Storage Volume	202 m^3	
Nominal Dewatering Rate	0.148 m^3/s	Based on existing CS LS pump rate
RTC Operational Rate	TBD	Future RTC/dewatering rate assessment to be completed

The proposed control gate will cause combined sewage to back-up within the collection system to the extent shown on Figure 11. The extent of the in-line storage and volume is related to the top elevation of the bypass side weir. The level of the top of the bypass side weir is determined in relation to the critical performance level in the system for basement flooding protection: when the system level increases above the bypass weir crest and proceeds above the top of the control gate or to this critical performance level within the system during high flow events, the gate drops out of the way. At this point, the district will only provide its original interception capacity via the primary weir for the district, and all excess CS would spill over the weir and discharge to the river. After the sewer levels in the system drops back below this critical performance level, the control gate moves back to its original position to capture the receding limb of the WWF event. The CS LS will continue with its current operation while the control gate is in position, with all DWF being diverted to the CS LS and pumped to the Main Interceptor on Furby Street. The CS LS will further dewater the in-line storage provided during a WWF event as downstream capacity becomes available after the WWF event.

Figure 11-01 provides an overview of the conceptual location and configuration of the proposed control gate and screening chambers. The proposed control gate will be installed in a new chamber within the trunk sewer alignment and be located west of the Cornish outfall gate chamber. The dimensions of a new chamber to provide an allowance for a side weir for floatables control are 5 m in length and 3.5 m in width. The existing sewer configuration including the construction of an additional off-take, and force main modifications may have to be completed accommodate the new control gate chamber. This will be confirmed in future design assessments.

The inline storage level increase as a result of the control gate construction has been evaluated and does not affect the performance of the upstream Cornish West CS outfall. The in-line storage allows the smaller rainfall events to be collected downstream at the Cornish East CS outfall. It is however still recommended that the impact on the secondary CS outfall at Cornish West be evaluated further during preliminary design.

The physical requirements for the off-take and station sizing for a modification to pumping capacity have not been considered in detail, but they will be required in the future as part of an RTC program or CS LS rehabilitation or replacement project.

The nominal rate for dewatering is set at the existing LS capacity. This allows dewatering through the existing interceptor system within 24 hours following the runoff event, allowing it to recover in time for a subsequent event. Future RTC / dewatering assessment will be necessary to define additional rates. This would provide some flexibility in the ability to increase the dewatering rate for spatial rainfall events. This would dewater the district more quickly, to capture and treat more volume for these localized storms by using the excess interceptor capacity where the runoff is less.

1.6.4 Floatables Management

Floatables management will require installation of a screening system to capture floatable materials. If outfall screening is required, off-line screens will be proposed to maintain the current level of basement flooding protection.

The type and size of screens depend on the specific station configuration and the head available for operation. A standard design was assumed for screening and is described in Part 3C. The design criteria for screening, with an in-line control gate implemented, are listed in Table 1-7.

Table 1-7. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Top of Gate	224.63 m	
Bypass Weir Crest	224.53 m	
NSWL	223.85 m	
Maximum Screen Head	0.65 m	
Peak Screening Rate	0.53 m^3/s	
Screen Size	1.5 m x 1 m	Modelled Screen Size

The proposed side bypass overflow weir and screening chamber will be located adjacent to the existing combined trunk sewer, as shown on Figure 11-01. The screens will operate once levels within the sewer surpassed the bypass weir elevation. A side bypass weir upstream of the gate will direct the initial overflow to the screens located in the new screening chamber, with screened flow discharged to the downstream side of the gate to the river. The screening chamber will include screenings pumps with a discharge returning the screened material back to the interceptor and on to the NEWPCC for removal.

The dimensions for the screen chamber to accommodate influent from the side bypass weir, the screen area, and the routing of discharge downstream of the gate are 5.5 m in length and 2.5 m in width. The existing sewer configuration will have to be modified to accommodate the new chamber to continue to allow the DWF to discharge to the CS LS. The chamber has been initially located within City-owned land available as part of Cornish Avenue.

1.6.5 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district will be reviewed to identify the most applicable GI controls.

Cornish has been classified as a medium GI potential district. Land use in Cornish is a mix of residential, commercial, and institutional, the south end of the district is bounded by the Assiniboine River. This district would be an ideal location for cisterns/rain barrels, and rain garden bioretention within the residential areas. There are a few commercial areas which may be suitable to green roofs and parking lot areas which would be ideal for paved porous pavement.

1.6.6 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Section 3C. Periodic maintenance of the gate and screens would be required, depending on the type of gate and screening selected.

In-line storage will impact the existing sewer and will require the addition of a new chamber and a moving gate at the outfall. In-line storage dewatering will be controlled with the existing Cornish CS LS, which will require more frequent and longer duration pump run times. Lower velocities will occur in the CS trunk in the vicinity of the control gate due to lower pass forward flows, and may create additional debris deposition requiring cleaning. Additional system monitoring, and level controls will be installed, which will require regular scheduled maintenance.

The latent storage would take advantage of the SRS infrastructure already in place, therefore, minimal additional maintenance will need to be anticipated. The proposed latent LSPS will require regular maintenance that would depend on the frequency of operation. The flap control gate will require maintenance inspection for continued assurance that the flap gate would open during WWF events.

Floatable control with outfall screening will require the addition of another chamber with screening equipment installed. The chamber will be installed adjacent to the control gate chamber and will operate in conjunction with it. Screening operation will occur during WWF events that surpass the in-line storage control level. WWF will be directed from the main CS trunk, over the side weir in the control gate chamber and through the screens to discharge into the river. The screens will operate intermittently during wet weather events and will likely require operations review and maintenance after each event. The frequency of a screened event will correlate to the number overflows identified for the district. Having the screenings pumped back to the interceptor system via a small LS and force main will be required. The screenings return will require O&M inspection after each event to assess the performance of the return pump system.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. An individual model was created to represent the sewer system baseline as represented in the year 2013 and a second model was created for the CSO Master Plan evaluation purposes, with all the control options recommended for the district to meet Control Option 1 implemented in the year 2037. A summary of relevant model data is provided in Table 1-8.

Table 1-8. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Added to Model
2013 Baseline	135	133	7,288	58	N/A
2037 Master Plan – Control Option 1	135	132	7,288	58	IS, Lat St, SC

Notes:

IS = In-line Storage
SC = Screening
Lat St = Latent Storage

Table 1-8. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Added to Model

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results in Table 1-9 are for the hydraulic model simulations using the year-round 1992 representative year. This table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan – Control Option 1. The Baseline and Control Option 1 performance number represent the comparison between the existing system and the proposed control options. Table 1-9 also includes overflow volumes specific to each individual control: these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-9. Performance Summary – Control Option 1

Control Option	Preliminary Proposal Annual Overflow Volume (m^3)	Master Plan Overflow Reduction (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [b]
Baseline (2013)	85,517	60,293	-	19	0.272 m^3/s
Latent Storage	85,372 [a]	-[c]	-[c]	-[c]	-[c]
Latent & In-line Storage		-[c]	-[c]	-[c]	-[c]
Control Option 1	**85,372**	**-[c]**	**-[c]**	**-[c]**	**-[c]**

[a] Latent and In-line Storage were not simulated independently during the Preliminary Proposal assessment.

[b] Pass forward flows assessed on the 1-year design rainfall event

[c] Model instability issues encountered within the Cornish district as part of the Master Plan performance evaluation for overall City of Winnipeg sewer network. The individual district performance values were instead utilized for the control option performance evaluation, and are shown below:

Table 1-10. Master Plan Performance Summary – Control Option 1 (Individual Model)

Control Option	Master Plan Overflow Reduction (m^3)	Master Plan Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [a]
Revised Baseline (2013)	64,659	-	20	0.180 m^3/s
Latent Storage	64,122	547	20	0.181 m^3/s
Latent & In-line Storage	63,724	398	20	0.068 m^3/s
Control Option 1	**63,724**	**931**	**20**	**0.068 m^3/s**

[a] Pass forward flows assessed on the 1-year design rainfall event

The percent capture performance measure is not included in Table 1-9 and Table 1-10, as it is applicable to the entire CS system and not for each district individually.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-11. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-11. Cost Estimate – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance (Over 35-year Period)
Latent Storage	$1,580,000	$2,440,000	$71,000	$1,520,000
In-line Control Gate	N/A [a]	$2,420,000 [b]	$44,000	$950,000
Screening		$2,350,000 [c]	$54,000	$1,150,000
Subtotal	**$1,580,000**	**$7,210,000**	**$168,000**	**$3,620,000**
Opportunities	N/A	$720,000	$17,000	$360,000
District Total	**$1,580,000**	**$7,930,000**	**$185,000**	**$3,980,000**

[a] Screening and In-line Storage were not included in the Preliminary Proposal 2015 costing. Solution developed as refinement to Preliminary Proposal work following submission of Preliminary Proposal costs. Costs for these items of work found to be $2,500,000 in 2014 dollars

[b] Costs associated with new off-take construction, as required, to accommodate control gate and screening chambers in location and allow intercepted CS flow to reach existing Cornish CS LS was not included in Master Plan

[c] Cost for bespoke screenings return/force main not included in Master Plan as will depend on selection of screen and type of screening return system selected

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The estimate for the in-line storage costs does not include the costs to construct the new off-take to the LS. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional cost for RTC. This has been listed as part of Opportunities costs.
- The Preliminary Proposal capital cost is on 2014 dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019 dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant difference between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-12.

Table 1-12. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Latent	Updated unit costs One of the two SRS locations, the Canora SRS Outfall, includes a LS system	
	Control Gate	A control gate was not included in the Preliminary Proposal estimate	Added for the MP primarily to allow for screening operation, but also to further reduce overflows
	Screening	Screening was not included in the Preliminary Proposal estimate	Added in conjunction with the Control Gate
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Costs	The lifecycle costs have been adjusted to 35 years.	City of Winnipeg Asset Management approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation.	Preliminary Proposal estimates were based on 2014-dollar values.	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, the future performance target is 98 percent capture for the representative year measured on a system-wide basis. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-13 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified for Control Option 1.

Overall the Cornish district would be classified as a low potential for implementation of complete sewer separation as the only feasible approach to achieve the 98 percent capture future performance target in the representative year. However, opportunistic sewer separation within a portion of the district may be completed in conjunction with other major infrastructure work to address future performance targets. Flap gate control upgrades to the latent storage arrangements currently recommended could be implemented to provide further volume capture. It is recommended to review the Aubrey district upstream of Cornish, as the available latent storage could further be utilized though existing infrastructure alterations to CS to SRS connections or new interconnections to increase flow to the SRS system for low to medium rainfall events. In addition, green infrastructure and off-line tank or tunnel storage may be utilized in key locations to provide additional storage and increase capture volume.

Table 1-13. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Opportunistic separation • Latent Storage (Revised Interconnections or Flap Gate Control) • Off-line Storage (Tank/Tunnel) • Increase use of GI

The control options selected for the Cornish district have been aligned for the requirement to provide screening on each of the primary outfalls and not specifically for the 85 percent capture performance target based on the system wide basis. The expandability of this district to meet the 98 percent capture would be based on a stepped approach from the system wide basis.

The cost for upgrading to meet an enhanced performance target depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-14.

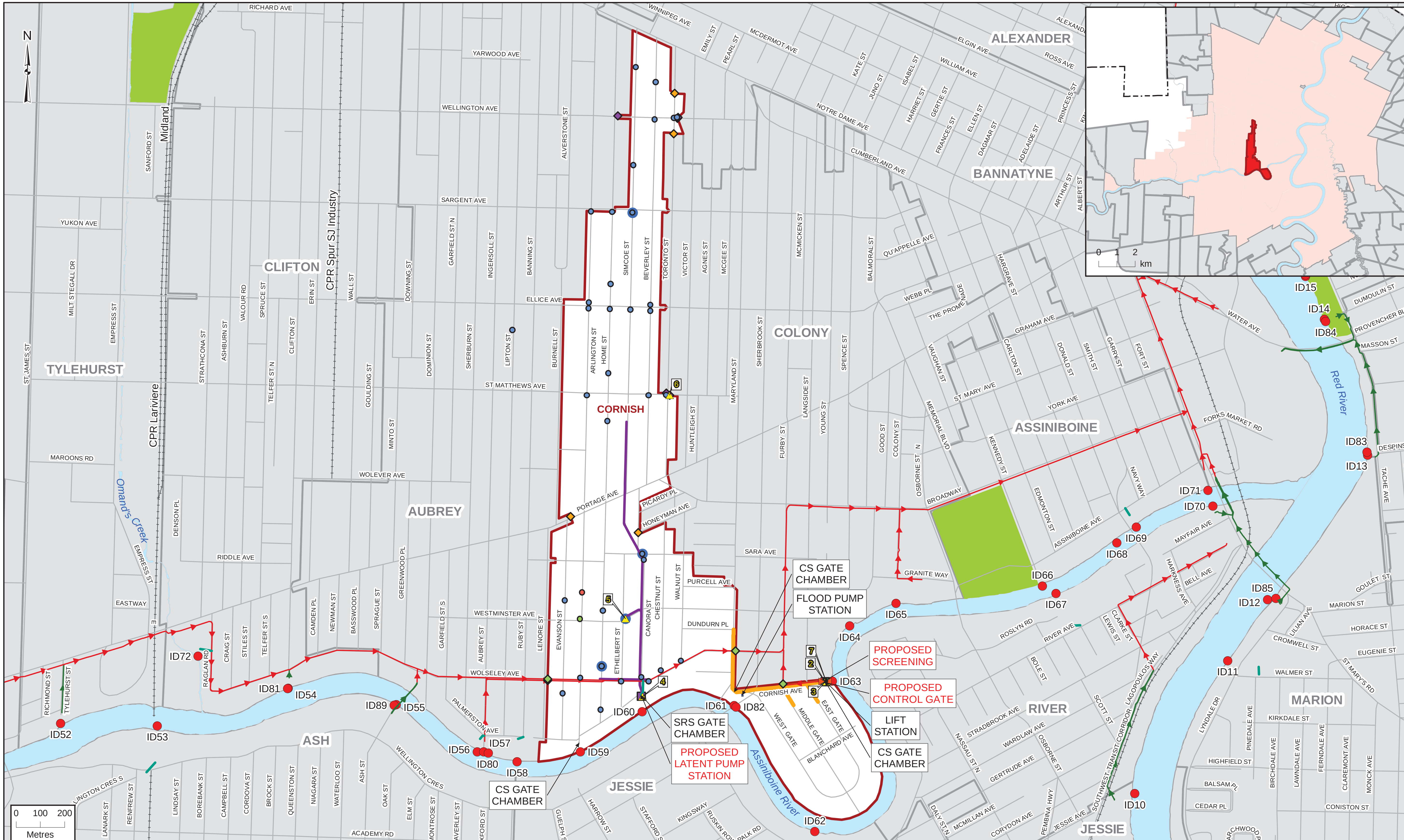
Table 1-14. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	R	R	-	-	-	-	-	-
2	Existing Lift Station	-	R	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	-	-	-	-
4	Construction Disruption	-	-	-	-	-	-	-	-
5	Implementation Schedule	-	-	-	-	-	-	R	-
6	Sewer Condition	R	R	-	-	-	-	-	-
7	Sewer Conflicts	R	R	-	-	-	-	-	-
8	Program Cost	O	O	-	-	-	-	-	O
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	R	-	-	-	-	O	O	-
12	Operations and Maintenance	R	R	-	-	-	R	O	R
13	Volume Capture Performance	O	O	-	-	-	O	O	-
14	Treatment	R	R	-	-	-	O	O	R

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

Girling, R.M. 1986. *Basement Flooding Relief Program Review – 1986.*



LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Low CS Manhole
- Low SRS Connection

Inter-System Connection
- CS - WWS
- SRS - CS
- SRS - WWS

District Boundary Crossing
- CS
- SRS
- WWS

- Interceptor Sewer
- Force Main
- Street
- Railway

- District Boundary
- Watercourse
- Greenspace

CSO MASTER PLAN PROPOSED SOLUTIONS

- Proposed Control Gate
- Proposed SRS Latent Storage Pump
- Latent Storage Limit
- Extent of In-line Storage
- Latent Force Main

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 11
District Overview Map
Sewer District: Cornish
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Manhole
- Flap Gate
- Sluice Gate
- Pump Location
- Force Main
- Sewer By Type
  - CS
  - WWS
- Control Structure Type
  - Gate Chamber
- Pump Station Type
  - Lift Station

CSO MASTER PLAN PROPOSED SOLUTIONS

- Control Gate
- Screening

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 11-01
Control Gate and Screening
Sewer District: Cornish
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- Critical Elevation
- CSO Outfall
- Manhole
- Sluice Gate

Sewer By Type
- CS
- SRS
- WWS

Control Structure Type
- Gate Chamber

Land Parcel

CSO MASTER PLAN
PROPOSED SOLUTIONS
- Proposed Latent Force Main
- Latent Pump

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 11-02
Latent SRS Control
Sewer District: Cornish
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- CSO Outfall
- Manhole
- Sluice Gate
- Pump Location

Sewer By Type
- CS

Control Structure Type
- Gate Chamber

Pump Station Type
- Flood Pump Station

- Land Parcel

CSO MASTER PLAN
PROPOSED SOLUTIONS

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 11-03
Flood Pumping Station
Sewer District: Cornish
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Despins District Plan

August 2019

City of Winnipeg

CSO Master Plan

Project No: 470010CH
Document Title: Despins District Plan
Revision: 03
Date: August 22, 2019
Client Name: City of Winnipeg
Project Manager: John Berry
Author: Scott Begg
File Name: Despins_Plan_Final_CO1MP_08182019

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Document History and Status

Revision	Date	Description	By	Review	Approved
0	10/05/2018	Version 1 DRAFT	SG	ES	
1	02/15/2019	DRAFT 2 for City Review	SB	MF	SG
2	06/2019	Final Draft Submission	DT	MF	MF
3	08/18/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

Tables

Figure

1. Despins District

1.1 District Description

Despins district is located along the eastern edge of the Red River near the centre of the combined sewer (CS) area. Hamel Avenue and Despins Street form the northern boundary, Bertrand Street and Eugenie Street form the southern boundary, and the Red River forms the western boundary. The Seine River runs along the eastern boundary.

Taché Avenue is a regional street that runs parallel to the Red River and connects Marion Street to Provencher Boulevard, providing access to the St. Boniface Hospital. Des Meurons Street also runs parallel to Taché Avenue and extends north to south along the eastern side of the district. Marion Street and Goulet Street are regional roads that run east-west through the district. The Canadian National Railway Sprague rail line passes through the northeastern section of the district.

Despins district is primarily residential with a small section of industrial and commercial land use. The industrial and commercial areas are located along Des Meurons Street and consist of general manufacturing facilities and community-based businesses. The residential land use make-up is primarily classified as two-family dwellings, but the district also includes small areas of single and multi-family.

The major non-residential areas are greenspaces which include Taché Promenade and La Verendrye Park located near the Red River. Approximately 14 ha of the district is classified as greenspace.

1.2 Development

There is limited land area available for new development within Despins district due to its location and residential land use. Due to its location close to the downtown however, there is a high potential for further densification via infill in the district. Redevelopment within this area could impact the CS system and will be investigated on a case-by-case basis for potential impacts to the combined sewer overflow (CSO) Master Plan. All developments within the CS districts are mandated to offset any peak combined sewage discharge by adding localized storage and flow restrictions, in order to comply with Clause 8 of the Environment Act Licence 3042.

1.3 Existing Sewer System

Despins district encompasses an area of 99 hectares[1] based on the district boundary and includes primarily combined sewer (CS), wastewater sewer (WWS), and land drainage sewer (LDS) systems. As shown in Figure 12, there is approximately 41 percent (41 ha) separated and 7 percent (7 ha) separation-ready areas.

The Despins sewer system includes a flood pump station (FPS), CS lift station (LS), FPS outfall, and a CS outfall gate chamber located adjacent to the Red River at Tache Avenue and Despins Street. Sewage flows collected in Despins district converge to a 1200 mm CS trunk flowing west on Despins Street and a 600 mm CS trunk sewer flowing north on Taché Avenue and drain towards the outfall. The two CS trunks meet at the intersection of Taché Avenue and Despins Street.

During dry weather flow (DWF), the Despins primary weir diverts flow through a 450 mm off-take pipe approximately 20 m south to the CS LS. The Despins CS LS pumps the flow through a 300 mm force main north along Tache Avenue across the Red River into the Bannatyne district and on to the North End Sewage Treatment Plant (NEWPCC).

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

During wet weather flow (WWF) events, any flows that exceed the diversion capacity overtop the primary weir and are discharged to the Red River via the CS outfall structure. When river levels are high and gravity flow is not possible, the FPS pumps the flow into the Red River through the FPS outfall which contains an elevated discharge box and stop log weirs. A flap and sluice gate are in place on the CS outfall to prevent river water from flowing into the CS under high river level conditions.

LDSs service the eastern industrial and residential sections of Despins district and collect surface runoff and discharge through two LDS outfalls into the Seine River.

Three independent LDS systems with outfalls collect the surface runoff and discharge to the rivers. Runoff from the northeast portion of the district flows to a 600 mm LDS outfall on Bourgeault Street and discharges to the Seine River. A 1000 mm LDS along Bertrand Street collects runoff from the eastern extents of the Despins district and discharges to the Seine River. A 525 mm LDS collects runoff from the southeastern portion of the district before crossing into Marion district and discharging to the Seine River via a 900 mm LDS outfall. Each LDS outfall includes a sluice and flap gate to prevent river water from backing up into the system.

The CS and FPS outfalls to the Red River are as follows:

- ID13 (S-MA70087426) – Despins CS Outfall
- ID83 (S-MA70087428) – Despins FPS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Despins and the surrounding districts. Interconnection are shown on Figure 12 which identifies locations where gravity and pumped flow can cross from one district to another. Each interconnection is listed as follows:

1.3.1.1 Interceptor Connections

No interceptor connections are found in this district.

1.3.1.2 District Interconnections

Bannatyne

WWS to WWS

- A 300 mm force main carries flow from the Despins CS LS across the Red River to the Bannatyne district and on to the NEWPCC for treatment. There is a pipe and a valve that connects a parallel force main from Dumoulin district, but it is kept closed and only opened for maintenance.
  - Bannatyne district east of Main Street invert – 227.52 m (S-MH70021611)

Marion

CS to CS

- Common high point sewer manholes:
  - Horace Street invert at Marion invert – 226.85 m (S-MH50002230)
  - Goulet Street and Des Meurons Street invert – 227.34 m (S-MH50002282)
- A 250 mm CS pipe from Marion flows by gravity westbound into Despins CS system at the intersection of Taché Avenue and Thomas Berry Street:
  - Tache Avenue and Thomas Berry invert – 226.50 m (S-MH50002657)
- A 375 mm SRS overflow pipe from Marion flows by gravity westbound into Despins CS system during an overflow:

- Tache Avenue and Rinella Place invert – 226.13 m (S-MH50002666)

- A 450 mm CS pipe from Marion flows by gravity eastbound into Despins CS system at the intersection of Enfield Crescent and Bertrand Street:
  - Enfield Crescent and Bertrand Street Invert – 224.56 m (S-MH50007262)
- A 1050 mm CS pipe from Despins flows by gravity westbound into Marion CS system at the intersection of Enfield Crescent and Bertrand Street:
  - Enfield Crescent and Bertrand Street Invert – 224.74 m (S-MH50002428)
- A 600 mm CS pipe from Marion flows by gravity eastbound into Despins district CS system at the intersection of Marion Street and Des Meurons Street:
  - Marion Street and Des Meurons Street Invert – 226.68 m (S-MH50002243)
- A 300 mm CS pipe from Despins flows by gravity westbound into Marion district CS system between Youville Street and Des Meurons Street:
  - Youville Street and Des Meurons Street Invert – 226.85 m (S-MH50002230)

<u>WWS to WWS</u>

- A 250 mm WWS and a 300 mm WWS flows southbound by gravity and converge at a manhole at the corner of Bertrand Street and Enfield Crescent and flow by gravity from Despins district into Marion district:
  - Bertrand Street and Enfield Crescent Invert – 223.00 m (S-MH70025546)

<u>LDS to LDS</u>

- A 300 mm LDS pipe from Marion flows eastbound by gravity into Despins on Horace Street, between Youville Street and Des Meurons Street:
  - Youville Street and Des Meurons Street Invert – 225.37 m (S-MH70007961)
- A 525 mm LDS pipe from Despins flows southbound along Youville Street by gravity into Marion district LDS system between Eugenie Street and Edgewood Street:
  - Invert at Marion district boundary – 224.34 m (S-MH70007984)

<u>LDS to CS</u>

- A 250 mm LDS short section of the LDS system extends from Marion and flows by gravity into Despins CS at Tache Avenue near the back alley of Thomas Berry Street:
  - Invert at Marion district boundary – 226.15 m (S-MH50002944)

Dumoulin

<u>CS to CS</u>

- Common high point sewer manholes:
  - Desautels Street and Des Meurons Street invert – 228.38 m (S-MH50008956)
  - Bourgeault Street and Desautels Street invert – 229.44 m (S-MH50008651)
  - Ritchot Avenue and Hamel Avenue invert – 228.85 m (S-MH50002546)
- A 750 mm by 1150 mm CS pipe from Despins CS system flows by gravity westbound on Hamel Avenue and connects to an overflow CS pipe that flows northbound on Langevin Street into the CS system in Dumoulin district:
  - Hamel Avenue and Lavgevin Street invert – 228.63 m (S-MH50002548)

- A 750 mm by 1150 mm CS pipe from Despins CS system flows westbound on Hamel Avenue and connects to an overflow CS pipe that flows northbound on St Jean Baptiste Street into the CS system in Dumoulin district:
  - Hamel Avenue and St. Jean Baptiste Street invert – 228.80 m (S-MH50002313
- A 750 mm CS pipe from the Dumoulin CS system flows by gravity southbound on De La Morenie Street and connects to the CS system in Despins district:
  - Cathedrale Street and De La Morenie Street Invert – 226.38 m (S-MH50008928)

<u>LDS to LDS</u>

- A 300 mm LDS pipe from Despins district LDS system flows by gravity northbound on Des Meurons Street and connects to the LDS system in Dumoulin district.
  - Desautels Street and Des Meurons Street invert into 375 LDS – 226.45 m (S-MH50008203)
- A 450 LDS pipe from Dumoulin district LDS system flows by gravity westbound on Desautels Street and connects to the LDS system Despins district where it flows back out into Dumoulin to be discharged into the Seine River.
  - Bourgeault Street and Desautels Street Invert (into Despins) – 225.73 m (S-MH70008209)
  - Bourgeault Street and Desautels Street Invert (into Dumoulin) – 225.70 m (S-MA70008215)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing district.

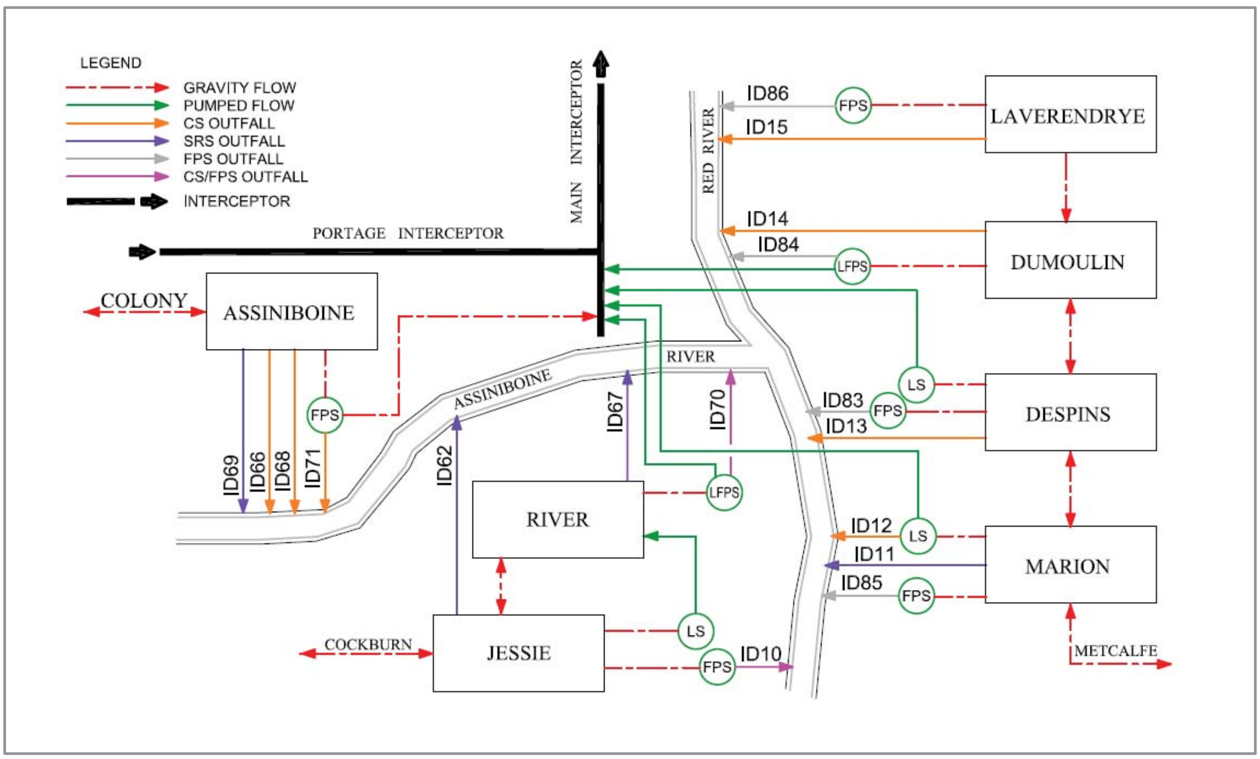


Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 12 and are listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID13)	S-MH70006397.1	S-MA70087426	1400 mm	Red River Invert: 222.51 m
Flood Pumping Station Outfall (ID83)	S-AC70008183.1	S-MA70087428	1200 mm	Red River Invert: 224.31 m
Other Overflows	N/A	N/A	N/A	
Main Trunk	N/A	S-MA70028366	1200 mm	Invert: 222.71 m
SRS Outfalls	N/A	N/A	N/A	No SRS Outfalls within the district.
SRS Interconnections	Not modelled	S-MA70026766	300 mm	Invert: 222.17 m
Main Trunk Flap Gate	S-AC70013556.1	S-CG00000784	1375 mm	Invert: 223.10 m
Main Trunk Sluice Gate	S-CG00000785.1	S-CG00000785	1375 x 1375 mm	Invert: 223.08 m
Off-Take	S-MH70010291.2	S-MA70017878	450 mm	Circular Invert: 222.72 m
Dry Well	N/A	N/A	N/A	No dry well in lift station arrangement.
Lift Station Total Capacity	N/A	N/A	0.114 m^3/s	1 x 0.062 m^3/s 1 x 0.052 m^3/s
Lift Station ADWF	N/A	N/A	0.0354 m^3/s	
Lift Station Force Main		S-MA70017878	300 mm	Invert: 225.70
Flood Pump Station Total Capacity	N/A	N/A	1.20 m^3/s	1 x 0.73 m^3/s 1 x 0.47 m^3/s
Pass Forward Flow – First Overflow	N/A	0.155 m^3/s	N/A	

Notes:

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Despins – 223.73
2	Trunk Invert at Off-Take	222.72
3	Top of Weir	223.25
4	Relief Outfall Invert at Flap Gate	N/A
5	Relief Interconnection	N/A
6	Sewer District Interconnection (Marion district boundary)	223.00
7	Low Basement (Metcalfe, Marion, Despins)	224.33
8	Flood Protection Level (Metcalfe, Marion, Despins)	229.95

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed in Despins district was the *Marion and Despins Sewer Relief Project Preliminary Design Report* (Wardrop, 2005). The Marion and Despins Combined Sewer Relief Project upgraded the capacity of the existing CS systems to alleviate basement flooding (Wardrop, 2005 The CS district relief, including the separate LDS and WWS installation, was completed between 2000 and 2003 and is aligned with the Wardrop Sewer Relief project. Note that the final draft of the report was issued in 2005 after the work was complete, but the original design report was prepared prior to the work taking place. No other relief or CSO-related sewer work has been completed since that time.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Despins Combined Sewer District was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations has a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Planned Completion
12 - Despins	2005 - Conceptual	Future Work	2013	Study Complete	N/A

1.5 Ongoing Investment Work

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall of the Despins district. This consists of monthly site visits in confined entry spaces to verify physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Despins sewer district are listed in Table 1-4. The proposed CSO control projects will include sewer separation. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	-	-	-	-	-	-	-	✓	✓	✓	-

Notes:

- = not included
✓ = included

The existing CS system was originally reviewed for in-line storage as well as floatable management as part of the system-wide Preliminary Proposal options. However, it was noted that the existing CS system is not fully suitable for in-line storage as the relative low level of the CS LS and associated CS outfall results in the modelling NSWL level being able the level of the recommended control gate level during the 1992 representative year assessment.

The existing CS system was originally reviewed for in-line storage as well as floatable management. The marginal evaluation indicated that complete separation will be similar to the in-line/screening control option. The capital costs to separate a district are higher than implementing the equivalent in-line storage and screening. Consideration of the operation and maintenance (O&M) costs however showed that the reduction of the pass forward flow to the downstream interceptor sewer from complete sewer separation would reduce the reliance on the Despins FPS, possibly removing its operation altogether. In addition, the more detailed analysis indicated the Despins CS outfall would not generate the hydraulic head conditions necessary for screen operation. Overflows from the district would still occur with implementation of in-line storage, making this district at risk of not having appropriate floatables management provisions in place. Therefore, the recommendation of complete separation would provide the added benefit of removing the requirement for screening at this outfall location. The additional operations and maintenance costs required with the in-line and screening implementation were also taken into consideration, and this associated O&M cost confirmed the selection of complete sewer separation for this district. Complete separation was recommended as it was found to be the most cost-effective solution from a life cycle cost perspective.

GI and RTC will be applied within each district on a system wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Sewer Separation

The sewer separation project for Despins will provide immediate benefits to the CSO program when complete. The proposed work may include installation of a new LDS trunk sewer along Despins Street as well as new LDS collector sewers along Dollard Boulevard. Current LDS systems will be extended to collect road drainage along Hamel Avenue and Bertrand Street. Collected stormwater runoff will be routed to the new LDS trunk sewer on Despins Street and from there will flow through a new LDS outfall parallel to the CS outfall at the Red River. The approximate area of sewer separation for Despins district is shown on Figure 12.

The flows to be collected after Despins separation will be as follows:

- Dry weather flows will remain the same for Despins district.
- Despins weather flow (WWF) will consist of sanitary sewage combined with foundation drainage.

This will result in a significant reduction in combined sewage flow received at Despins CS LS after the separation project is complete. The separation project will provide a full reduction of overflows for the 1992 representative year.

In addition to reducing the CSO volume, the benefits of Despins sewer separation include a reduction of pumped flows entering the downstream interceptor sewer, as well as reducing the amount of flood pumping required at the Despins FPS.

It is proposed that future flow monitoring of the district be completed to verify that the sewer separation is fully compliant with the modelled simulated elimination of all CSO overflows. A static weir elevation increase may be necessary at the CS diversion to eliminate the occurrence of all CSOs. Any weir elevation raise will also be evaluated in terms of existing basement flood protection to ensure the existing level of basement flood protection remains.

1.6.3 Green Infrastructure

The approach to green infrastructure (GI) is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district will be reviewed to identify applicable GI controls.

Despins has been classified as a medium GI potential district. Land use in Despins is primarily residential with a small section of industrial and commercial land uses. This district would be an ideal location for cisterns/rain barrels, and rain garden bioretention within the residential areas. There are a few commercial areas which may be suitable to green roofs and parking lot areas which would be ideal for paved porous pavement.

1.6.4 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

Sewer separation will include the installation of additional sewers that will require inspection, cleaning and rehabilitation. This will result in additional maintenance costs over the long term, but operational costs will be minimal. The existing larger CS pipes within the district may also receive insufficient flow with the separation work for proper scouring velocities in the sewer pipes. This could result in solids settling within the sewers and require more frequent cleaning operations. The impacts of the reduced flows in larger CS pipes will be evaluated as part of the sewer separation design for the district. There will also be a future reduction on FPS operational requirements, as the overflows in the district will be greatly reduced.

The reduction in storm flows entering the CS LS will reduce the requirement for operation of the flood pump within the FPS. It is recommended to continue to maintain and operate the flow monitoring instrumentation and assess the results after district separation work has been completed. This will allow the full understanding of the non-separated storm elements (foundation drain connections to the CS system) extent within the Despins district.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. Two versions of the sewer system model were created and used to measure system performance. The 2013 Baseline model represents the sewer system baseline in the year 2013 and the 2037 Master Plan – Control Option 1 model, which includes the proposed control options in the year 2037. A summary of relevant model data is provided in Table 1-5.

Table 1-5. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	96	96	3,621	62	N/A
2037 Master Plan – Control Option 1	96	39	3,621	16	SEP

Table 1-5. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model

Notes:

SEP = Separation

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district. While this district is to be separated and as a result Clause 8 of Licence No. 3042 will not be in effect, the wet weather response of the district overall will still need to be assessed.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-6 are for the hydraulic model simulations using the year-round 1992 representative year. The table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. The table also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-6. District Performance Summary – Control Option 1

Control Option	Preliminary Proposal	Master Plan			
	Annual Overflow Volume (m^3)	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow
Baseline (2013)	30,553	43,955	0	20	0.155 m^3/s [b]
In-Line Storage	30,545	N/A [c]	N/A	N/A	N/A
Separation	N/A [a]	0	43,955	0	0.113 m^3/s [d]
Control Option 1	**30,545**	**0**	**43,955**	**0**	**0.113 m^3/s [d]**

[a] Separation was not simulated during the Preliminary Proposal assessment.

[b] Pass forward flows assessed with the 1-year design rainfall event

[c] In-Line Storage was not simulated as sewer separation proposed for the Master Plan assessment

[d] Pass forward flows assessed with the 5-year design rainfall event.

The percent capture performance measure is not included in Table 1-6, as it is applicable to the entire CS system and not for each district individually. However, the elimination of the district overflows from complete sewer separation represents the 100 percent capture target at this district.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-7. The cost estimates are Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-7. District Cost Estimate – Control Option 1

<table>
<tr><th>Control Option</th><th>2014
Preliminary Proposal
Capital Cost</th><th>2019
CSO Master Plan
Capital Cost</th><th>2019
Annual Operations and Maintenance Cost</th><th>2019
Total Operations and Maintenance
(Over 35-year period)</th></tr>
<tr><td>In-line Storage</td><td rowspan="2">- [a]</td><td>N/A [c]</td><td>N/A [c]</td><td>N/A [c]</td></tr>
<tr><td>Screening</td><td>N/A [c]</td><td>N/A [c]</td><td>N/A [c]</td></tr>
<tr><td>Separation</td><td>N/A [b]</td><td>$39,980,000</td><td>$24,000</td><td>$510,000</td></tr>
<tr><td>Subtotal</td><td>$0</td><td>$39,980,000</td><td>$24,000</td><td>$510,000</td></tr>
<tr><td>Opportunities</td><td>N/A</td><td>$4,000,000</td><td>$2,000</td><td>$50,000</td></tr>
<tr><td>District Total</td><td>$0 [a]</td><td>$43,980,000</td><td>$26,000</td><td>$560,000</td></tr>
</table>

[a] In-line storage and Screening not costs in initial Preliminary Proposal costs. Solution developed as refinement to Preliminary Proposal work following submission of Preliminary Proposal costs. Costs for these items of work found to be $1,810,000 in 2014 dollars.

[b] Sewer separation not assessed in this district for the Preliminary Proposal

[c] In-line storage and screening not recommended as part of Master Plan assessment, in favour of complete separation.

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculation of the cost estimate for the CSO Master Plan includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional cost for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014-dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019-dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of alternative plans for the entire system, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-8.

Table 1-8. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Separation	Separation was not included in the Preliminary Proposal.	The Master plan identified sewer separation as the control option.
	Removal of In-Line Storage	In-Line Storage was not included in the Master Plan.	The Master plan identified sewer separation as the most

Table 1-8. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
			cost effective control option over in-line storage.
	Removal of Screening	Screening was not included in the Master Plan.	With sewer separation recommended all CSO events will be removed, and there will no longer be a requirement for screening.
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation	Preliminary estimates were based on 2014-dollar values	

1.10 Meeting Future Performance Targets

The proposed complete separation of the Despins district will achieve the 100 percent capture figure and no further work will be required to meet the future performance target.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-9.

Table 1-9. Control Option 1 Significant Risks and Opportunities

ID Number	Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	-	-	-	O	-	-	-
2	Existing Lift Station	-	-	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	O	-	-	-
4	Construction Disruption	-	-	-	-	R	-	-	-
5	Implementation Schedule	-	-	-	-	R	-	R	-
6	Sewer Condition	-	-	-	-	-	-	-	-

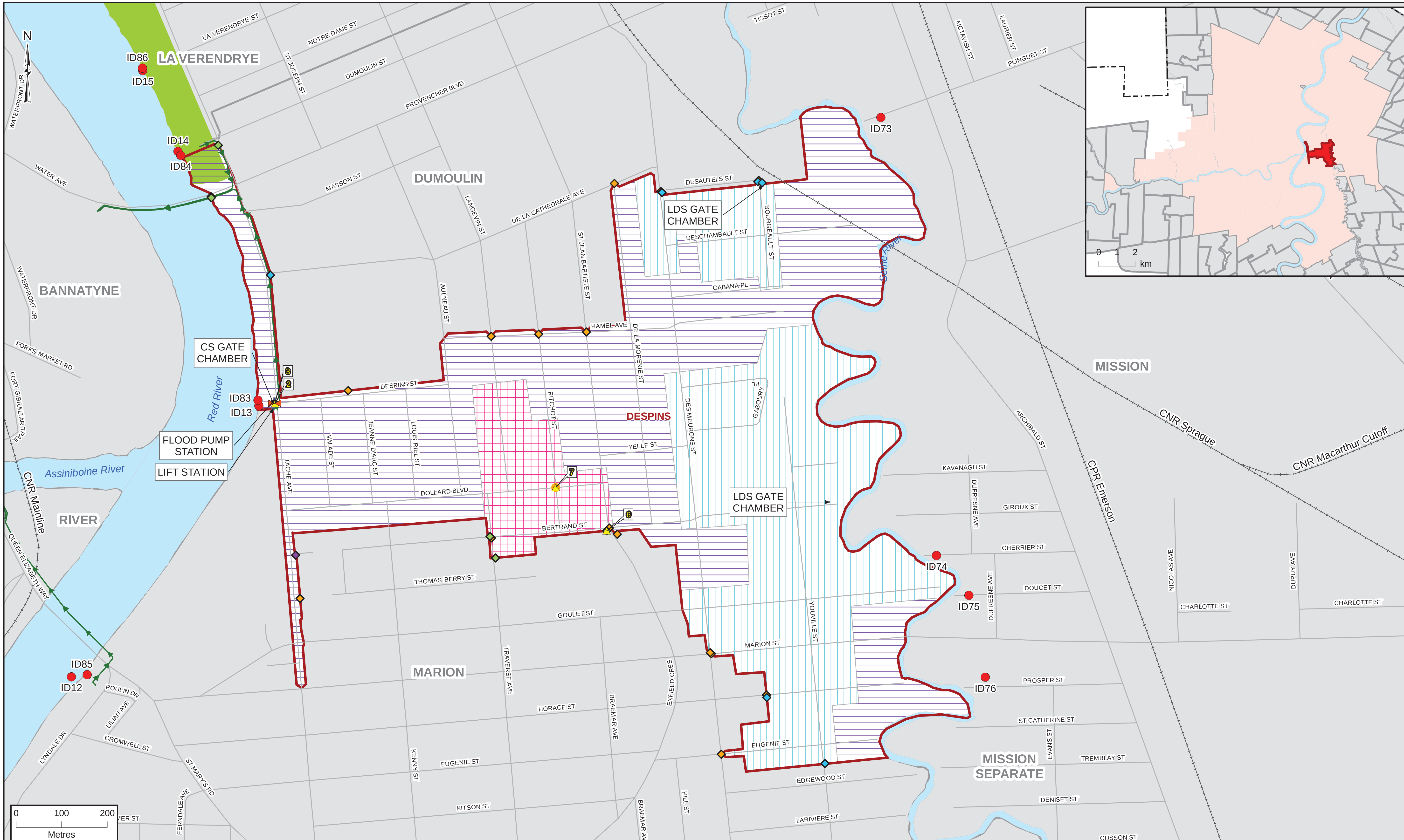
Table 1-9. Control Option 1 Significant Risks and Opportunities

ID Number	Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
7	Sewer Conflicts	-	-	-	-	R	-	-	-
8	Program Cost	-	-	-	-	R	-	-	-
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	-	-	-	-	O	O	O	-
12	Operations and Maintenance	-	-	-	-	R / O	R	O	-
13	Volume Capture Performance	-	-	-	-	-	O	O	-
14	Treatment	-	-	-	-	O	O	O	-

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

Wardrop. 2005. *Marion and Despins Sewer Relief Project Preliminary Design Report*. Prepared for the City of Winnipeg Water and Waste Department. February.



LEGEND

- Primary Weir
- Critical Elevation
- Decommissioned Outfall
- CSO Outfall
- Low CS Manhole

Inter-System Connection
- CS - WWS

District Boundary Crossing
- CS
- LDS
- SRS
- WWS

- Force Main
- Street
- Railway
- District Boundary
- Watercourse

CSO MASTER PLAN PROPOSED SOLUTIONS

- Sewer Separation - Planning
- Sewer Separation - Complete
- Sewer Separation - Ready

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 12
District Overview Map
Sewer District: Despins
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Doncaster District Plan

August 2019

City of Winnipeg

JACOBS

CSO Master Plan

Project No: 470010CH
Document Title: Doncaster District Plan
Revision: 03
Date: August 16, 2019
Client Name: City of Winnipeg
Project Manager: John Berry
Author: Scott Begg
File Name: Doncaster_Plan_Final_CO1MP_08152019

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Document History and Status

Revision	Date	Description	By	Review	Approved
0	08/2018	Version 1 DRAFT	SG	ES	
1	02/15/2019	DRAFT 2 for City Review	SB	MF	SG
2	05/2019	Final Draft Submission	DT	MF	MF
3	08/16/2019	Final Submission For CSO Master Plan	MF	MF	MF

Contents

Tables

Figure

1. Doncaster District

1.1 District Description

Doncaster district is located towards the southwestern limit of the combined sewer (CS) area. The district stretches from the Canadian National Railway main line north to the Assiniboine River. The eastern boundary consists of Centennial Street, Kenaston Boulevard, and Doncaster Street, and the western boundary follows Edgeland Boulevard and Morpeth Boulevard. Doncaster is surrounded by Ash to the east; Area 3.4 and Area 3.1 to the south; and Tuxedo, Area 3, and Area 1 to the west. Doncaster district contains numerous major transportation routes that pass through the district. They consist of Kenaston Boulevard, Tuxedo Avenue, Grant Avenue, and Corydon Avenue.

Land use in Doncaster is balanced between residential and commercial with the majority being occupied by residential. Most single-family residential homes are located in the northern and eastern section of the district. A mix of single and multi-family properties are located along Kenaston Boulevard. The commercial businesses are located along the major transportation routes. A large section of Doncaster is taken up by the Kapyong Barracks, which is currently unused but will be redeveloped in the future.

Major non-residential properties include the Real Canadian Superstore on the corner of Grant Avenue and Kenaston Boulevard, Joe Malone Park, and Kapyong Barracks on Kenaston Boulevard. Approximately 2 ha of the district is classified as greenspace.

1.2 Development

A Route 90 Improvement Study is currently underway that will lead to a significant amount of construction and right of way adjustments along Route 90/Kenaston Boulevard. This work, which will impact both the Doncaster and Ash districts, could impact the Combined Sewer Overflow (CSO) Master Plan.

One area within the Doncaster CS district has also been identified as a Major Redevelopment Site with OurWinnipeg, the former Kapyong Barracks. This site includes the lands primarily west of Kenaston Boulevard, from Taylor Avenue to Grenadier Drive. This Major Redevelopment Site is considered underused and will be prioritized to be developed into a higher density, mixed-use community.

1.3 Existing Sewer System

Doncaster district encompasses an area of 152 ha[1] based on the district boundary GIS information and includes combined sewer (CS), wastewater sewers (WWS), and land drainage sewer (LDS) systems. As shown in Figure 13, there is approximately 1 percent (2 ha) already separated and 8 percent (12 ha) of the district by area is separation ready.

The Doncaster CS system includes a CS outfall gate chamber discharging to the Assiniboine River at the northern end of Doncaster Street. The CS system collects sewage from the district and transports it northward along the main 2100 mm sewer trunk on Doncaster Street towards the CS outfall. The trunk decreases in size to 450 mm on the western edge of Doncaster Street and connects with the interceptor pipe that carries sewage from Tuxedo district.

A small number of land drainage sewers (LDS) exist in the south part of the district. The district includes an LDS system at the southern boundary which flows south through a 750 mm pipe beneath the

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[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.
The discrepancy between the area attributed to the Doncaster district between the GIS district boundary (152 ha) and InfoWorks model (118 ha) is due to the multiple bifurcations between the Doncaster and Ash districts changing the allocation of subcatchments, large permeable areas not included as model subcatchments and the missing area that is not covered by the GIS boundary. The City is currently reviewing the district boundaries.

Kenaston Boulevard underpass, and ties into the separate sewer districts south of Doncaster. In the future district boundary for Doncaster may be revised to exclude this section of LDS, as it is no longer associated with the CS system.

During dry weather flow (DWF), the primary weir diverts the wastewater southbound through a 2250 mm pipe and into the CS system of Ash district, where it is conveyed to the Ash sewage LS and sent across the Assiniboine River via river crossing, and ultimately to the North End Sewage Treatment Plant (NEWPCC) for treatment.

The district does not have a flood pump station (FPS) or a lift station (LS). During wet weather flow (WWF), any flow that exceeds the diversion capacity overtops the primary weir and is discharged to the Assiniboine river via the Doncaster CS outfall. Sluice and flap gates are installed on the Doncaster CS outfall to prevent back-up of the river into the CS system under high river levels along the Assiniboine River. When the Assiniboine River levels are high during WWF events however, no gravity discharge is possible due to the flap gate installed on the CS outfall. Under these high river level conditions, the excess flow assumes regular flow, diverting into the CS system of Ash district.

The single CS outfall to the Assiniboine River is as follows:

- ID48 (S-MA70019277) – Doncaster CS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Doncaster and the surrounding districts. Each interconnection is shown in Figure 13 and shows gravity and pumped flow from one district to another. Each interconnection is listed as follows:

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

Ash

– A 750 mm CS pipe during a surge flows by gravity southbound on Doncaster Street and connects into the CS system in Ash:
    - o Willow Avenue and Doncaster Street invert = 226.37 m (S-MH60006151)

1.3.1.2 Interceptor Connections – Upstream of Primary Weir

Tuxedo

– A 150 mm force main from the Tuxedo CS lift and flood pumping station (CS LFPS) pumps CS into the Doncaster interceptor sewer along Wellington Crescent. This CS is then intercepted along with the CS in the Doncaster district by the primary weir for the Doncaster district, and flows by gravity to the Ash district.
    - o Wellington Crescent and Doncaster boundary interceptor invert - 228.57 m (S-CO70008693)

1.3.1.3 District Interconnections

Ash

<u>CS to CS</u>

- Common high point CS manhole:

– Kenaston Boulevard and Corydon Avenue = 227.70 m (S-MH60006019)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing district.

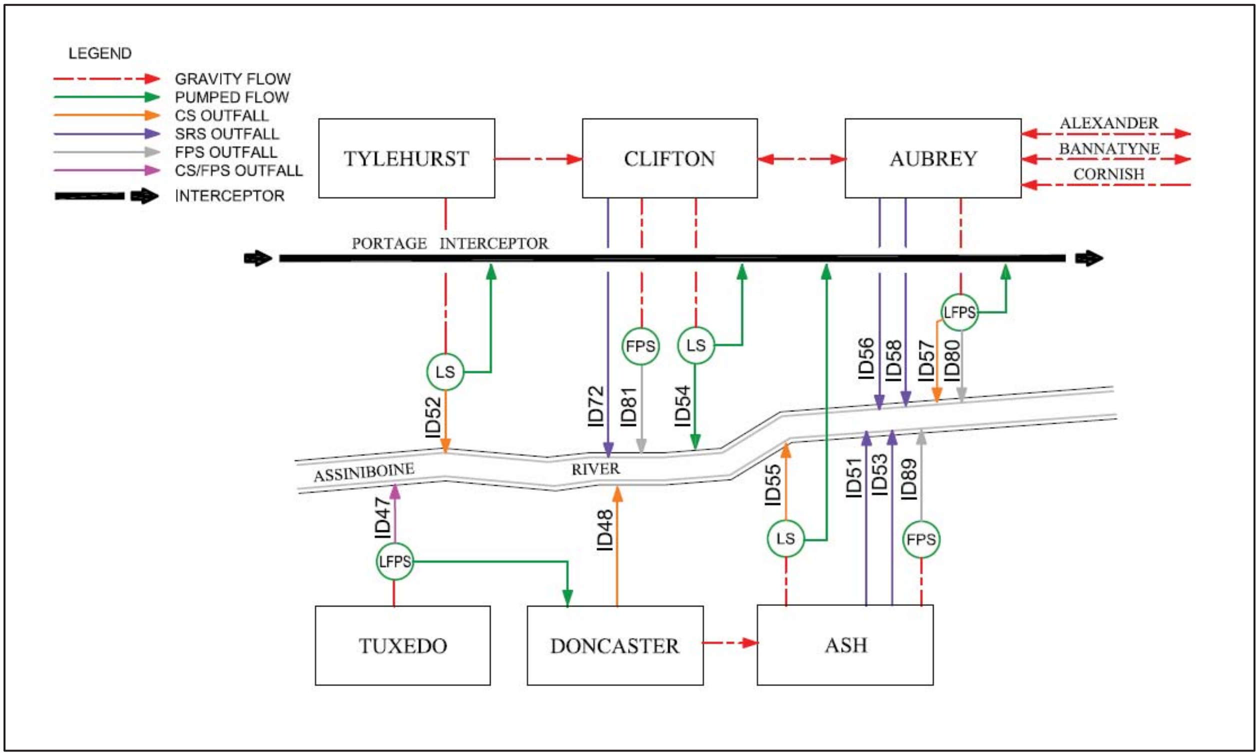

Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 13 and are listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID48)	S-AC70016534.1	S-MA70019277	1810 mm	Assiniboine River Invert: 225.22 m
Flood Pumping Outfall	N/A	N/A	N/A	No flood pumping station in this district.
Other Overflows	N/A	N/A	N/A	No flood pumping station in this district.
Main Trunk	S-TE60002661.2	S-MA60007598	2250 mm	Invert: 226.48 m
SRS Outfalls	N/A	N/A	N/A	No SRS system in this district.
SRS Interconnections	N/A	N/A	N/A	No SRS system in this district.
Main Trunk Flap Gate	DONCASTER_GC2.1	S-CG00000686	2250 mm	Invert: 226.76 m
Main Trunk Sluice Gate	DONCASTER_GC1.1	S-CG00000685	2250 x 2250 mm	Invert: 226.76 m
Off-Take	S-MH60006151.1	S-MA60007599	750 mm	Invert: 226.37 m
Dry Well	N/A	N/A	N/A	Diversion structure, no lift station as part of outfall in this district.
Lift Station Total Capacity	N/A	S-MA60007599 (1)	750mm (1)	0.355 m^3/s (1)
Lift Station ADWF	N/A	N/A	0.013 m^3/s	District ADWF (not considering Tuxedo ADWF)

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Lift Station Force Main	N/A	N/A	N/A	Diversion structure, no lift station force main as part of outfall in this district.
Flood Pump Station Total Capacity	N/A	N/A	N/A	No flood pumping station in this district
Pass Forward Flow – First Overflow	N/A	N/A	0.106 m^3/s	

Notes:

(1) – Gravity pipe replacing Lift Station as Doncaster is a gravity discharge district

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

Doncaster does not use an SRS system; therefore, an SRS outfall and interconnections to the combined sewers are not available.

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Doncaster – 224.51
2	Trunk Invert at Off-Take	226.48
3	Top of Weir	227.25
4	Relief Outfall Invert	N/A
5	Relief Interconnection	N/A
6	Sewer District Interconnection (Willow Avenue and Doncaster Street)	Invert at district boundary = 226.37
7	Low Basement	230.67
8	Flood Protection Level	230.60

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed in Doncaster was the 1986 Basement Flooding Relief Program Review (Girling, 1986). No other work has been completed on the district since that time.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Doncaster Combined Sewer District was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations has a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Expected Completion
13 – Doncaster	1986	Future Work Following Separation	2013	Study Complete	N/A

1.5 Ongoing Investment Work

Proposed investment work is being considered for Kenaston Boulevard/Route 90, which will occur in both Doncaster and Ash with more of the work taking place in Doncaster. This major route runs through the central and eastern sections of Doncaster and, therefore, will affect the sewer systems in this district. The existing combined sewers will be evaluated for separation potential as part of the Route 90 Widening Project. Opportunistic separation will be incorporated where there is benefit. The separation costs may be reduced if separation work is planned as part of road reconstruction.

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Doncaster district. This consists of monthly site visits in confined entry spaces to verify physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Doncaster sewer district are listed in Table 1-4. The proposed CSO control projects will be primarily complete sewer separation of the district. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	-	-	-	-	-	-	-	✓	✓	✓	-

Notes:

- = not included
✓ = included

The marginal evaluation completed during the CSO Master Plan development indicated that complete separation will be similar to the in-line/screening control option in life cycle costs. In-line storage in combination with screening was originally recommended for the Doncaster district as part of the Preliminary Proposal. Operations and maintenance (O&M) costs required with the in-line / screening option are also taken into consideration, and this associated O&M cost results in the selection of full separation as the most preferable in this district. The redevelopment of the vacant Kapyong barracks may also provide the opportunity to fully separate these areas as part of the Doncaster district, which would be beneficial to the district as well as the downstream Ash district.

GI and RTC will be applied within each district on a system wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Sewer Separation

The sewer separation project for the Doncaster district will provide immediate benefits to the CSO program when complete. The work proposed includes installation of a new LDS trunk and collector sewers within the district. The existing CS trunks along Kenaston Boulevard will be separated into distinct storm and sanitary sewer systems, which will allow for sanitary sewage that contains untreated domestic, industrial, and commercial wastes to be separated from the storm runoff. A 2400 mm SRS outfall is currently in place off Wellington Crescent in the Ash district, which would allow for the addition of a new LDS or SRS system and a connection to the existing SRS system. The storm runoff could then be discharged into the Assiniboine River during high rainfall events. The existing combined sewers would be retained for use as separate WWS to convey sanitary sewage through the Ash sewer system to the appropriate treatment plant. The drawbacks of sewer separation are the high cost and the wide-spread disruption to the neighbouring residential homes, but the control option would address the majority of the CSO issues.

The approximate area of sewer separation is shown on Figure 13.

The flows to be collected after Doncaster separation are proposed to be as follows:

- Dry weather flows will remain the same for the Doncaster district with all DWF being diverted to the Ash CS system through the sewer trunk along Willow Avenue. To reach the desired interceptor pipe, the flow passes through Ash district to the Ash CS LS and into Aubrey district. From there, it is taken to the NEWPCC for treatment.
- Doncaster WWF will consist of sanitary sewage combined with foundation drainage.

Sewer separation will provide the near complete removal of overflows for the 1992 representative year. In addition to reducing the CSO volume, the benefits of Doncaster separation include a reduction of flows entering both the immediate downstream Ash district as well as reducing the amount of flood pumping required at the Ash FPS. A static weir elevation increase may be necessary at the CS diversion structure for Doncaster to eliminate the occurrence of a CSO as the hydraulic model shows one CSO occurring following complete separation under the 1992 representative year. An increase of 250 mm is predicted to be required, this does not impact upstream hydraulic grade due to the removal of WWF from the separation projects. This will be verified from on site flow monitoring within the district after the separation has been completed.

1.6.3 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district will be reviewed to identify applicable GI controls.

Doncaster has been classified as a high GI potential district. Land use in Doncaster is mainly residential with a small amount of commercial, the north end of the district is bounded by the Assiniboine River. This district would be an ideal location for cisterns/rain barrels, and rain garden bioretention. There are a few commercial areas which may be suitable to green roofs and parking lot areas which would be ideal for paved porous pavement.

1.6.4 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

Sewer separation will include the installation of additional sewers that will require inspection, cleaning and rehabilitation. This will result in additional maintenance costs over the long term, but operational costs will be minimal. The existing larger CS pipes within the district may also receive insufficient flow with the separation work for proper scouring velocities in the sewer pipes. This could result in solids settling within the sewers, requiring more frequent cleaning operations. The impacts of the reduced flows in larger CS pipes will be evaluated as part of the sewer separation design for the district.

The reduction in storm flows entering the downstream Ash FPS will reduce the requirements and frequency of operation of the flood pump. It is recommended to continue to maintain and operate the flow monitoring instrumentation and assess the results after district separation work has been completed. This will allow the full understanding of the non-separated storm elements (i.e. foundation drains) extent within the Doncaster district, and any static weir raises required.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. Two versions of the sewer system model were created and used to measure system performance. The 2013 Baseline model represents the sewer system baseline in the year 2013 and the 2037 Master Plan – Control Option 1 model, which includes the proposed control options in the year 2037. A summary of relevant model data is provided in Table 1-5.

Table 1-5. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	118	116	2,678	32	-
2037 Master Plan – Control Option 1	118	93	2,678	10	SEP

Notes:

SEP = Separation

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district. While this district is to be separated and as a result Clause 8 of Licence No. 3042 will not be in effect, the wet weather response of the district will still need to be assessed and corrected.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

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The performance results listed in Table 1-6 are for the hydraulic model simulations using the year-round 1992 representative year. The table lists the results for the Baseline, for each individual control option and

for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. The table also includes overflow volumes specific to each individual control option when simulations were completed; these are listed to provide an indication of benefit gained only and are independent volume reductions unless noted otherwise.

Table 1-6. District Performance Summary – Control Option 1

	Preliminary Proposal	Master Plan			
Control Option	**Annual Overflow Volume (m^3)**	**Annual Overflow Volume (m^3)**	**Overflow Reduction (m^3)**	**Number of Overflows**	**Pass Forward Flow at First Overflow**
Baseline (2013)	30,171	30,644	-	18	0.021 m^3/s [b]
In-Line	30,180	N/A	-	N/A	N/A
Separation	N/A [a]	0	30,644	0	0.126 m3/s [c]
Control Option 1	**30,180**	**0**	**30,644**	**0**	**0.126 m3/s [c]**

[a] Separation was not simulated during the Preliminary Proposal assessment

[b] Pass forward flows assessed with the 1-year design rainfall event

[c] Pass forward flows assessed with the 5-year design rainfall event

The revised CSO Master Plan control option to separate the Doncaster district has been based on the more focused district assessment as opposed to the previous Preliminary Proposal network performance assessment. In addition, several improvements to the overflow performance at the downstream Ash district was part of the overall selection process, but is not included as part of Table 1-6.

The percent capture performance measure is not included in Table 1-6, as it is applicable to the entire CS system and not for each district individually. However, the elimination of the district overflows represents the 100 percent capture at this district.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option recommended, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-7. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-7. District Cost Estimate – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period)
Sewer Separation	N/A [a]	$49,890,000	$30,000	$640,000
In-Line Storage	$- [b]	N/A	N/A	N/A
Screening		N/A	N/A	N/A
Subtotal	**$0**	**$49,890,000**	**$30,000**	**$640,000**
Opportunities	N/A	$4,990,000	$3,000	$60,000

Table 1-7. District Cost Estimate – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period)
District Total	**$0**	**$54,880,000**	**$33,000**	**$700,000**

[a] Sewer separation not assessed in this district for the Preliminary Proposal
[b] Solution developed as refinement to Preliminary Proposal work following submission of Preliminary Proposal costs. Costs for these items of work found to be $1,710,000 in 2014 dollars.

The estimates include changes to the control option selection since the Preliminary Proposal, and updated construction costs. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional cost for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014 dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019 dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019. Each of these values include equipment replacement and O&M costs.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-8.

Table 1-8. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Separation	The Master plan identified sewer separation as the control option.	
	Removal Of In-Line Storage	Not included in the Master Plan Control Options	Removed during marginal analysis process in Master Plan development.
	Removal Of Screening	Not included in the Master Plan Control Options	Removed during marginal analysis process in Master Plan development.
Opportunities	A fixed allowance of 10 percent has been included for program opportunities.	Preliminary Proposal estimate did not include a cost for GI opportunities.	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management approach.	

Table 1-8. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation.	Preliminary Proposal estimates were based on 2014-dollar values.	

1.10 Meeting Future Performance Targets

The proposed complete separation of the Doncaster district will achieve the 100 percent capture figure and no further work will be required to meet the future performance target.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-9.

Table 1-9. Control Option 1 Significant Risks and Opportunities

ID Number	Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	-	-	-	O	-	-	-
2	Existing Lift Station	-	-	-	-	-	-	-	-
3	Flood Pumping Station	-	-	-	-	O	-	-	-
4	Construction Disruption	-	-	-	-	R	-	-	-
5	Implementation Schedule	-	-	-	-	R	-	R	-
6	Sewer Condition	-	-	-	-	-	-	-	-
7	Sewer Conflicts	-	-	-	-	R	-	-	-
8	Program Cost	-	-	-	-	R	-	-	-
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	-	-	-	-	O	O	O	-
12	Operations and Maintenance	-	-	-	-	R / O	R	O	-

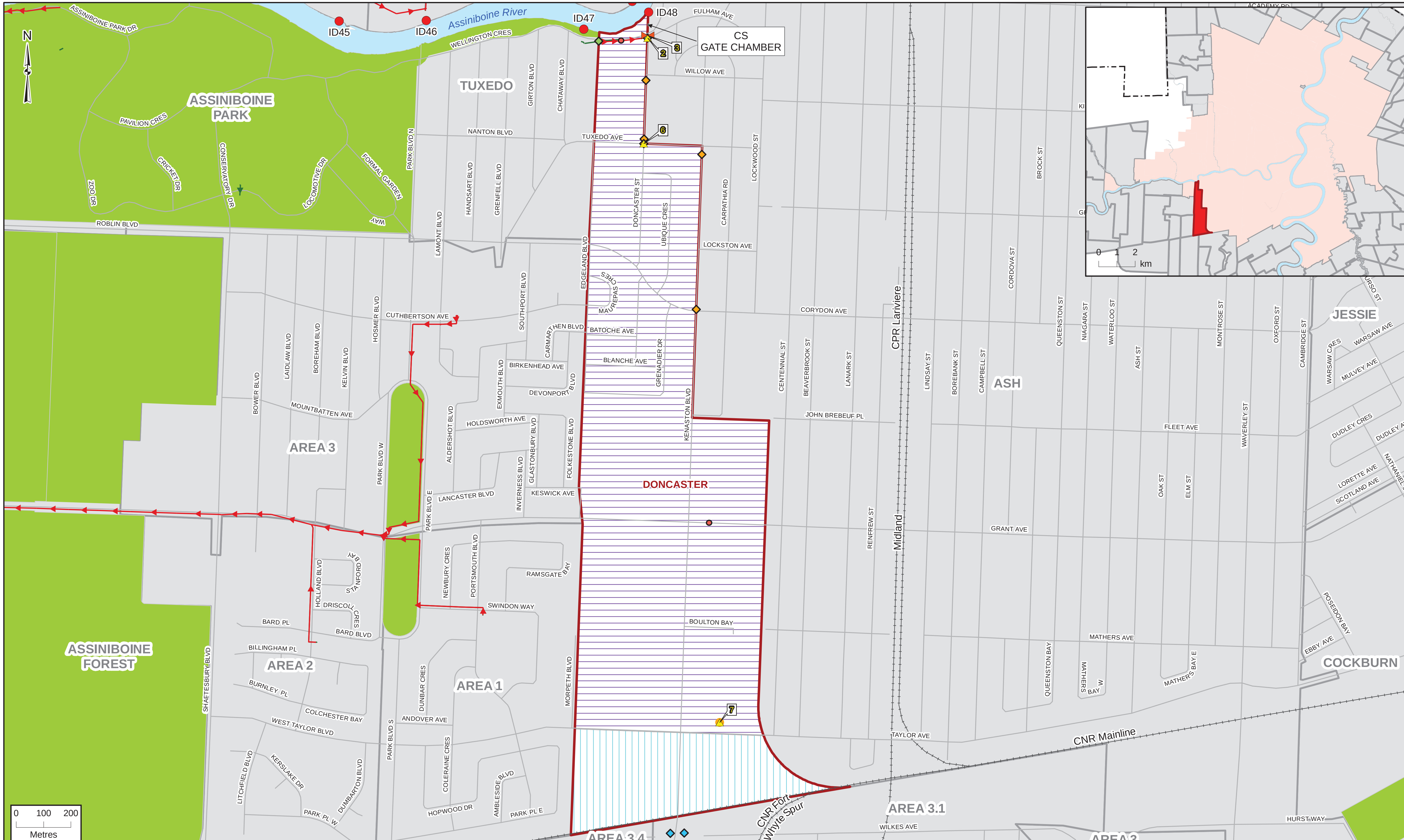
Table 1-9. Control Option 1 Significant Risks and Opportunities

ID Number	Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
13	Volume Capture Performance	-	-	-	-	-	O	O	-
14	Treatment	-	-	-	-	O	O	O	-

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

Girling, R.M. & Sharp, E.J. 1986. *Basement Flooding Relief Program Review.* Prepared for City of Winnipeg.



LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Low CS Manhole
- Inter-System Connection: CS - WWS
- District Boundary Crossing: CS, LDS, WWS
- Interceptor Sewer
- Force Main
- Street
- Railway
- District Boundary
- Watercourse
- Greenspace

CSO MASTER PLAN PROPOSED SOLUTIONS

- Sewer Separation - Planning
- Sewer Separation - Complete

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 13
District Overview Map
Sewer District: Doncaster
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Douglas Park District Plan

August 2019

City of Winnipeg

JACOBS

CSO Master Plan

Project No:	470010CH
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Document History and Status

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0	08/2018	Version 1 DRAFT	SG	ES	
1	02/2019	DRAFT 2 for City Review	MF	SG	MF
2	08/2019	Final Draft Submission	DT	MF	MF
3	08/16/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

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Figure

1. Douglas Park District

1.1 District Description

Douglas Park is a small district located on the western edge of the north end treatment area of the combined sewer (CS) area. It is bounded by Ferry Road district to the north and east, Moorgate district to the west, and the Assiniboine River to the south. Portage Avenue forms the northern border, Deer Lodge Place forms the western border, and Library Place forms the eastern border.

Douglas Park district land use is classified primarily as residential and parks, with a commercial area located on Portage Avenue. The residential homes are classified mostly as single-family homes. Bruce Park is a green space located in the centre of the district. Truro Creek runs through Bruce Park to the Assiniboine River.

Portage Avenue is the only regional transportation route that passes through Douglas Park along the northern border running parallel to the Assiniboine River.

1.2 Development

A portion of Portage Avenue is located within the Douglas Park District. Portage Avenue is identified as Regional Mixed-Use Corridor as part of the OurWinnipeg future development plans. As such, focused intensification along Portage Avenue is to be promoted in the future.

1.3 Existing Sewer System

Douglas Park encompasses an area of 23 hectares (ha)[1] and consists of a CS system with one outfall located on the southern end of Douglas Park Road. The combined sewage is collected from three residential blocks including Douglas Park Road to Deer Lodge Place and flows to the 300 millimetre (mm) interceptor pipe that connects to the Douglas Park CS outfall. The western section of Douglas Park district flows beneath the Truro Creek using a 300-mm siphon. The area west of Bruce Park has undergone sewer separation with a separate land drainage sewer (LDS) to collect the overland runoff and the decommissioning of the Douglas Park secondary outfall.

During dry weather flow (DWF), combined sewage is diverted by the primary weir, through a 375 mm interceptor pipe that flows west to tie into the Ferry Road CS system. The intercepted CS from the Douglas Park district is then intercepted once more within the Ferry Road district, where it enters the Ferry Road LS. The CS is then pumped into the Portage Interceptor, and flows by gravity to the North End Sewage Treatment Plant (NEWPCC).

During wet weather flow (WWF) events, high flow in the system may cause the level in the trunk sewer to increase above the primary weir and overflow by gravity to the Assiniboine River via the Douglas Park CS outfall. This CS outfall consists of a sluice gate that may be closed during high river conditions to prevent backflow from the river entering the system. There is no flap gate at this outfall; thus, the response to high river conditions is not immediate and requires response and monitoring from the collections system operators for the district. There is also no flood station at this location; however, in the case where high river levels are predicted and overflow operation will be prevented by the positive gate during a WWF event, temporary flood pumping can be put in place.

The two CS outfalls to the Assiniboine River are as follows:

- ID44 (S-MA70028291) – Deer Lodge CS Outfall - Decommissioned

[1] City of Winnipeg GIS information relied upon for area statistics, The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

- ID45 (S-MA20008519) – Douglas Park CS Outfall

1.3.1 District-to-District Interconnections

There is one district-to-district interconnection between the Douglas Park and Ferry Road districts. This interconnection is shown on Figure 14 and shows the location where gravity flow crosses from one district to another Each interconnection is listed in the following subsections.

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

Ferry Road

- Diverted wastewater sewage crosses into Ferry Road district from Douglas Park district through the 375 mm interceptor pipe. It flows through Bourkevale Park (east of Douglas Park Road), to be discharged to the Ferry Road LS:
  - Invert at district boundary - 226.1 m (S-MA20008531)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing district.

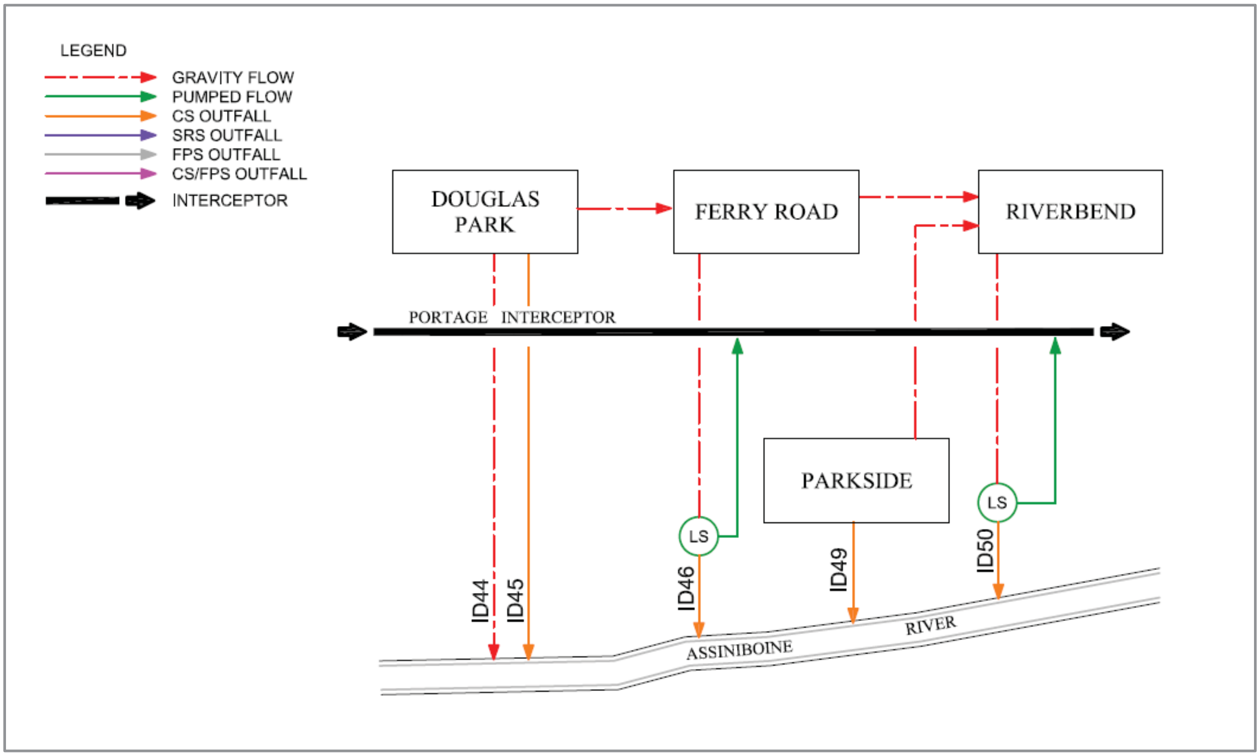

Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 14 and are listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID45)	S-MH20007846.1	S-MA20008519	300 mm	Circular Invert: 225.75 m
Flood Pumping Outfall	N/A	N/A	N/A	No flood pump station within the district.
Other Overflows	N/A	N/A	N/A	
Main Sewer Trunk	S-MH20007855.1	S-MA20008525	300	Circular Invert: 226.35 m
Storm Relief Sewer Outfalls	N/A	N/A	N/A	No SRS within the district.
Storm Relief Sewer Interconnections	N/A	N/A	N/A	No SRS within the district.
Main Trunk Flap Gate	N/A	N/A	N/A	No flap gate on the primary CS outfall.
Main Trunk Sluice Gate	DOUGLAS_PARK_GC.1	S-CG00001141	300 x 300 mm	Invert: 226.00 m
Off-Take (Interceptor)	S-MH20007847.2	S-MA20008518	375 mm	Circular Invert: 226.34 m
Dry Well	N/A	N/A	N/A	No lift station within the primary CS outfall.
Lift Station Total Capacity	N/A	S-MA20008518 (1)	375mm (1)	0.078 m^3/s (1)
Lift Station ADWF	N/A	N/A	0.004 m^3/s	
Lift Station Force Main	N/A	S-MA70017062	200 mm	Invert: 229.30 m
Flood Pump Station Total Capacity	N/A	N/A	N/A	No flood pump station within the district.
Pass Forward Flow – First Overflow	N/A	N/A	0.053 m^3/s	

Note:

(1) – Gravity pipe replacing Lift Station as Douglas Park is a gravity discharge district

ADWF = average dry-weather flow

GIS = geographic information system

ID = identification

N/A = not applicable

The critical elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Douglas Park – 224.55
2	Trunk Invert at Off-Take	226.34
3	Top of Weir	226.78
4	Relief Outfall Invert at Flap Gate	N/A
5	Low Relief Interconnection	N/A

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
6	Sewer District Interconnection (Ferry Road)	226.10
7	Low Basement	228.86
8	Flood Protection Level	230.68

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed for Douglas Park was in 2006 with the *Ferry Road and Riverbend Combined Sewer Relief Works* (Wardrop, 2006). This study discussed the possible separation work available for both the Ferry Road and Riverbend CS systems to reduce the incidence of basement flooding. To date, the separation work within the Douglas Park district located west of Bruce Park has been completed and the Deer Lodge outfall (ID 44) has been decommissioned.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Expected Completion
14 – Douglas Park	2006 - Conceptual	Future Work Following Complete Separation	2013	Study Complete Separation Ongoing	2018

1.5 Ongoing Investment Work

The Ferry Road and Riverbend basement flooding relief (BFR) work began in 2013 with ongoing separation work being completed within the districts. Once completed, it will provide complete road drainage separation of Ferry Road and Douglas Park.

The separation work within the Douglas Park district has been ongoing since 2016 and has been integrated into the CSO Master Plan. The remainder of the district is anticipated to be separated in the next 5-10 years.

There is no further study or construction proposed for the Douglas Park district at this time.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Douglas Park district are listed in Table 1-4. The proposed CSO control is complete sewer separation to align with the work currently underway. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 percent Capture in a Representative Year	-	-	-		-	-	-	✓	✓	✓	-

Notes:

- = not included
✓ = included

The decision to include complete separation of Douglas Park under the basement flooding relief work will remove a volume of land drainage from the CS system, thereby completely removing CSO occurrences for the Douglas Park district. The intent of complete separation was to eliminate all CSOs from the district under the 1992 representative year rainfall conditions. Post separation flow monitoring is required to confirm the sewer system performance and remaining wet weather response in the district from existing building foundation drainage connections to the CS system.

GI and RTC will be applied within each district on a system-wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Sewer Separation

Sewer separation is proposed for Douglas Park district as part of the CSO Master Plan and is underway as part of the Ferry Road and Riverbend separation projects.

The work to date includes installation of a new independent LDS system to collect road drainage. New LDSs have been installed along Deer Lodge Place as east and west legs with connection to Truro creek in Bruce Park. The collected stormwater runoff was routed through the new LDS to a new outfall discharging to the Truro Creek. This separates the west section of the Douglas Park district. The remainder of the district is anticipated to be separated in the next 5-10 year.

The flows to be collected after separation will be as follows:

- DWF will remain the same – with it being diverted by gravity to the Ferry Road CS LS via the primary weir for the district.
- WWF will consist of sanitary sewage combined with foundation drainage.

This has resulted in a reduction in combined sewage flow received at Ferry Road CS LS since the separation project was complete. Future monitoring of the district will be completed to verify that the sewer separation is fully compliant with the goal of elimination of all CSO overflows under 1992 rainfall conditions. The monitored data will also be used to determine if a raise to the static weir elevation is necessary. Any weir elevation raise will also be evaluated in terms of existing basement flood protection to ensure the existing level of basement flood protection remains.

1.6.3 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district will be reviewed to identify the most applicable GI controls.

Douglas Park has been classified as a high GI potential district. The land usage is categorized as mainly residential. This means the district would be an ideal location for bioswales, permeable paved roadways, cisterns/rain barrels, and rain gardens. The higher area of greenspace in Douglas Park district is suitable for biorientation garden projects.

1.6.4 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 Systems Operations and Maintenance

Systems operations and maintenance (O&M) changes were required to address the completed control options. This section identifies general O&M requirements for each control option completed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

Sewer separation included the installation of additional sewers that require inspection, cleaning and rehabilitation. This will result in additional maintenance costs over the long term, but operational costs will be minimal. The existing larger CS pipes within the district may also receive insufficient flow with the separation work for proper scouring velocities in the sewer pipes. This could result in solids settling within the sewers, and requiring more frequent cleaning operations. The impacts of the reduced flows in larger CS pipes will be evaluated as part of the sewer separation design for the district.

The primary CS outfall is believed to be either collapsed or plugged with river silt. Physical access to the outfall structure is also limited, previous City inspections have been attempted but unsuccessful. The separation of the district will greatly reduce the operation of this outfall and any post separation monitoring and impact assessment undertaken, may result in this outfall being decommissioned in the future. This will reduce this aspect of operations and maintenance requirements for the district.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. An individual model was created to represent the sewer system baseline as represented in the year 2013 and a model for the CSO Master Plan with the control options implemented in the year 2037. A summary of relevant model data is summarized in Table 1-5.

Table 1-5. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	13	13	698	32	N/A
2037 Master Plan – Control Option 1	13	8	698	2	SEP

Notes:

Total area is based on the model subcatchment boundaries for the district.
SEP = Separation
% = percent

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district. While this district is to be separated and as a result Clause 8 of Licence No. 3042 will not be in effect, the wet weather response of the district overall will still need to be assessed.

City of Winnipeg Hydraulic Model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-6, are for the hydraulic model simulations using the year-round 1992 representative year applied uniformly. The table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan – Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. The table also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-6. Performance Summary – Control Option 1

Control Option	Preliminary Proposal Annual Overflow Volume (m^3)	Master Plan Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [a]
Baseline (2013)	754	739	-	5	0.053 m^3/s
Separation	0	0	739	0	TBD
Control Option 1	**0**	**0**	**739**	**0**	**TBD**

[a] Pass forward flows assessed up to 5-year design rainfall event. Possible overflow for larger design events to be confirmed.

The percent capture performance measure is not included in the table above as it is applicable to the entre CS system, and not for each district individually. However, the full capture of overflows volumes for the Douglas Park district would represent a 100 percent capture rate on a district level.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each relevant control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-7. The cost estimates are a Class 5 planning level estimate with a level of accuracy range of minus 50 percent to plus 100 percent.

Table 1-7. Cost Estimates – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost [a]	2019 Annual Operations and Maintenance Cost [b]	2019 Total Operations and Maintenance Cost (Over 35-year period) [b]
Sewer Separation	$11,000,000	$0	$0	$0
Subtotal	**$11,000,000**	**$0**	**$0**	**$0**
Opportunities	N/A	$0	$0	$0
District Total	**$11,000,000**	**$0**	**$0**	**$0**

[a] Douglas Park separation work has yet to be fully completed, with the separation of the area along Douglas Park Road to be finalized within the near future (5-10 year period). This cost was not included for the CO1MP submission cost breakdown. Costs for this item of work found be $3,200,00 in 2019 dollars.

[b] O&M costs within the Cost Estimation Breakdown are based on future proposed control option and not on previously completed work. Since the Douglas Park district is not completely separated, additional O&M costs should be attributed to the overall cost program. Cost for the Annual O&M Costs in 2019 dollars found to be $6,400. Total O&M Cost (Over 35-year Period) found to be $150,000 in 2019 dollars. Both O&M costs include opportunities allowance of 10%.

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional costs for RTC (depending on future monitoring of post separation WWF impacts).
- The Preliminary Proposal capital cost is in 2014-dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019-dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-8.

Table 1-8. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Sewer Separation	Updated Unit costs	Separation of part of district still ongoing.
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management approach.	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation	Preliminary Proposal estimates were based on 2014-dollar values	

1.10 Meeting Future Performance Targets

The proposed complete separation of the Douglas Park district will achieve the 100 percent capture figure and no further work will be required to meet the future performance target. It is recommended to complete post separation modelling to confirm the target is fully achieved.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk and Opportunity Control Option Matrix covering the district control options has been developed as part of the CSO Master Plan and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-9.

Table 1-9. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	-	-	-	O	-	-	-
2	Existing Lift Station	-	-	-	-	-	-	-	-
3	Flood Pumping Station	-	-	-	-	O	-	-	-
4	Construction Disruption	-	-	-	-	R	-	-	-
5	Implementation Schedule	-	-	-	-	R	-	-	-
6	Sewer Condition	-	-	-	-	-	-	-	-
7	Sewer Conflicts	-	-	-	-	R	-	-	-
8	Program Cost	-	-	-	-	R	-	-	-
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	-	-	-	-	O	O	-	-
12	Operations and Maintenance	-	-	-	-	R / O	R	-	-
13	Volume Capture Performance	-	-	-	-	-	O	--	-
14	Treatment	-	-	-	-	O	O	-	-

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

Wardrop. 2006. *Ferry Road and Riverbend Combined Sewer Relief Works*. Prepared for the City of Winnipeg Water and Waste Department. November.

LEGEND

- Primary Weir
- Critical Elevation
- Decommissioned Outfall
- CSO Outfall
- Low CS Manhole

Inter-System Connection
- CS - WWS

District Boundary Crossing
- WWS

- Force Main
- Street
- District Boundary
- Watercourse
- Greenspace

CSO MASTER PLAN PROPOSED SOLUTIONS

- Sewer Separation - Underway
- Sewer Separation - Complete

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 14
District Overview Map
Sewer District: Douglas Park
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Dumoulin District Plan

August 2019

City of Winnipeg

CSO Master Plan

Project No:	470010CH
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Revision	Date	Description	By	Review	Approved
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1	02/15/2019	Second DRAFT for City Review	SB	MF	SG
2	06/2019	Final Draft Submission	DT	MF	MF
3	08/19/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

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Figure

1. Dumoulin District

1.1 District Description

Dumoulin district is located near the centre of the combined sewer (CS) area. Dumoulin is bounded by Mission district to the east, Despins district to the south and west, La Verendrye district to the north, and the Red River to the west. Dumoulin Street forms the northern boundary, De La Cathedrale the southern boundary, the Red River the western boundary, and the Seine River the eastern boundary.

The regional transportation routes that pass through Dumoulin district are Provencher Boulevard, Taché Avenue, and Des Meurons Street. Provencher Boulevard runs east-west and crosses the Red River and connects from the St. Boniface area to downtown. Taché Avenue runs parallel to the Red River and connects Marion Street to Provencher Boulevard, providing access to the St. Boniface Hospital. The Canadian National Railway Sprague rail line passes through the northeastern section of the Dumoulin district.

This district includes residential, with commercial areas located along the Provencher Boulevard and Des Meurons corridors. A small area of industrial land use with light and general manufacturing is located in the eastern portion of the district. The residential land use areas contain an distribution of multi-family, single-family, and two-family homes. Numerous institutional facilities are located in this district including St. Boniface University and College Louis-Riel. Other significant properties include the St. Boniface Cathedral, and Provencher Park, which encompass a large area in the centre of the district. Approximately 10 ha of the district is classified as greenspace.

1.2 Development

Provencher Boulevard, which is recognized as a Mixed Used Corridor within OurWinnipeg and will be promoted for future development and densification.

Provencher Boulevard has also been identified as one of the potential routes for the Eastern Corridor of Winnipeg's Bus Rapid Transit. This could result in additional development in the area. This could also present an opportunity to coordinate sewer separation works alongside the transit corridor development, providing further separation within the Dumoulin district. This would reduce the extent of the Control Options listed in this plan required.

1.3 Existing Sewer System

Dumoulin district encompasses an area of 70 ha[1] based on the district boundary and includes combined sewer (CS), wastewater sewer (WWS), and land drainage sewer (LDS) systems. As shown in Figure 15, there is approximately 38 percent (27 ha) separated and no separation-ready areas.

The Dumoulin sewer system includes a diversion chamber, a dual lift and flood pump station (LFPS), a flood pump station (FPS) outfall, and a CS outfall with gate chamber located adjacent to the Red River at Tache Avenue and Dumoulin Street. Sewage flows collected in the Dumoulin district converge to a 1050 mm CS trunk flowing west on Dumoulin Street and a 450 mm CS trunk sewer flowing west on Provencher Boulevard and drain towards the outfall. The two CS trunks meet at the intersection of Taché Avenue and Dumoulin Street. Intercepted CS from the La Verendrye district also enters Dumoulin district, from either a 300 mm pipe offtake pipe or a 450 mm overflow pipe. Each of these interconnections with the La Verendrye district flow south along Tache Avenue to tie into the Dumoulin CS trunk upstream of the district primary weir.

[1] City of Winnipeg GIS information relied upon from area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

During dry weather flow (DWF), the Dumoulin primary weir diverts flow to the lift station section of the Dumoulin LFPS through a 300 mm off-take pipe. The Dumoulin LFPS pumps the flow south down Tache Avenue through a 350 mm force main, and across the Red River into the Bannatyne district and on to the North End Sewage Treatment Plant (NEWPCC). The river crossing from the Despins district is located adjacent to this Dumoulin river crossing, with interconnection valves installed between the two river crossings. During normal operations however these valves remains closed and there is no interaction between the two river crossings.

During wet weather flow (WWF) events, any flows that exceed the diversion capacity overtop the primary weir and are discharged to the Red River via the CS outfall structure. A flap and sluice gate are in place on the CS outfall to prevent the Red River from back flowing into the CS under high river level conditions. When river levels are high such this however the flap gate prevents gravity flow discharge from the CS outfall. Under these conditions the FPS pumps from the Dumoulin LFPS collect the excess CS trapped behind the outfall flap gate, and pump the flow to an elevated discharge box. The discharge box then allows flow by gravity into the Red River through a dedicated FPS outfall which contains no positive or flap gate.

Three independent LDS systems with outfalls collect the surface runoff and discharge to the adjacent rivers. Runoff from the southeast portion of the district (mainly from Despins district) flows to a 600 mm LDS outfall on Bourgeault Street and discharges to the Seine River. A 1050 mm LDS along De La Cathedrale Avenue collects runoff from the southern extents of the Dumoulin district. This LDS trunk crosses Taché Avenue in the Despins district and discharges to the Red River via a 1200 mm LDS outfall. Each LDS outfall includes a sluice and flap gate to prevent river water from backing up into the system.

The two outfalls (one CS and one FPS) to the Red River are listed as follows:

- ID14 (S-MA70047759) – Dumoulin CS Outfall
- ID84 (S-MA70016522) – Dumoulin FPS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Dumoulin and the surrounding districts. Each interconnection is shown on Figure 15 and shows locations where gravity and pumped flow can cross from one district to another. Each interconnection is listed as follows:

1.3.1.1 Interceptor Connections

No interceptor connections

1.3.1.2 District Interconnections

Despins

<u>WWS to WWS</u>

- A 350 mm force main carries intercepted flow from the Dumoulin LFPS to the Despins district. Within the Despins district the CS then crosses the Red River via river crossing, and on to the North End Sewage Treatment Plant (NEWPCC) for treatment:
  - Bannatyne district east of Main Street invert – 227.52 m (S-MH70021611)

<u>CS to CS</u>

- Common high point sewer manholes:
  - Desautels Street and Des Meurons Street invert – 228.38 m (S-MH50008956)
  - Bourgeault Street and Desautels Street invert – 229.44 m (S-MH50008651)

- – Ritchot Avenue and Hamel Avenue invert – 228.85 m (S-MH50002546)

- A 750 mm by 1150 mm CS pipe from Despins CS system flows by gravity westbound on Hamel Avenue and connects to an overflow CS pipe that flows northbound on Langevin Street into the CS system in Dumoulin district:
  - – Hamel Avenue and Lavgevin Street invert – 228.63 m (S-MH50002548)
- A 750 mm by 1150 mm CS pipe from Despins CS system flows westbound on Hamel Avenue and connects to an overflow CS pipe that flows northbound on St Jean Baptiste Street into the CS system in Dumoulin district:
  - – Hamel Avenue and St. Jean Baptiste Street invert – 228.80 m (S-MH50002313
- A 750 mm CS pipe from the Dumoulin CS system flows by gravity southbound on De La Morenie Street and connects to the CS system in Despins district:
  - – Cathedrale Street and De La Morenie Street Invert – 226.38 m (S-MH50008928)

<u>LDS to LDS</u>

- A 300 mm LDS pipe from Despins district LDS system flows by gravity northbound on Des Meurons Street and connects to the LDS system in Dumoulin district.
  - – Desautels Street and Des Meurons Street invert into 375 LDS – 226.45 m (S-MH50008203)
- A 450 mm LDS pipe from Dumoulin district LDS system flows by gravity westbound on Desautels Street and connects to the LDS system Despins district where it flows back out into Dumoulin to be discharged into the Seine River.
  - – Bourgeault Street and Desautels Street Invert (into Despins) – 225.73 m (S-MH70008209)
  - – Bourgeault Street and Desautels Street Invert (into Dumoulin) – 225.70 m (S-MA70008215)

La Verendrye

<u>CS to CS</u>

- A 300 mm CS pipe carries the intercepted CS diverted by the primary weir from the La Verendrye district, and flows by gravity southbound on Tache Avenue and connects to the CS system in the Dumoulin district.
  - – Tache Avenue and Dumoulin Street invert – 222.53 m (S-MH50008804)
- A 450 mm CS high overflow pipe diverts CS from the La Varendrye trunk sewer upstream of the primary weir, and flows by gravity southbound on Tache Avenue and connects to the CS system in the Dumoulin district.
  - – Tache Avenue and Dumoulin Street invert – 225.49 m (S-MH50004016)

<u>WWS to CS</u>

- A 600 mm WWS pipe from La Verendrye flows by gravity southbound on Langevin Street and connects into the CS system in Dumoulin district.
  - – Langevin Street and Dumoulin district boundary invert – 226.77 m (S-MH-50003890)

<u>LDS to LDS</u>

- A 600 mm LDS pipe from Dumoulin district flows by gravity northbound into La Verendrye district at the intersection of Thibault Street and Dumoulin Street and is discharged into the outfall at the Seine River and does not interact with the CS system.
  - – Thibault Street and Dumoulin Street at district boundary invert - 227.19 m (S-MH50004223)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing district.

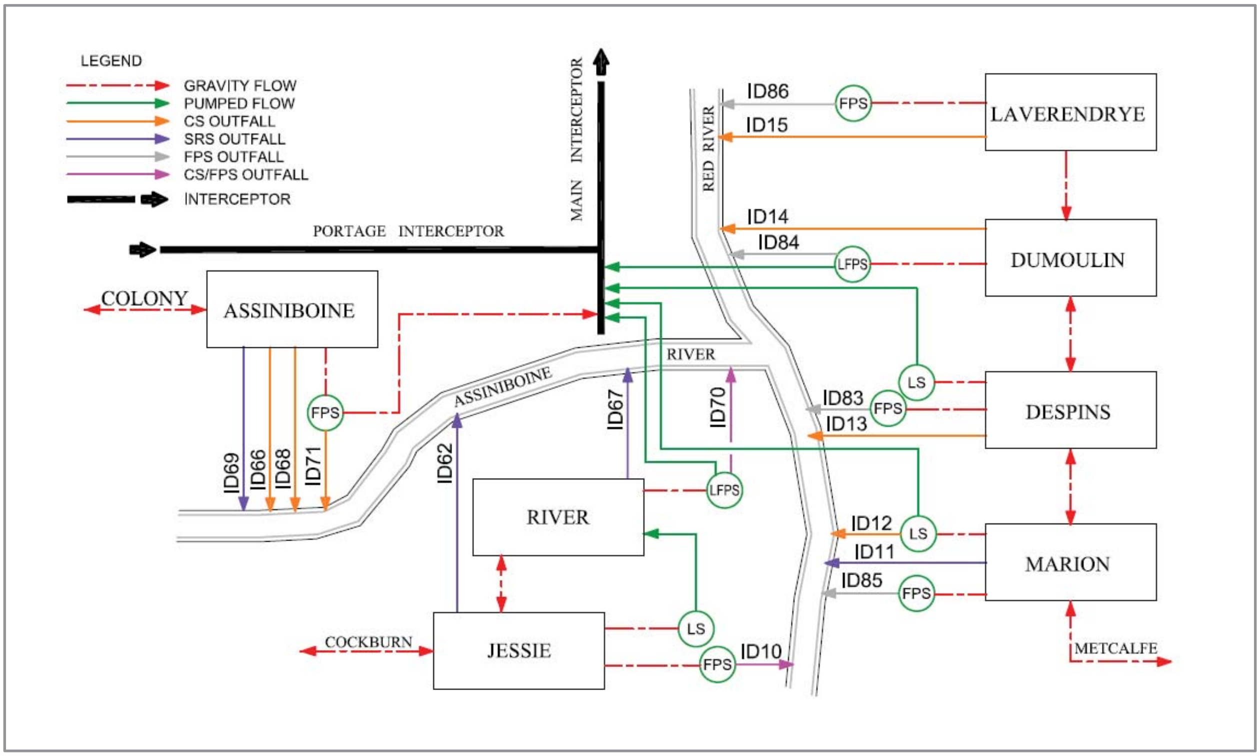


Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 15 and are listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID14)	S-CO70023242.1	S-MA70047759	1050 mm	Red River Invert: 222.70 m
Flood Pumping Outfall (ID84)	S-AC70007576.1	S-MA70016522	1200 mm	Red River Invert: 225.30 m
Other Overflows	N/A	N/A	N/A	
Main Trunk	N/A	S-MA70017914	1050 mm	Invert: 225.19 m
SRS Outfalls	N/A	N/A	N/A	No SRS within the Dumoulin district.
SRS Interconnections	N/A	N/A	N/A	No SRS within the Dumoulin district.
Main Trunk Flap Gate	S-CG00000787.1	S-CG00000786	1350 mm	Invert: 224.38 m
Main Trunk Sluice Gate	S-AC70008153.1	S-CG00000787	1200 x 1200 mm	Invert: 224.15 m
Off-Take	S-MH50008801.2	S-MA70017598	300 mm	Circular Invert: 224.73 m

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Dry Well	N/A	N/A	N/A	No dry well arrangement within the LFPS.
Lift Station Total Capacity[1]	N/A	N/A	0.15 m^3/s	2 x 0.075 m^3/s
Lift Station ADWF	N/A	N/A	0.036 m^3/s	
Lift Station Force Main	S-BE70008151.1	S-MA70017614	350 mm	Invert: 226.60 m
Flood Pump Station Total Capacity	N/A	N/A	1.77 m^3/s	1 x 0.59 m^3/s, 1 x 1.18 m^3/s
Pass Forward Flow – First Overflow	N/A	0.178 m^3/s	N/A	

Notes:

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

[1]Lift Station pump capacity will need to be verified from flow monitoring.

The critical system elevations for the existing system relevant to the development of the Combined Sewer Overflow (CSO) control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Dumoulin – 223.73
2	Trunk Invert at Off-Take	224.85
3	Top of Weir	225.02
4	Relief Outfall Invert At Flap Gate	N/A
5	Low Relief Interconnection	N/A
6	Sewer District Interconnection (La Verendrye district boundary)	222.53
7	Low Basement	228.75
8	Flood Protection Level	229.72

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed in Dumoulin district was the *Dumoulin and La Verendrye Districts Combined Sewer Relief Study* (Wardrop, 2006). This report led to the construction of relief works for the existing CS systems to alleviate basement flooding. The CS district relief was completed at the same time for both Dumoulin and La Verendrye districts from 2002 to 2004. No other sewer work has been completed since that time.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Dumoulin Combined Sewer District was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations has a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Expected Completion
15 - Dumoulin	2006 - Conceptual	Future Work	2013	Study Complete	N/A

1.5 Ongoing Investment Work

There is no current or proposed CSO or sewer relief investment work occurring within Dumoulin district.

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Dumoulin district. This consists of monthly site visits in confined entry spaces to ensure physical readings concur with displayed transmitted readings, and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The Dumoulin district has in-line and floatable control projects proposed to meet CSO Control Option 1. Table 1-4 provides an overview of the control options to be included in the 85 percent capture in a representative year option. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	-	-	-	✓	✓	-	-	-	✓	✓	✓

Notes:

- = not included
✓ = included

The existing CS systems are suitable for use as in-line storage. These options would take advantage of the existing pipe networks for additional storage volume. Existing DWF from the collection system would remain the same, and overall district operations would remain the same.

Floatable control will be necessary to capture any undesirable floatables in the sewage. Floatables will be captured with all implemented control options to some extent, but screening may be added as required to reach the desired capture level. Installation of a control gate will be also required for the screen operation, in addition to providing the mechanism for capture of the in-line storage.

GI and RTC will be applied within each district on a system-wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 In-Line Storage

In-line storage has been proposed as a CSO control for Dumoulin district. The in-line storage will require the installation of a control gate at the CS outfall. The gate will increase the storage level in the existing CS to provide an overall higher volume capture, primarily during low to moderate rainfall events. The control gate installation also provides the additional hydraulic head necessary for screening operations. It should be noted that for more severe rainfall events the control gate will no longer increase the storage levels in the existing CS, allowing the system to maintain the level of basement flooding protection.

A standard design was assumed for the control gate, as described in Part 3C. A standard approach was used for conceptual gate sizing by assuming it to be the lesser of the height of half of the site-specific trunk diameter or the maximum height of the gate available. The design criteria for in-line storage are listed in Table 1-5.

Table 1-5. In-Line Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	225.19 m	
Trunk Diameter	1050 mm	
Gate Height	0.80 m	Gate height based on half trunk height assumption
Top of Gate Elevation	225.82 m	
Bypass Weir Elevation	225.70 m	
Maximum Storage Volume	109 m^3	
Nominal Dewatering Rate	0.15 m^3/s	Based on capacity of existing CS LS
RTC Operational Rate	TBD	Future RTC/dewatering review on assessment

Note:
RTC = Real Time Control
TBD = to be determined

The proposed control gate will cause combined sewage to back-up within the collection system to the extent shown on Figure 15. The extent of the in-line storage and volume is related to the top elevation of the bypass weir. The level of the bypass side weir and adjacent control gate level are determined in relation to the critical performance levels in the system for basement flooding protection: when the system level increases above the bypass weir crest and proceeds above the top of the control gate during high flow events, the gate drops out of the way. At this point, the district will only provide its original interception capacity via the primary weir for the district, and all excess CS would flow over the weir and discharge to the river. After the sewer levels in the system drops back below the bypass side weir critical performance level, the control gate moves back to its original raised position to capture the receding limb of the WWF event. The CS LS will continue with its current operation while the control gate is in either position, with all DWF being diverted to the CS LS and pumped. The CS LS will further dewater the in-line storage provided during a WWF event as downstream capacity becomes available.

Figure 15-01 provides an overview of the conceptual location and configuration of the control gate, bypass weir and screening chambers. The proposed control gate will be installed in a new chamber within the existing trunk sewer alignment near the existing LFPS. The dimensions of the chamber to accommodate the bottom pivoting gate and an allowance for a side weir for floatables control are 5.3 m in length and 2.3 m in width, with an allowance for a longitudinal overflow weir. The existing sewer configuration including the construction of an additional off-take, and force main modifications may have to be completed accommodate the new chamber. This will be confirmed in future design assessments.

The physical requirements for the off-take and station sizing for a modification to pumping capacity have not been considered in detail, but they will be required in the future as part of an RTC program or LS rehabilitation or replacement project. The control gate is proposed to be constructed within the existing lands the LFPS is located; therefore, minor disruptions are expected.

The nominal rate for dewatering is set at the capacity of the existing CS LS. This accommodates dewatering through the existing interceptor system within 24 hours following the runoff event, allowing it to recover in time for a subsequent event. Any future considerations, for RTC improvements, would be completed with spatial rainfall as any reduction to the existing pipe capacity/operation for large events will adversely affect the overflows at this district. Similar basis for the rate matching the lift station philosophy of two times nominal dewatering rate would be adopted. This future RTC control will provide the ability to capture and treat more volume for localized storms by using the excess interceptor capacity where the runoff is less.

1.6.3 Floatables Management

Floatables management will require installation of a screening system to capture floatable materials. The off-line screens would allow the system to maintain the current level of basement flooding protection. The screens would operate with the control gate in the raised position. A side weir upstream of the gate would direct the flow to the screens located in a new screening chamber, with screened flow discharged to the downstream side of the gate to reconnect into the outfall structure, and discharge to the river.

The type and size of screens depend on the specific station, and the hydraulic head available for their operation. A standard design was assumed for screening is described in Part 3C. The design criteria for screening with gate control implemented, are listed in Table 1-6.

Table 1-6. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Top of Gate	225.82 m	
Bypass Weir Crest	225.7 m	
Normal Summer River Level	223.73 m	
Maximum Screen Head	1.97 m	
Peak Screening Rate	0.32 m^3/s	
Screen Size	1.5 m x 1.0 m	Modelled Screen Size

The proposed side overflow bypass weir and screening chamber will be located adjacent to the proposed control gate and existing CS trunk, as shown on Figure 15-01. The screens will operate with the control gate in its fully raised position. The bypass weir upstream of the gate will direct the flow to the screens located in the new screening chamber, with screened flow discharged to the downstream side of the gate to the river. The screening chamber will include screenings pumps with a discharge returning the screened material to the LS for routing to the NEWPCC for removal. The provision of screening pumps is dependent on final level assessment within the existing infrastructure and the Dumoulin trunk has potential for gravity screening return to occur. This will be confirmed during the future assessment stage.

The dimensions for the screen chamber to accommodate flow from the side by-pass weir, the screen area, and the routing of the discharge piping downstream of the gate are 2.0 m in length and 3.1 m in width. The existing sewer configuration may have to be modified to accommodate the new chamber.

1.6.4 Green Infrastructure

The approach to green infrastructure (GI) is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed.

The land use, topography and soil classification for the district will be reviewed to identify applicable GI controls.

Dumoulin has been classified as a high GI potential district. Land use in Dumoulin is mix of residential, commercial, and institutional. The west end of the district is bounded by the Red River. This district would be an ideal location for cisterns/rain barrels, and rain garden bioretention within the residential areas. Commercial areas are suitable to green roofs and parking lot areas are ideal for paved porous pavement. Bioswales may be suitable to the industrial areas.

1.6.5 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

In-line storage will impact the existing sewer and will require the addition of a new chamber and a moving gate at the outfall. In-line storage dewatering will be controlled with the existing LS, which may require more frequent and longer duration pump run times. Lower velocities will occur in the CS trunk in the vicinity of the control gate due to lower pass forward flows, and may create additional debris deposition requiring cleaning. Additional system monitoring and level controls will be installed, which will require regular scheduled maintenance.

Floatable control with outfall screening will require the addition of another chamber with screening equipment installed. The chamber will be installed adjacent to the control gate chamber and will operate in conjunction with it. Screening operation will occur during WWF events that surpass the in-line storage control level. WWF would be directed from the main outfall trunk, over the side weir in the control gate chamber and through the screens to discharge into the river. The screens will operate intermittently during wet weather events and will likely require operations review and maintenance after each event. The frequency of a screened event would correlate to the number overflows identified for the district. Having the screenings pumped back to the interceptor system via a small LS and force main will be required. The screenings return will require O&M inspection after each event to assess the performance of the return pump system.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. Two versions of the sewer system model were created and used to measure system performance. The 2013 Baseline model represents the sewer system baseline in the year 2013 and the 2037 Master Plan – Control Option 1 model, which includes the proposed control options in the year 2037. A summary of relevant model data is provided in Table 1-7.

Table 1-7. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	59	59	2,837	74	N/A
2037 Master Plan – Control Option 1	59	59	2,837	74	IS, SC

Notes:

Table 1-7. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model

Notes:
IS = In-line Storage
SC = Screening

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-8 are for the hydraulic model simulations using the year-round 1992 representative year. The table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. The table also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-8. District Performance Summary – Control Option 1

Control Option	Preliminary Proposal	Master Plan			
	Annual Overflow Volume (m^3)	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [a]
Baseline (2013)	47,112	49,524	-	14	0.169 m^3/s
In-Line Storage	46,894	42,539	6,985	14	0.162 m^3/s
Control Option 1	**46,894**	**42,539**	**6,985**	**14**	**0.162 m^3/s**

[a] Pass forward flows assessed on the 1-year design rainfall event

The percent capture performance measure is not included in Table 1-8, as it is applicable to the entire CS system and not for each district individually. The improvement of this district is also associated with the proposed control options for the upstream gravity La Verendrye district.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-9. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-9. District Cost Estimate – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance (Over 35-year period)
In-Line Storage	N/A [a]	$2,250,000 [b]	$41,000	$880,000

Table 1-9. District Cost Estimate – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance (Over 35-year period)
Screening		$1,920,000 [c]	$45,000	$970,000
Subtotal	**$0**	**$4,170,000**	**$86,000**	**$1,850,000**
Opportunities	N/A	$420000	$9,000	$190,000
District Total	**$0**	**$4,590,000**	**$95,000**	**$2,040,000**

[a] Solution development as refinement to Preliminary Proposal costs submission. Revised costs for this control gate and screenings work found to be $1,810,000 in 2014 dollars.

[b] Costs associated with any revision to existing off-take, as required, to accommodate the control gate location and allow the intercepted CS flow to reach the existing Dumoulin CS LS are not included.

[c] Cost for bespoke screenings return pump/force main not included in Master Plan as will depend on selection of screen and type of screening return system selected.

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculation of the cost estimate for the CSO Master Plan includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional cost for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014-dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019-dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-10.

Table 1-10. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	In-Line Storage	Control Gate was not included in the Preliminary Proposal cost estimate	Added for the MP to further reduce overflows and optimize in-line storage

Table 1-10. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
	Screening	Screening was not included in the Preliminary Proposal cost estimate.	Added in conjunction with the Control Gate.
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation	Preliminary estimates were based on 2014-dollar values	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, the future performance target is 98 percent capture for the representative year measured on a system-wide basis. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-11 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified for Control Option 1.

Overall the Dumoulin district would be classified as high potential for implementation of complete sewer separation as a feasible approach to meet future performance targets. The non-separation measures recommended as part of this district engineering plan to meet Control Option 1, specifically in-line storage and floatables management via off-line screening, are therefore at risk of becoming redundant and unnecessary when the measures to achieve future performance targets are pursued. As a result, these measures should not be pursued until the requirements to meet future performance targets are more defined. Should it be confirmed that complete separation is the recommended solution to meet future performance targets, then complete separation will likely be pursued to address Control Option 1 instead of implementing the non-separation measures. This will be with the understanding that while initial complete separation is less cost-effective to meet Control Option 1, it is the most cost effective solution to meet the future performance target and removes the capital costs on short term temporary solutions. The focused use of green infrastructure at key locations would also be utilized to provide volume capture benefits to meet future performance targets.

Table 1-11. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Sewer Separation • Increased use of GI

The control options selected for the Dumoulin district has been aligned for the 85 percent capture performance target based on the system wide basis. The expandability of this district to meet the 98 percent capture would not align with the proposed options for the 85 percent capture target. The future higher level of percent capture indicate that complete sewer separation would be applicable in this district. This district is linked to the upstream La Verendrye district, as this district discharges via gravity directly to the Dumoulin CS LS and any recommendations require to be integrated with those of La Verendrye district.

The cost for upgrading to 98 percent capture depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-12.

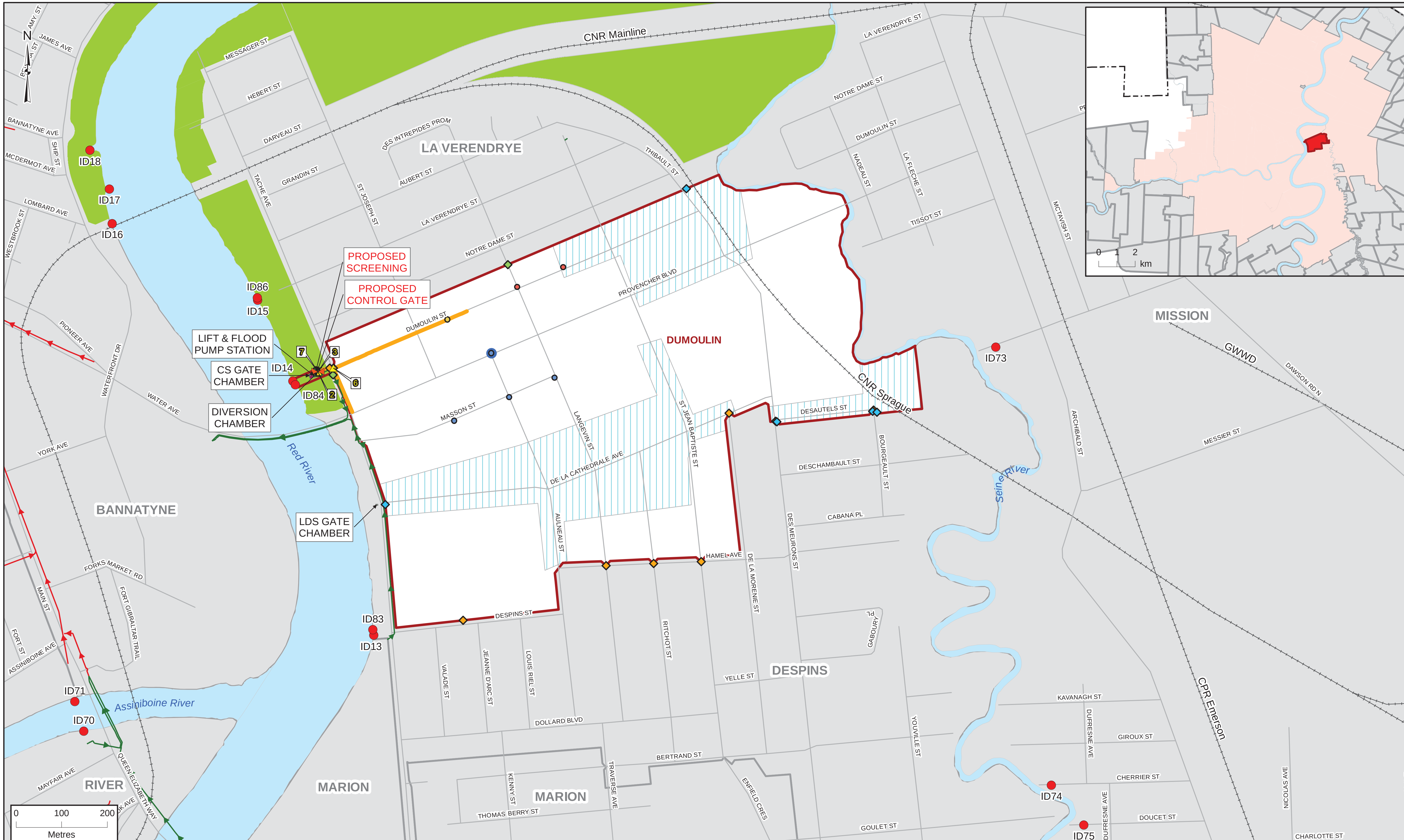
Table 1-12. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	R	-	-	-	-	-	-
2	Existing Lift Station	-	R	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	-	-	-	-
4	Construction Disruption	-	-	-	-	-	-	-	-
5	Implementation Schedule	-	-	-	-	-	-	R	-
6	Sewer Condition	-	R	-	-	-	-	-	-
7	Sewer Conflicts	-	R	-	-	-	-	-	-
8	Program Cost	-	O	-	-	-	-	-	O
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	-	-	-	-	-	O	O	-
12	Operations and Maintenance	-	R	-	-	-	R	O	R
13	Volume Capture Performance	-	O	-	-	-	O	O	-
14	Treatment	-	R	-	-	-	O	O	R

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

Wardrop Engineering Consultants (Wardrop). 2006. *Dumoulin and La Verendrye Districts Combined Sewer Relief Study*. Prepared for the City of Winnipeg. December.



LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Low CS Manhole
- Low SRS Connection

Inter-System Connection
- CS - LDS
- CS - WWS
- SRS - CS

District Boundary Crossing
- CS
- LDS
- WWS

- Interceptor Sewer
- Force Main
- Street
- Railway

- District Boundary
- Watercourse
- Greenspace

CSO MASTER PLAN PROPOSED SOLUTIONS

- Proposed Control Gate
- Extent of In-line Storage
- Sewer Separation - Complete

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 15
District Overview Map
Sewer District: Dumoulin
City of Winnipeg
Combined Sewer Overflow Master Plan

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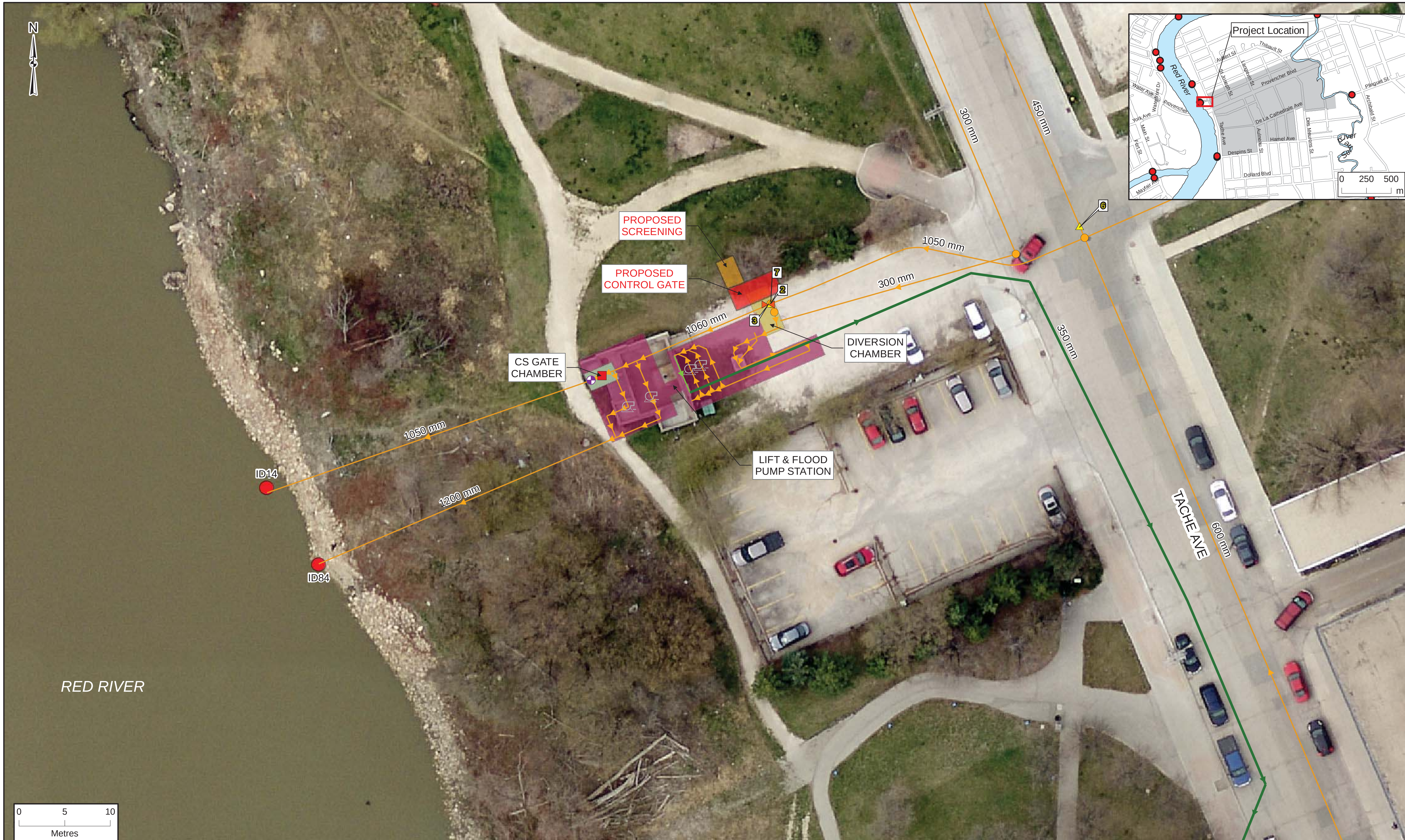

LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Manhole
- Flap Gate
- Sluice Gate
- Pump Location
- Force Main
- Sewer By Type
  - CS
  - WWS
- Control Structure Type
  - Gate Chamber
- Pump Station Type
  - Diversion Chamber
  - Lift & Flood Combined Station

CSO MASTER PLAN PROPOSED SOLUTIONS

- Control Gate
- Screening

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 15-01
Control Gate and Screening
Sewer District: Dumoulin
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Ferry Road District Plan

August 2019

City of Winnipeg

CSO Master Plan

Project No: 470010CH
Document Title: Ferry Road District Plan
Revision: 03
Date: August 16, 2019
Client Name: City of Winnipeg
Project Manager: John Berry
Author: Stephen Godon
File Name: FerryRoad_Final_CO1MP_08162019

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Document History and Status

Revision	Date	Description	By	Review	Approved
0	08/2018	Version 1 DRAFT	DT / SG	ES	
1	02/15/2019	DRAFT 2 for City Review	MF	SG	MF
2	08/13/2019	Final Draft Submission	DT	MF	MF
3	08/16/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

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Figure

1. Ferry Road District

1.1 District Description

Ferry Road district is located towards the western edge of the combined sewer (CS) area, southeast of the Winnipeg James Armstrong Richardson International Airport (Winnipeg Airport). This district is bounded by Moorgate and Douglas Park districts to the west, Parkside and Riverbend districts to the east, and the Red River to the south. The district is bounded by Sargent Avenue to the north and the Assiniboine River to the south. The boundaries to the east and west vary but are generally from Queen Street to Winchester Street north of Portage Avenue and from Library Place to Bourkevale Drive south of Portage Avenue.

Regional transportation routes that pass through this district include Portage Avenue, Ness Avenue, Ellice Avenue and Ferry Road.

Ferry Road is primarily residential with commercial areas along Portage Avenue and Ness Avenue and a general manufacturing/industrial region north of St. Matthews Avenue near the Winnipeg Airport. A small section in the east of Ferry Road is split by the Riverbend district. This area contains a mixture of residential and commercial areas and stretches from Silver Avenue to Portage Avenue and from Century Street to St. James Street.

The most significant non-residential building in Ferry Road is the Royal Aviation Museum of Western Canada, located south of the Winnipeg Airport. Other small green spaces, such as Truro Park and a section of St. James Rods Football club, can be found within Ferry Road. Truro Creek, which flows through and divides the west side of Ferry Road, flows from the Winnipeg Airport lands to the Assiniboine River.

1.2 Development

A portion of Portage Avenue is located within the Ferry Road District. Portage Avenue is identified as Regional Mixed-Use Corridor as part of the OurWinnipeg future development plans. As such, focused intensification along Portage Avenue is to be promoted in the future.

1.3 Existing Sewer System

Ferry Road encompasses an area of 290 hectares (ha)[1] based on the district boundary. Ferry Road is currently undergoing separation work that includes the installation of a separate land drainage sewer (LDS) system. The area to the north west of the district, around the airport lands has been classed as a separation ready area, covering approximately 7 percent by area. As of December 2018, the area east of Hampton Street has been completed and overall 30 percent of the district by area has been separated. As part of the separation work ongoing 100 percent of the district is anticipated to be separated in the future.

The CS system includes a CS lift station (LS) and one CS outfall. CS collected from the northern, western, and eastern sections flows into collector pipes along Ness Avenue, St. Matthews, and Ferry Road. These collectors then meet at the intersection of Ness Avenue and Ferry Road and flow southbound through the main 1950 by 3000 mm egg-shaped sewer trunk. The Ferry Road CS outfall located on the Assiniboine River near Assiniboine Avenue and Ferry Road receives the CS from this main trunk and from a 900 mm CS on Assiniboine Avenue serving the district area south of Portage Avenue. The Ferry Road main trunk also receives the intercepted CS from the Douglas Park district via a 375 mm interceptor pipe which connects upstream of the primary interception weir.

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

During dry weather flow (DWF), the flow is diverted by the primary weir through a 500 mm off-take pipe to the Ferry Road CS LS. The sewage is then pumped through the 350 mm force main pipe north towards to the Portage Interceptor along Portage Avenue, where it flows eastwards ultimately towards the North End Sewage Treatment Plant (NEWPCC) for treatment.

During wet weather flow (WWF), high flow in the system may cause the level in the trunk sewer to increase above the primary weir and overflow to the Assiniboine River via the Ferry Road CS outfall. The outfall consists of a positive and flap gate to protect against back-up due to high river levels. Under these same conditions however gravity discharge from the CS outfall is not possible, due to sewage backing up against the flap gate. There is no flood station at this location; however, in the case where high river levels are predicted to prevent flap gate operation during a WWF event, temporary flood pumping can be put in place.

The northern section of the Ferry Road district encompasses a small area surrounding the Winnipeg Airport lands and includes separate LDS and wastewater sewer (WWS) network that serves the buildings locally. Both the LDS and WWS for this area connect to the CS system and flow to the CS trunk on Ferry Road.

The CS outfall to the Assiniboine River is as follows:

- ID46 (S-MA70019349) – Ferry Road CS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Ferry Road and the surrounding districts. Each interconnection is shown on Figure 16 and shows locations where gravity and pumped flow can cross from one district to another. Each interconnection is listed in the following subsections.

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

Riverbend

– The Ferry CS LS discharges to the Portage Avenue Interceptor, a 900mm interceptor carrying intercepted CS flows by gravity from the Ferry Road district into the Riverbend district and on to the North End Sewage Treatment Plant (NEWPCC) for treatment.

    o Portage Avenue interceptor invert – 230.65 m (S-MH20008213)

1.3.1.2 Interceptor Connections – Upstream of Primary Weir

Douglas Park

- Intercepted CS from the Douglas Park district crosses into Ferry Road district through the 375 mm interceptor pipe. It flows through Bourkevale Park (east of Douglas Park Road), to be discharged to the Ferry Road LS.
    - o Invert at district boundary - 226.1 m (S-MA20008531)

1.3.1.3 District Interconnections

Riverbend

<u>CS to CS</u>

- High Point Manholes (flow is directed into both districts from this manhole)
    - – Marjorie Street and St. Matthews Avenue. 230.65 m (S-MH20007039)
    - – Silver Avenue and Madison Street (Riverbend district boundary) – 231.52 m (S-MH20009635)

Parkside

CS to CS

- A 450 mm CS overflow into Parkside district from Ferry Road is at the intersection of Assiniboine Avenue and Bourkevale Drive
  - – Assiniboine Avenue – 228.93 m (S-MH20008113)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing district.

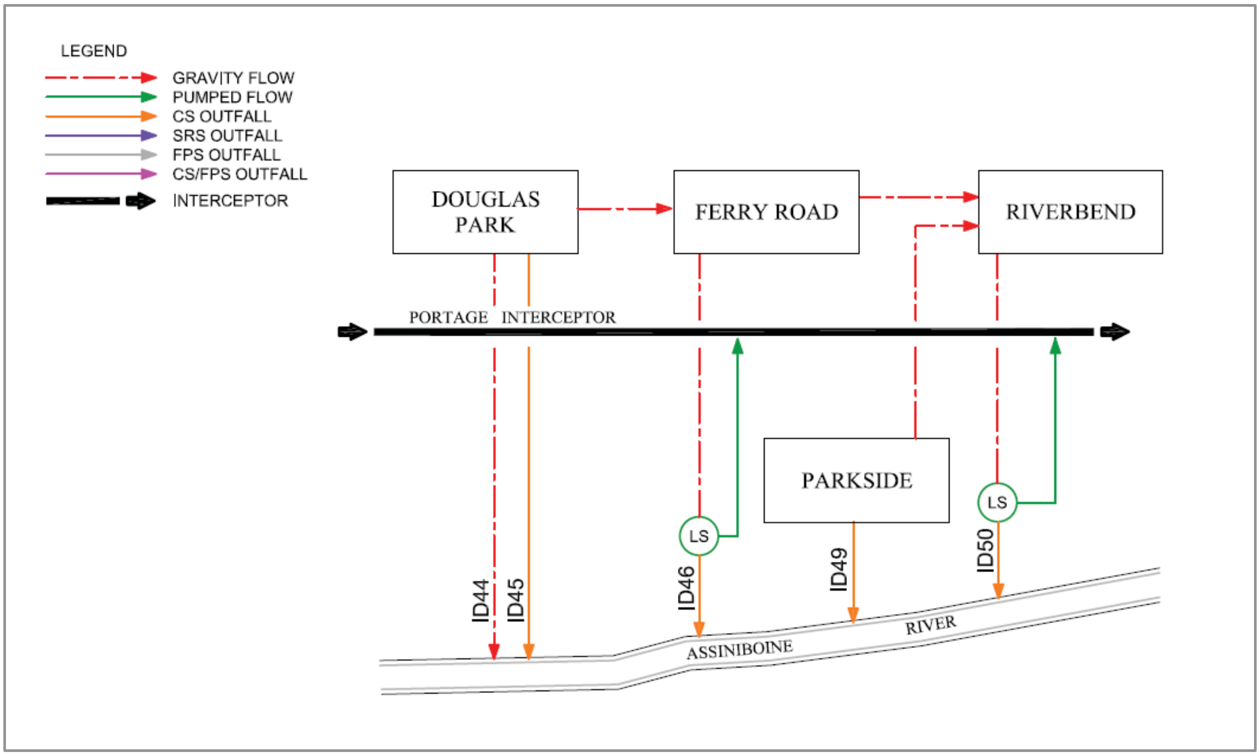


Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 16 and are listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID46)	S-AC70009025.1	S-MA70019346	1800 mm	Circular Invert: 224.99 m
Flood Pumping Outfall (ID46)	N/A	N/A	N/A	No flood pump station within the district.
Other Overflows	N/A	N/A	N/A	
Main Trunk	S-AC70013535.1	S-MA70028302	1980 x 3050 mm	Egg-shaped Invert: 224.99 m
SRS Outfalls	N/A	N/A	N/A	No SRS within the district.
SRS Interconnections	N/A	N/A	N/A	No SRS within the district.
Main Trunk Flap Gate	S-AC70013537.1	S-CG00000807	1800 mm	Invert: 224.97 m
Main Trunk Sluice Gate	S-AC70009023.1	S-CG00000808	1800 x 1800 mm	Invert: 224.97 m

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Off-Take	S-MH70010263.1	S-MA70019359	500 mm	Circular Invert: 224.99 m
Dry Well	N/A	N/A	N/A	
Lift Station Total Capacity	N/A	N/A	0.158 m^3/s	1 x 0.082 m^3/s 1 x 0.076 m^3/s
Lift Station ADWF	N/A	N/A	0.061 m^3/s	Ferry Road district as 0.057 m^3/s (no Douglas Park contribution)
Lift Station Force Main	S-AC70009022.1	S-MA70019343	350 mm	Invert: 223.35 m
Flood Pump Station Total Capacity	N/A	N/A	N/A	No flood pump station within the district.
Pass Forward Flow – First Overflow	N/A	N/A	0.155 m^3/s	

Note:
ADWF = average dry-weather flow
GIS = geographic information system ID = identification m^3/s = cubic metre(s) per second
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	224.55
2	Trunk Invert at Off-Take	224.99
3	Top of Weir	225.29
4	Relief Outfall Invert at Flap Gate	N/A
5	Low Relief Interconnection	N/A
6	Sewer District Interconnection (Douglas Park)	226.34
7	Low Basement	228.75
8	Flood Protection Level	230.55

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed for Ferry Road was in 2006 with the *Ferry Road and Riverbend Combined Sewer Relief Works* (Wardrop, 2006). This study discussed the possible separation work available for both Ferry Road and Riverbend CS systems to reduce the incidence of basement flooding. Since that time dedicated sewer separation work aligned with this study has been designed and constructed. To date, the area located to the east of Hampton Street has been completely separated.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Ferry Road CS District was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations have a combination of inflow and overflow level meters and flap gate inclinometers, if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Planned Completion
16 – Ferry Road	2006 - Conceptual	Future Work – Following Sewer Separation	2013	Sewer Separation Ongoing	TBD (estimated completion of 2028)

Note:
TBD = to be determined

1.5 Ongoing Investment Work

The Ferry Road basement flooding relief program began in 2013 with separation work being completed within the district. It is expected to continue through the beginning stages of the CSO Master Plan. Once completed, it will provide complete road drainage separation of the Ferry Road, Douglas Park, Parkside and Riverbend districts. Separation work will be integrated into the CSO Master Plan along with other control options.

To date, the separation work has been completed on the sections of Berry Street, Brooklyn Street, King Edward Street, Queen Street, and Madison Street between Portage Avenue and Silver Avenue and a section of Kensington Street between Ness Avenue and Silver Avenue. A further 10 Contracts for separation work on various segments of streets are to be completed in the future to completely separate the Ferry Road district.

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Ferry Road district. This consists of monthly site visits in confined entry spaces to verify physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Ferry Road district are listed in Table 1-4**Error! Reference source not found.**. The proposed CSO control is sewer separation to align with work currently underway. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85% Capture in a Representative Year	-	-	-	-	-	-	-	✓	✓	✓	-

Notes:

- = not included
✓ = included

The decision to include complete sewer separation of Ferry Road under the BFR work will remove a large volume of land drainage from the CS system, thereby reducing the volume and number of CSOs for the district. The intent of complete separation would be to eliminate all CSOs from the district under the 1992 representative year rainfall conditions. This will require post separation monitoring to confirm the elimination of CSOs and remaining wet weather response in the district from existing building foundation drainage connections to the CS system.

GI and RTC will be applied within each district on a system-wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Sewer Separation

Sewer separation is proposed for Ferry Road district as part of the CSO Master Plan and is underway as part of the Ferry Road and Riverbend separation work. Complete separation of Douglas Park is also included as part of this work will also remove a large volume of land drainage runoff from the neighboring district's CS system entering Ferry Road, thereby reducing the volume and number of CSOs for the district.

The work includes installation of a new independent LDS system to collect road drainage and divert this flow to a new connection point on the existing 1500 mm LDS sewer at intersection of Ness Avenue and Century Street, which is part of the Riverbend CS district. This existing LDS system drains to the Assiniboine River at near Century Street and Wolseley Avenue West.

The flows to be collected after separation will be as follows:

- DWF will remain the same – collected flow pumped from Ferry Road CS LS to the interceptor.
- WWF will consist of sanitary sewage combined with foundation drainage.

This will result in a reduction in combined sewage flow received at Ferry Road CS LS after the separation project is complete. It is proposed that future monitoring of the district is completed to verify that the sewer separation is fully compliant with the goal of elimination of all CSO overflows under 1992 rainfall conditions. A static weir elevation increase may be necessary at the CS diversion to eliminate the occurrence of all CSO events during the 1992 representative year. The initial hydraulic model assessment indicated that using the existing static weir level one CSO occurrence for the Ferry Road district would continue to occur after the separation work is complete. An increase of 580 mm in the primary weir height was assessed to be required, and this increase has been evaluated in the hydraulic model and was found to not impact the upstream hydraulic grade. This is primarily due to the removal of WWF from the separation projects in neighboring districts as part of the BFR work. Any weir elevation raise will be further evaluated in terms of actual flow monitoring data to confirm ensure the existing level of basement flood protection remains.

1.6.3 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district will be reviewed to identify the most applicable GI controls.

Ferry Road has been classified as a high GI potential district. The land use is primarily residential with commercial areas along Portage Avenue and Ness Avenue and a general manufacturing/industrial region north of St. Matthews Avenue near the Winnipeg Airport. This means the district would be an ideal location for bioswales, permeable paved roadways, cisterns/rain barrels, and rain gardens. The commercial buildings along Portage Avenue would be ideal for green roof projects, and the greenspace areas in the district would be ideal for bioretention garden projects.

1.6.4 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the master plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

Sewer separation will include the installation of additional sewers that will require inspection, cleaning and rehabilitation. This will result in additional maintenance costs over the long term, but operational costs will be minimal. The existing larger CS pipes within the district may also receive insufficient flow with the separation work for proper scouring velocities in the sewer pipes. This could result in solids settling within the sewers, and requiring more frequent cleaning operations. The impacts of the reduced flows in larger CS pipes will be evaluated as part of the sewer separation design for the district.

It is recommended to continue to maintain and operate the flow monitoring instrumentation and assess the results after district separation work has been completed. This will allow the full understanding of the non-separated storm elements (foundation drain connections to the CS system) extent within the Ferry Road district.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. An individual model was created to represent the sewer system baseline as represented in the year 2013 and a model for the CSO Master Plan with the control options implemented in the year 2037. A summary of relevant model data is summarized in Table 1-5.

Table 1-5. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	235	235	6,822	36	N/A
2037 Master Plan – Control Option 1	235	216	6,822	1	SEP

Table 1-5. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model

Notes:

Total area is based on the model subcatchment boundaries for the district.
SEP = Separation
% = percent

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district. While this district is to be separated and as a result Clause 8 of Licence No. 3042 will not be in effect, the wet weather response of the district overall will still need to be assessed.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-6, are for the hydraulic model simulations using the year-round 1992 representative year applied uniformly. The table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan – Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. The table also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-6. Performance Summary – Control Option 1

Control Option	Preliminary Proposal Annual Overflow Volume (m^3)	Master Plan Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow
Baseline (2013)	124,634	136,599	-	22	0.185 m^3/s [b]
Sewer Separation	0 [a]	420	136,179	1	0.171 m^3/s [b]
Separation & Static Weir Height Increase		0	420	0	0.170 m^3/s [c]
Control Option 1	**0**	**0**	**136,599**	**0**	**0.170 m^3/s [c]**

[a] Separation and In-line storage were not simulated independently during the Preliminary Proposal assessment

[b] Pass forward flows assessed with the 1-year design rainfall event

c Pass forward flows assessed with the 5-year design rainfall event

The percent capture performance measure is not included in Table 1-6, as it is applicable to the entre CS system, and not for each district individually. However, the full capture of overflows volumes for the Ferry Road district would represent a 100 percent capture rate on a district level.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each relevant control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-7. The cost estimates are a Class 5 planning level estimate with a level of accuracy range of minus 50 percent to plus 100 percent.

Table 1-7. Cost Estimates – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost [a]	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period) [a]
Sewer Separation	$195,600,000	$129,360,000 [b]	$77,000	$1,650,000
Subtotal	**$195,600,000**	**$129,360,000**	**$77,000**	**$1,650,000**
Opportunities	N/A	$12,940,000	$8,000	$170,000
District Total	**$195,600,000**	**$142,300,000**	**$85,000**	**$1,820,000**

[a] Ferry Road separation is approximately 30% complete and an adjustment has been included in the CSO Master Plan district capital cost estimate to account for this.

[b] Separation capital costs do not include static weir height raise work recommended.

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional costs for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014-dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019-dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-8.

Table 1-8. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Sewer Separation	Unit Costs were updated. Cost adjusted for percentage of sewer separation completed	
-Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management Approach	

Table 1-8. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation	Preliminary Proposal estimates were based on 2014-dollar values	

1.10 Meeting Future Performance Targets

The complete separation of the Ferry Road district will achieve the 100 percent capture figure, and no other further work will be required to meet the future performance target. It is recommended to complete post separation modelling to confirm the target is fully achieved.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed as part of the CSO Master Plan and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-9.

Table 1-9. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	-	-	-	O	-	-	-
2	Existing Lift Station	-	-	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	O	-	-	-
4	Construction Disruption	-	-	-	-	R	-	-	-
5	Implementation Schedule	-	-	-	-	R	-	R	-
6	Sewer Condition	-	-	-	-	-	-	-	-
7	Sewer Conflicts	-	-	-	-	R	-	-	-
8	Program Cost	-	-	-	-	R	-	-	-
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	-	-	-	-	O	O	O	-
12	Operations and Maintenance	-	-	-	-	R / O	R	O	-

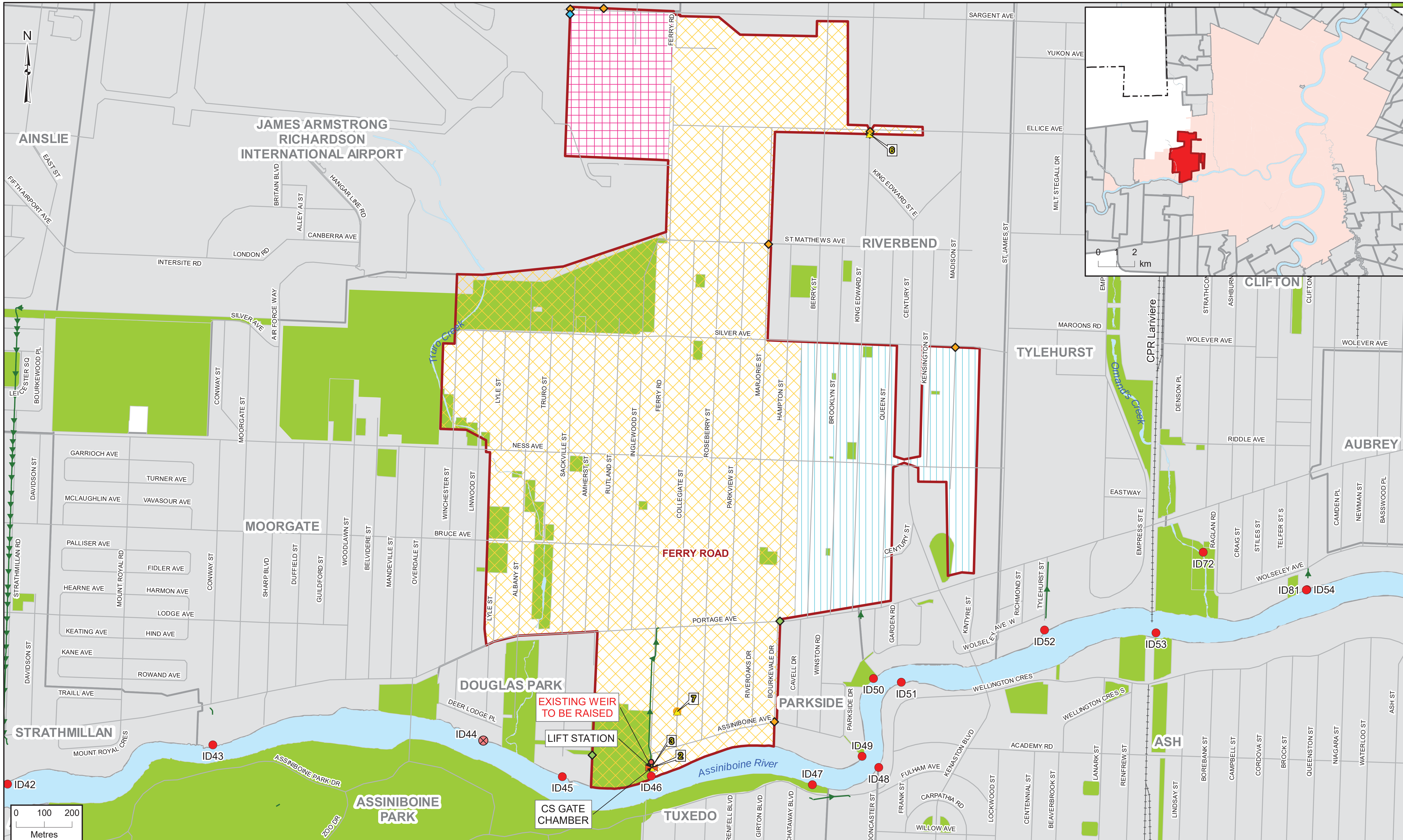
Table 1-9. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
13	Volume Capture Performance	-	-	-	-	-	O	O	-
14	Treatment	-	-	-	-	O	O	O	-

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

Wardrop. 2006. *Ferry Road and Riverbend Combined Sewer Relief Works*. Prepared for the City of Winnipeg Water and Waste Department. November.



LEGEND

Primary Weir
Critical Elevation
Decommissioned Outfall
CSO Outfall
Low CS Manhole

Inter-System Connection
CS - WWS

District Boundary Crossing
CS
LDS
WWS

Force Main
Street
Railway

District Boundary
Watercourse
Greenspace

CSO MASTER PLAN PROPOSED SOLUTIONS

Sewer Separation - Underway
Sewer Separation - Complete
Sewer Separation - Ready

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 16
District Overview Map
Sewer District: Ferry Road
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Hart District Plan

August 2019

City of Winnipeg

JACOBS

CSO Master Plan

Project No: 470010CH
Document Title: Hart District Plan
Revision: 03
Date: August 22, 2019
Client Name: City of Winnipeg
Project Manager: John Berry
Author: Jack Tinker
File Name: Hart_Plan_Final_CO1MP_08192019

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Document History and Status

Revision	Date	Description	By	Review	Approved
0	10/05/2018	DRAFT for City Comment	AK, DT	SG	
1	02/15/2019	DRAFT 2 for City Review	JT	MF	MF
2	6/20/2019	Final Draft Submission	DT	MF	MF
3	08/19/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

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Figure

1. Hart District

1.1 District Description

The Hart district is located in the northeastern sector of the combined sewer (CS) area along the eastern edge of the Red River, south of the Munroe district and west of the Roland district. Hart is approximately bounded by the Red River to the south and west, Gateway Road to the east, and Harbison Avenue West to the north.

The majority of Hart is mixed residential with smaller areas of commercial and industrial land use. Residential areas are mainly single-family with some two-family and multi-family along Watt Street and Stadacona Street. Manufacturing and commercial areas are located along Henderson Highway, Watt Street, and Stadacona Street. Approximately 45 ha of the district is classified as greenspace. Greenspace areas include Elmwood Winter Park, Chalmers Park, and Ernie O'Dowda Park; and various school parks, playgrounds, and community areas throughout the district. The Elmwood Cemetery makes up a large area in the southwestern part of the district.

This district is located in proximity to downtown and has many transportation routes. Regional roads in the district include Henderson Highway and Watt Street in the north-south direction and Nairn Avenue, Talbot Avenue, Midwinter Avenue, Hespler Avenue, and Johnson Avenue in the east-west direction. The Harry Lazeranko Bridge on Hespler Avenue and both the Disraeli (Henderson Highway) and Louise Bridges (Stadacona Street) cross the Red River into St Johns and Syndicate districts, respectively.

1.2 Development

A portion of Nairn Avenue and Henderson Highway are located within the Hart District. These streets are identified as a Regional Mixed Use Corridors as part of the OurWinnipeg future development plans. As such, focused intensification along Nairn Avenue and Henderson Highway is to be promoted in the future.

Nairn Avenue, Watt Street, and a portion of Stradacona Street within the Hart District have been identified as part of the potential routes for the Eastern Corridor of Winnipeg's Bus Rapid Transit. The work along these streets could result in additional development in the area. This could also present an opportunity to coordinate sewer separation works alongside the transit corridor development, providing further sewer separation within the Hart District. This would reduce the extent of the Control Options listed in this plan required.

1.3 Existing Sewer System

Hart district encompasses an area of 222 ha[1] based on the district boundary and includes a CS system and a storm relief sewer (SRS) system. This district includes 15 percent (33 ha) identified as land drainage sewer (LDS) separated. There are no separation-ready areas identified.

The CS system includes a diversion structure, flood pump station (FPS), CS lift station (LS), CS outfall, and outfall gate chamber within the FPS. The CS systems drain towards the pump stations and Hart CS outfall located at the western end of Hart Avenue at the Red River. Sewage is either diverted to the SPS and pumped across the Red River and connects to the Main Interceptor within the St. Johns district, or overflows the primary weir and flows through the FPS wet well and into the CS outfall into the Red River.

A single CS trunk collects flow from most of the district and directs flow to the primary weir near Hart Avenue. The main 1625 mm by 2060 mm CS trunk extends from the primary weir east along Hart Avenue. Multiple collector pipes in the eastern and centre areas of Hart district flow into the CSmain

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur

along Henderson Highway. The Henderson Highway CS main then flows to tie into the main trunk sewer on Hart Avenue.

The SRS system includes various interconnections to the CS system. The southeastern portion of the district east of Stadacona Street and south of Chalmers Avenue is serviced by a complete SRS system including connected catch basins and an outfall to the Red River. This portion of the SRS connects downstream of the gate chamber that services the Roland district CS system and shares this outfall with the SRS and CS from the Roland district. As the Hart SRS ties into the outfall downstream of the gate chamber, there is no flap gate or positive gate to provide protection against high river levels. The remainder of the SRS pipe in the district west of Stadacona and north of Chalmers Avenue provides extra capacity during high flow events, such that the CS system can overflow into the SRS. When CS capacity is regained, the SRS drains back into the Hart CS system. Most catch basins, aside from the southeastern SRS area, are still connected to the CS system.

During dry weather flow (DWF), the SRS is not required; sanitary sewage flows to the diversion chamber and is diverted by the primary weir to a 450 mm off-take pipe, where it flows by gravity to an adjacent CS LS to be pumped through a force main river crossing. The river crossing flows into the St. John's district and discharges by gravity into the Main Interceptor, which eventually flows by gravity to the North End Sewage Treatment Plant (NEWPCC) for treatment.

During wet weather flow (WWF) events, any flows that exceed the diversion capacity overtop the primary weir and are discharged to the Red River via the outfall structure. Sluice and flap gates are installed on the CS outfall to prevent back-up of the Red River into the CS system under high river level conditions. Under these high river level conditions gravity discharge is not possible, and excess flow is pumped by the Hart FPS to an alternate outfall flow path, which allows it to by-pass the flap and sluice gates and be discharged directly to the river via the same outfall.

There is one (shared CS and SRS) outfall to the Red River as follows:

- ID27 (S-MA70043042) – Hart CS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Hart and the surrounding districts. Each interconnection is shown on Figure 17 and shows locations where gravity flow can cross from one district to another. Each interconnection is listed as follows:

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

St John's

- Two 300 mm force mains carry flow from the Hart SPS across the Red River to the St. John's district:
  - Invert at manhole in St. John's district east of Main Street – 227.72 m (S-MH70028727)

1.3.1.2 District Interconnections

Mission

CS to CS

- CS flows through a 600 mm CS off-take secondary interceptor pipe south by gravity on Archibald Street from Hart district into Mission district. This is CS intercepted from the Roland district. This CS then flows into the Montcalm CS LS and is pumped via force main river crossing into the Syndicate district. There is no interaction with the Hart CS system.
  - Invert at Hart district boundary 223.56 m (S-MA50018054)

Roland

CS to CS

- A 1625 by 2060 mm CS flows west by gravity on Elmwood Road at Watt Street from Roland district into Hart district to enter the Roland CS outfall. There is no interaction with the Hart CS system.
  - Invert at Hart district boundary 223.52 m (S-MA40011002)

SRS to SRS

- A 2900 mm SRS flows southwest by gravity crossing Elmwood Road from Roland district into Hart district. This trunk connects into the same gate chamber and outfall as the Watt Street SRS; there is no interaction with the Hart SRS system upstream of the gate chamber.
  - Invert at Hart district boundary 222.27 m (S-MA40011025)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, flow controls, pumping systems, and discharge points for the existing system.

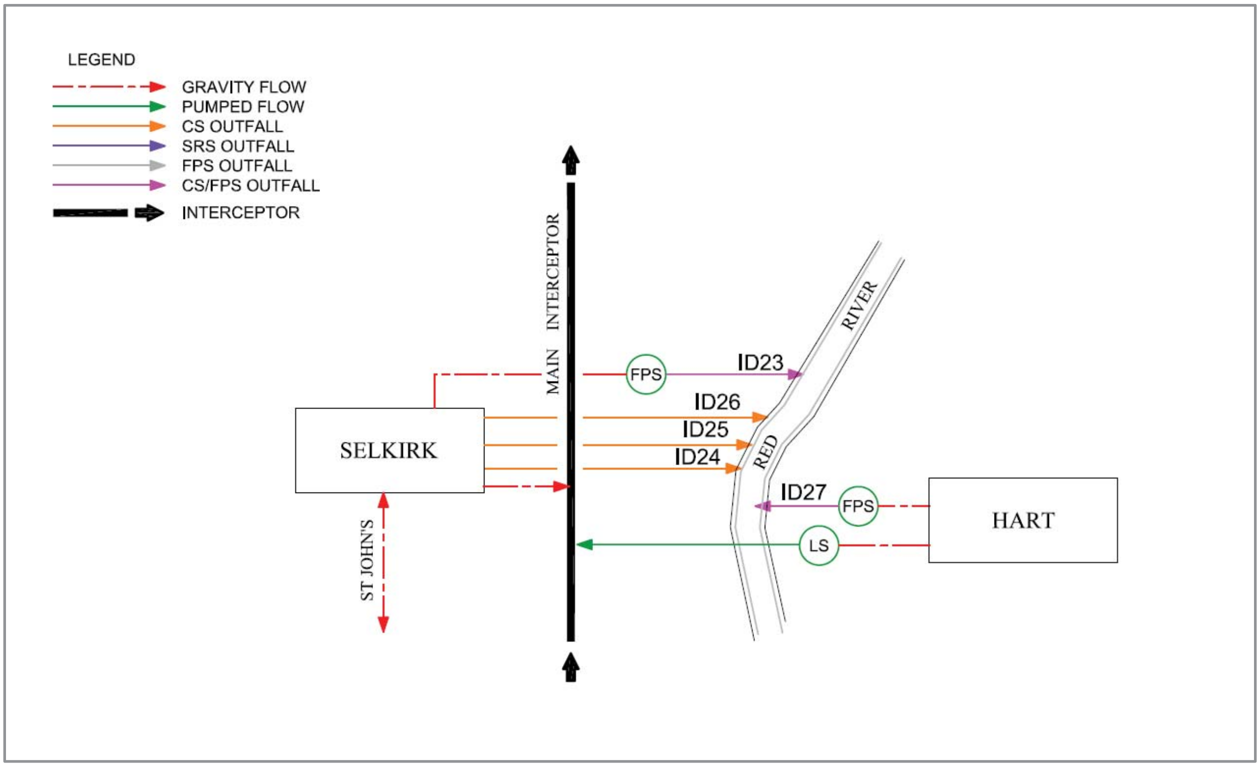


Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 17 and listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID27)	S-AC70016714.1	S-MA70043042	2550 mm, Invert: 222.02 m	Red River (SAP_E-34 has 2400 mm)

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Flood Pumping Outfall (ID27)	S-AC70016714.1	S-MA70043042	2550 mm, Invert: 222.02 m	Red River (SAP_E-34 has 2400 mm)
Main Trunk	S-TE40000965.1	S-MA70016456	2850 mm Invert: 222.76 m	Main CS that flows west on Hart Avenue (SAP_E-34 has 2850 x 2160 mm)
SRS Outfalls	N/A	N/A	N/A	SRS outfall from Hart shared with primary CS outfall from Roland district.
SRS Interconnections	N/A	N/A	N/A	52 SRS - CS
Main Trunk Flap Gate	S-TE70026133.1	S-CG00001075	2400 mm	Invert: 223.14 m
Main Trunk Sluice Gate	S-CG00001075.1	S-CG00001076	2400 x 2400 mm	Invert: 222.87 m
Off-Take	S-MH70006540.1	S-MA70016455	450 mm	Diverts DWF to lift stations for treatment Invert: 222.76 m
Dry Well	N/A	N/A	N/A	
Lift Station Total Capacity	N/A	N/A	0.114 m^3/s	2 x 0.057 m^3/s
ADWF	N/A	N/A	0.029 m^3/s	
Lift Station Force Main	S-MH70028728.2	S-MA70062904	300 mm	Pumped for treatment at NEWPCC Invert: 226.46 m
	S-MH70028728.1	S-MA70062904	300 mm	Pumped for treatment at NEWPCC Invert: 226.46 m
Flood Pump Station Total Capacity	N/A	N/A	1.83 m^3/s	2 x 0.53 m^3/s 1 x 0.77 m^3/s
Pass Forward Flow – First Overflow	N/A	N/A	0.124 m^3/s	

Notes:

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification

N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Hart – 223.683
2	Trunk Invert at Off-Take To Lift Station	222.76
3	Top of Weir	223.08
4	Relief Outfall Invert at Flap Gate	N/A

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
5	Low Relief Interconnection (S-TE40000965)	223.46
6	Sewer District Interconnection (Roland)	222.52
7	Low Basement	226.65
8	Flood Protection Level (Hart)	229.32

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed in Roland was the *Munroe, Roland, Hart Combined Sewer Study* (Wardrop, 1985). The study's purpose was to develop sewer relief options to reduce surcharge levels and relieve basement flooding. No other studies have been completed on the district sewer system since that time.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Hart Combined Sewer District was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations has a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Expected Completion
17 – Hart	1985	Future Work	2013	Study Complete	N/A

Source: Report *Munroe, Roland, Hart Combined Sewer Study*, 1985

1.5 Ongoing Investment Work

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Hart district. This consists of monthly site visits in confined entry spaces to verify that physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Hart sewer district are listed in Table 1-4. The proposed CSO control projects will include in-line storage via a control gate, and floatable management via screening. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	-	-	-	✓	✓	-	-	-	✓	✓	✓

Notes:

- = not included
✓ = included

The existing CS system is suitable for use as in-line storage. This control options will take advantage of the existing CS pipe networks for additional storage volume. Existing DWF from the collection system will remain the same, and overall district operations will remain the same. The district has a large CS trunk and capacity available to operate as storage.

All primary overflow locations are to be screen under the current CSO control plan. Installation of a control gate will be required for the screen operation, and it will provide the mechanism for capture of the in-line storage. Floatable control will be necessary to capture floatables in the sewage. Floatables will be captured with all implemented control options to some extent, but screening may be added as required to reach the desired level of capture.

Complete sewer separation was also assessed for the Hart district, given the extent of separation which has occurred to date and the access to the Red River from multiple points within the district. The system wide assessment however did not find complete sewer separation to be necessary to achieve the 85 percent capture performance target. Complete sewer separation in this instance was found to not be cost effective to achieve the necessary percent capture.

GI and RTC will be applied within each district on a system-wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.1 In-Line Storage

In-line storage has been proposed as a CSO control for the Hart district. In-line storage will require the installation of a control gate at the CS outfall. The gate will increase the storage level in the existing CS and provide an overall higher volume capture. The existing SPS will provide the dewatering for the in-line storage.

A standard design was assumed for the control gate, as described in Part 3C. A standard approach was used for conceptual gate sizing by assuming it to be the lesser of the height of half of the site-specific trunk diameter or the maximum height of the gate available. The design criteria for the in-line storage are listed in Table 1-5.

Table 1-5. In-Line Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	222.76 m	N/A
Trunk Diameter	2850 mm	N/A

Table 1-5. In-Line Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Gate Height	1.21 m	Gate height based on half trunk diameter assumption
Top of Gate Elevation	224.28 m	N/A
Maximum Storage Volume	2027 m^3	N/A
Nominal Dewatering Rate	0.114 m^3/s	Based on existing CS LS capacity
RTC Operational Rate	TBD	Future RTC / dewatering review on performance, potentially based on 2 times nominal rate

Note:
RTC = Real Time Control

TBD = to be determined

The proposed control gate will cause combined sewage to back-up within the collection system to the extent shown on Figure 17. The extent of the in-line storage and volume is related to the top elevation of the bypass side weir. The level of the top of the bypass side weir and adjacent control gate level are determined in relation to the critical performance levels in the system for basement flooding protection: when the system level increases above the bypass weir crest and proceeds above the top of the control gate during high flow events, , the control gate drops out of the way. At this point, the district will only provide its original interception capacity via the primary weir for the district, and all excess CS would flow over the weir and discharge to the river. After the sewer levels in the system drops back below the bypass side weir critical performance level, the control gate moves back to its original position to capture the receding limb of the WWF event. The CS LS will continue with its current operation while the control gate is in either position, with all DWF being diverted to the CS LS and pumped. The CS LS will further dewater the in-line storage provided during a WWF event as downstream capacity becomes available.

The physical requirements for the off-take and station sizing for a modification to pumping capacity have not been considered in detail, but they will be required in the future as part of an RTC program or lift station rehabilitation or replacement project.

Figure 17-01 provides an overview of the conceptual location and configuration of the control gate and screening chambers. The control gate will be installed in a new chamber within the trunk sewer alignment upstream of the FPS and CS LS. The dimensions of a new chamber to provide an allowance for a side weir for floatables control are 6 m in length and 4 m in width. The existing pipe configuration, including the weir and off-take, will have to be modified to allow the installation of the in-line gate and screening chambers. The outfall easement is constricted which may add difficulty to construction in this location. Residential homes are located directly adjacent to the existing gate chamber and easement.

The nominal rate for dewatering is set at the existing CS LS capacity. This allows dewatering through the existing interceptor system within 24 hours following the runoff event, allowing it to recover in time for a subsequent event. The future RTC upgrades will provide the ability to capture and treat more volume for localized storms by using the excess interceptor capacity where the runoff is less. Further assessment of the actual impact of the future RTC/dewatering arrangement will be necessary to review the downstream impacts.

1.6.2 Floatables Management

Floatables management will require installation of a screening system to capture floatable materials. The off-line screens will be designed to maintain the current level of basement flooding protection.

The type and size of screens depend on the specific station configuration and the head available for operation. A standard design was assumed for screening and is described in Part 3C. The design criteria for screening, with an in-line control gate implemented, are listed in Table 1-6.

Table 1-6. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Top of Gate	224.28 m	
Bypass Weir Crest	224.18 m	
NSWL	223.68 m	
Maximum Screen Head	0.50 m	
Peak Screening Rate	0.52 m^3/s	
Screen Size	1.5 m wide x 1 m high	Modelled Screen Size

The side overflow weir and screening chamber will be located adjacent to the existing combined trunk sewer, as shown on Figure 17-01. The screens will operate once levels within the sewer surpass the in-line control elevation. A side weir upstream of the control gate will direct the overflow to the screens located in the new screening chamber, with screened flow discharged to the downstream side of the gate to the river. The screening chamber will include screenings pumps with a discharge returning the screened material back to Hart CS LS and on to NEWPCC for removal. The provision of screening pumps is dependent on final level assessment within the existing infrastructure and the Hart trunk is likely to require pumped screenings return. This will be confined during the future assessment stage.

The dimensions for the screen chamber to accommodate influent from the side weir, the screen area, and the routing of discharge downstream of the gate are 3.5 m in length and 3 m in width.

1.6.3 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district was reviewed to identify the most applicable GI controls.

Hart has been classified as a high GI potential district. Land use in Hart is mixed residential with smaller areas of commercial and industrial land use. Residential areas are mainly single-family with some two-family and multi-family along Watt Street and Stadacona Street. Manufacturing and commercial areas are located along Henderson Highway. This means the district would be an ideal location for bioswales, permeable paved roadways, cisterns/rain barrels, and rain gardens. The flat roof commercial buildings along Henderson Highway make would be an ideal location for green roofs. There is also a higher area of greenspace in Hart district which could be used for rain garden projects.

1.6.4 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

In-line storage will impact the existing sewer and will require the addition of a new chamber and a moving gate at the outfall. In-line storage dewatering will be controlled with the existing Clifton CS LS, which will require more frequent and longer duration pump run times. Lower velocities will occur in the CS trunk in the vicinity of the control gate due to lower pass forward flows, and may create additional debris deposition requiring cleaning. Additional system monitoring, and level controls will be installed, which will require regular scheduled maintenance.

Floatable control with outfall screening will require the addition of another chamber with screening equipment installed. The chamber will be installed adjacent to the control gate chamber and will operate in conjunction with it. Screening operation will occur during WWF events that surpass the in-line storage control level. WWF will be directed from the main CS trunk, over the side weir in the control gate chamber and through the screens to discharge into the river. The screens will operate intermittently during wet weather events and will likely require operations review and maintenance after each event. The frequency of a screened event will correlate to the number overflows identified for the district. Having the screenings pumped back to the interceptor system via a small LS and force main will be required. The screenings return will require O&M inspection after each event to assess the performance of the return pump system.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. An individual model was created to represent the sewer system baseline as represented in the year 2013 and a second model was created for the CSO Master Plan evaluation purposes, with all the control options recommended for the district to meet Control Option 1 implemented in the year 2037. A summary of relevant model data is provided in Table 1-7.

Table 1-7. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	193	193	9,488	68	N/A
2037 Master Plan – Control Option 1	193	193	9,488	68	IS, SC

Notes:

Total area is based on the model subcatchment boundaries for the district.
IS = In-line Storage
SC = Screening

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-8 are for the hydraulic model simulations using the year-round 1992 representative year. The table lists the results for the Baseline, for each individual control option, and for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. The table also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-8. Performance Summary – Control Option 1

Control Option	Preliminary Proposal Annual Overflow Volume (m^3)	Master Plan Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [a]
Baseline (2013)	202,990	202,745	-	21	0.090 m^3/s
In-Line Storage	158,187	165,575	37,170	20	0.127 m^3/s
Control Option 1	**158,187**	165,575	37,170	**20**	**0.127 m^3/s**

[a] Pass forward flows assessed on the 1-year design rainfall event

The percent capture performance measure is not included in Table 1-8, as it is applicable to the entire CS system and not for each district individually.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-9. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-9. Cost Estimates – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period)
In-Line Storage	$7,740,000 [a]	$2,950,000 [b]	$47,000	$1,010,000
Screening		$2,330,000 [c]	$54,000	$1,150,000
Subtotal	**$7,740,000**	**$5,280,000**	**$101,000**	**$2,160,000**
Opportunities	N/A	$530,000	$10,000	$220,000
District Total	**$7,7400,000**	**$5,810,000**	**$111,000**	**$2,380,000**

[a] Control Gate and screening costed together as part of the Preliminary Proposal costing.

[b] Cost associated with new off-take construction, as required, to accommodate control gate location and allow intercepted CS flow to reach existing Clifton LS not included

[c] Cost for bespoke screenings return pump/force main not included in Master Plan as will depend on selection of screen and type of screening return system selected

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional costs for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014-dollar values.

- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019-dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-10.

Table 1-10. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Option	Control Gate	Preliminary Proposal estimate was based on a standard cost per district, which has been updated to a site-specific cost estimate.	Updates to costing estimates adopted for Master Plan costing
	Screening	Preliminary Proposal estimate was based on a standard cost per district, which has been updated to a site-specific cost estimate.	Updates to costing estimates adopted for Master Plan costing
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management Approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation.	Preliminary Proposal estimates were based on 2014-dollar values.	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to 98 percent capture for the representative year. This will still be on a system-wide basis and will permit the number of overflows and percent capture to vary by district to meet the 98 percent capture target. Table 1-11 provides a description of how the upgrade could be met by building off controls identified in Control Option 1.

Overall the Hart district would be classified as a high potential for implementation of complete sewer separation as a feasible approach to achieve the 98 percent capture future performance target in the representative year. . The non-separation measures recommended as part of this district engineering plan to meet Control Option 1, specifically in-line storage and floatables management via off-line screening, are therefore at risk of becoming redundant and unnecessary when the measures to achieve future performance targets are pursued. As a result, these measures should not be pursued until the requirements to meet future performance targets are more defined. Should it be confirmed that complete separation is the recommended solution to meet future performance targets, then complete separation will likely be pursued to address Control Option 1 instead of implementing the non-separation measures. This will be with the understanding that while initial complete separation is less cost-effective to meet Control Option 1, it is the most cost effective solution to meet the future performance target and removes the capital costs on short term temporary solutions. The focused use of green infrastructure at key locations would also provide additional volume capture benefits to meet future performance targets.

Table 1-11. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Sewer Separation • Increased use of GI

The control options selected for the Hart district have been aligned for the 85 percent capture performance target based on the system wide basis. The expandability of this district to meet the 98 percent capture would be restricted as proposals for Control Option No.1 do not match with the 98 percent target. This would involve the expansion of the SRS systems, although this would require connection of the existing catch basins in locations where SRS pipes have been installed and this will be required to be completed to achieve complete sewer separation of this district.

The cost for upgrading to an enhanced performance target depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-12.

Table 1-12. Control Option 1 Significant Risks and Opportunities

ID Number	Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	R	-	-	-	-	-	-
2	Existing Lift Station	-	R	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	-	-	-	-
4	Construction Disruption	-	-	-	-	-	-	-	-
5	Implementation Schedule	-	-	-	-	-	-	R	-

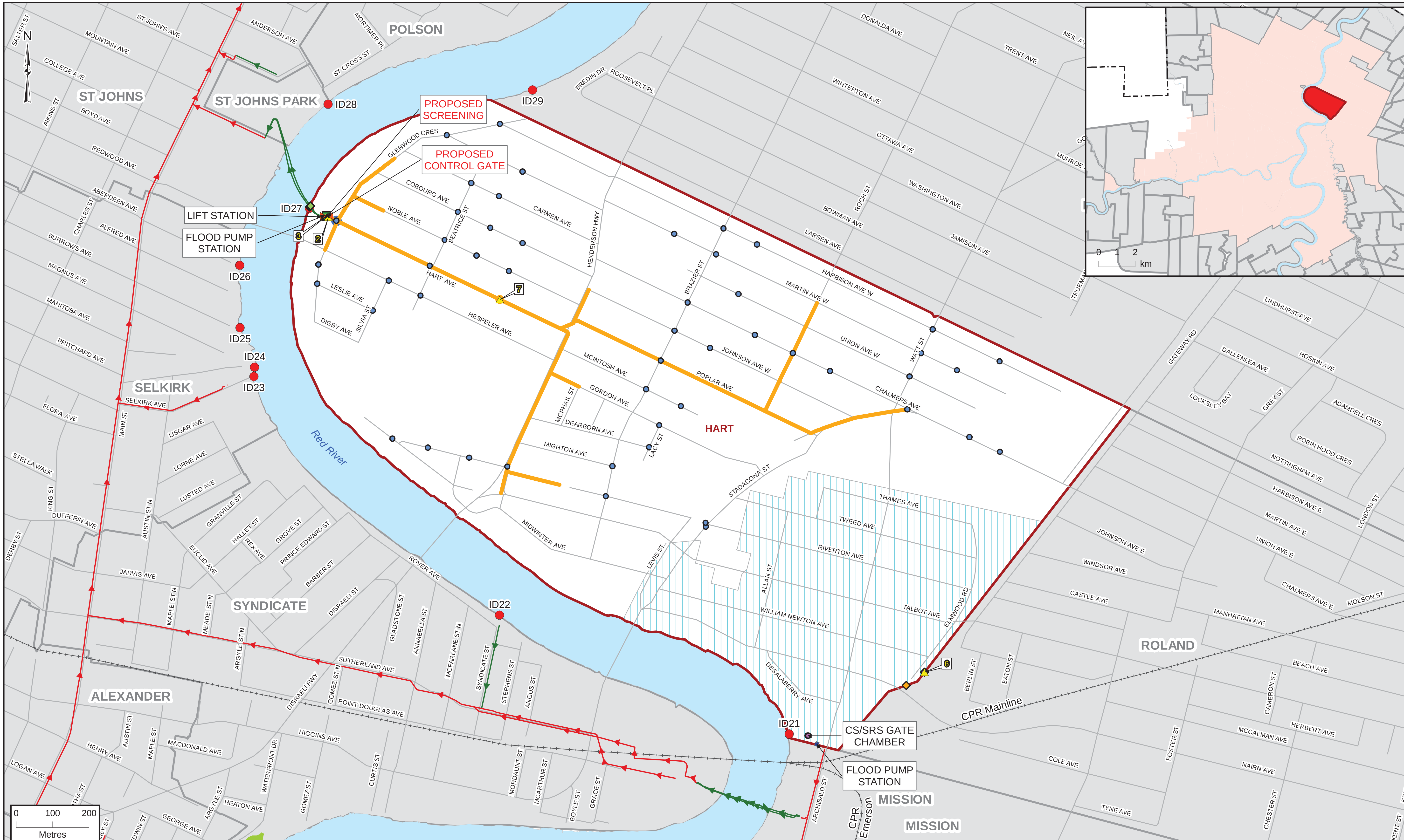
Table 1-12. Control Option 1 Significant Risks and Opportunities

ID Number	Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
6	Sewer Condition	-	R	-	-	-	-	-	-
7	Sewer Conflicts	-	R	-	-	-	-	-	-
8	Program Cost	-	O	-	-	-	-	-	O
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	-	-	-	-	-	O	O	-
12	Operations and Maintenance	-	R	-	-	-	R	O	R
13	Volume Capture Performance	-	O	-	-	-	O	O	-
14	Treatment	-	R	-	-	-	O	O	R

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

Wardrop Engineering Consultants (Wardrop). 1985. *Munroe, Roland, Hart Combined Sewer Relief Study.* Prepared for the City of Winnipeg, Waterworks, Waster and Disposal Department. June.



LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Low CS Manhole
- Low SRS Connection

Inter-System Connection
- CS - WWS
- SRS - CS
- SRS - LDS

District Boundary Crossing
- CS
- SRS
- WWS

- Interceptor Sewer
- Force Main
- Street
- Railway

- District Boundary
- Watercourse
- Greenspace

CSO MASTER PLAN PROPOSED SOLUTIONS

- Proposed Control Gate
- Extent of In-line Storage
- Sewer Separation - Complete

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 17
District Overview Map
Sewer District: Hart
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

Primary Weir	Flap Gate	Force Main	Sewer By Type	Pump Station Type
Critical Elevation	Sluice Gate		CS	Flood Pump Station
CSO Outfall	Pump Location		SRS	Lift Station
Manhole			WWS	

CSO MASTER PLAN
PROPOSED SOLUTIONS

- Control Gate
- Screening

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 17-01
Control Gate and Screening
Sewer District: Hart
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Hawthorne District Plan

August 2019

City of Winnipeg

JACOBS

CSO Master Plan

Project No: 470010CH
Document Title: Hawthorne District Plan
Revision: 03
Date: August 22, 2019
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Project Manager: John Berry
Author: Scott Begg
File Name: Hawthorne_Plan_Final_CO1MP_08192019

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Document History and Status

Revision	Date	Description	By	Review	Approved
0	10/05/2018	Version 1 DRAFT	KM	DT SG	
1	02/15/2019	DRAFT 2 for City Review	SB	SG	MF
2	07/2019	Final Draft Submission	DT	MF	MF
3	08/19/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

Tables

Figure

1. Hawthorne District

1.1 District Description

Hawthorne district is in the northeast sector of the combined sewer (CS) area along the eastern edge of the Red River and north of Linden and Munroe Annex districts. Hawthorne is approximately bounded by Fraser's Grove, Colvin Avenue, and Cameo Crescent to the south, the Red River to the west, Springfield Road to the north, and Raleigh Street to the east.

Most of the Hawthorne district is residential with portions of commercial and greenspace land use. Most of the residential units consist of single-family dwellings; multi-family and two-family units are located along Edison Avenue and Henderson Highway. Several parks are located throughout the district, with greenspace areas and parks bounding portions of the district. Approximately 17 ha of the district is classified as greenspace.

Henderson Highway, running in the north-south direction, is the only regional roadway in the district. Other main transportation routes include Roch Street, Rothesay Street, and Raleigh Street in a north-south direction and Kingsford Avenue, Edison Avenue, Oakland Avenue, Mcleod Avenue, and Hawthorne Avenue in the east-west direction.

1.2 Development

A portion of Henderson Highway is located within the Hawthorne District. Henderson Highway is identified as a Regional Mixed-Use Corridors as part of the OurWinnipeg future development plans. As such, focused intensification along Henderson Highway is to be promoted in the future.

1.3 Existing Sewer System

Hawthorne district encompasses an area of 245 ha[1] based on the district boundary and includes a CS system with a relatively small portion of separated wastewater sewer (WWS) and land drainage sewer (LDS) in the southwestern corner of the district. As shown in Figure 18, there is approximately 11 ha (4 percent) already separated. There are no identifiable separation ready areas. Hawthorne district does not have an SRS system.

The CS system includes a dual lift and flood pump station (LFPS), and one combined CS/FPS outfall. All of the CS from the district flows towards to the primary CS outfall, located at the intersection of Hawthorne Avenue and Kildonan Drive. Two main CS trunk sewers collect flow from the district. The larger of the two trunks is a 1050 mm increasing to 1650 mm CS, which extends east to west along Hawthorne Avenue and Kingsford Avenue. The second CS trunk sewer is a 600 mm increasing to 1350 mm sewer that generally extends east to west along Mcleod Avenue, Rowandale Avenue, Larchdale Crescent, and Kildonan Drive. Multiple secondary sewers connect to the CS trunks from the north and south to service the entire district.

During dry weather flow (DWF), the Hawthorne primary weir diverts flow to the lift section of the Hawthorne LFPS through a 525 mm off-take pipe, where it is pumped under pressure through a force main crossing the Red River and to the Newton district. From here, the intercepted combined sewage ties into the secondary sewer in the Newton district, which ties into the Main Interceptor, and eventually on to the North End Sewage Treatment Plant (NEWPCC) for treatment.

During wet weather flow (WWF), any flows that exceeds the diversion capacity overtops the primary weir and is discharged to the Red River through the Hawthorne CS outfall. Sluice and flap gates are installed

[1] City Of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur

on the outfall to prevent back-up of the Red River into the system under high river level conditions. However not only does the flap gate prevent river water intrusion, but it also prevents gravity discharge from the Hawthorne CS outfall. Under these conditions the excess flow is pumped by the flood pumps of the Hawthorne LFPS to a point in the Hawthorne CS Outfall downstream of the flap gate, where it can be discharged to the river by gravity once more.

The WWS system in the southwest corner of the Hawthorne district, and directs flow to a small WWS lift Station (LS) on Rowandale Avenue and Larchdale Crescent, where sewage is pumped into the CS system.

The LDS system is predominately in the southwestern corner of the Hawthorne district, and directs the surface runoff flow received from this area to the Red River via a dedicated LDS outfall located near the intersection of Rowandale Crescent and Kildonan Drive. Sluice and flap gates are installed on this LDS outfall to prevent back-up of the Red River into the LDS system under high river level conditions.

There is also an older LDS system, which flows through what was previously McLeod Creek in the northwestern corner of Hawthorne district. To allow for development over this existing creek, LDS pipes were installed where the creek originally existed to still allow for drainage of surface runoff to the Red River. Two distinct LDS systems exist surrounding McLeod Creek, one north of Hawthorne Avenue and another south. The LDS system north of Hawthorne drains north via a combination of buried pipes and open channel ditch arrangements, and eventually discharges into the Red River immediately north of Chief Peguis Trail. The LDS system south of Hawthorne collects in a 750 mm corrugated metal pipe, which then ties into the Hawthrone CS trunk sewer at Hawthorne Avenue immediately east of Kildonan Drive.

There is one CS outfall to the Red River:

- ID38 (S-MA70062167) – Hawthorne CS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Hawthorne and the surrounding districts. Each interconnection is shown on Figure 18 and shows locations where gravity flow can cross from one district to another. Each interconnection is listed as follows:

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

Newton

- Two 350 mm force mains carry flow from the sewage pump stations in the Linden and Hawthorne districts across the Red River to the Newton district. These force mains are connected back assumed isolated from each other within the current system and the Linden force main is added for information:
  - Invert at manhole on Newton Avenue at Newton district boundary (Hawthorne force main) – 225.66 m (S-MA70021128)
  - Invert at manhole on Newton Avenue at Newton district boundary (Linden force main) – 225.63 m (S-MA00017639)

1.3.1.2 District Interconnections

Linden

<u>CS to CS</u>

- A 300 mm CS on Brazier Avenue and Colvin Avenue is diverted into the CS system in the Hawthorne from the 375 mm CS flowing by gravity westbound on Colvin Avenue:
  - Invert at Linden district boundary 226.68 m (S-MH40001749)

- High Point Manhole
    - 300 mm CS on Colvin Avenue and Roch Street – 227.71 m (S-MH40005627)

Whellams (Area 2 (NE))

<u>WWS to CS</u>

- A 200 mm WWS is diverted from the WWS system in Whellams district on Springfield Road and flows by gravity into the CS system in the Hawthorne district:
    - Invert at Hawthorne district boundary 226.94 m (S-MA40002474) LDS to LDS

<u>LDS to LDS</u>

- A 550X900 mm LDS flows north from the Hawthorne district into Whellams district:
    - Invert at Whellams district boundary 224.07 m (S-MA70133155)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing district.

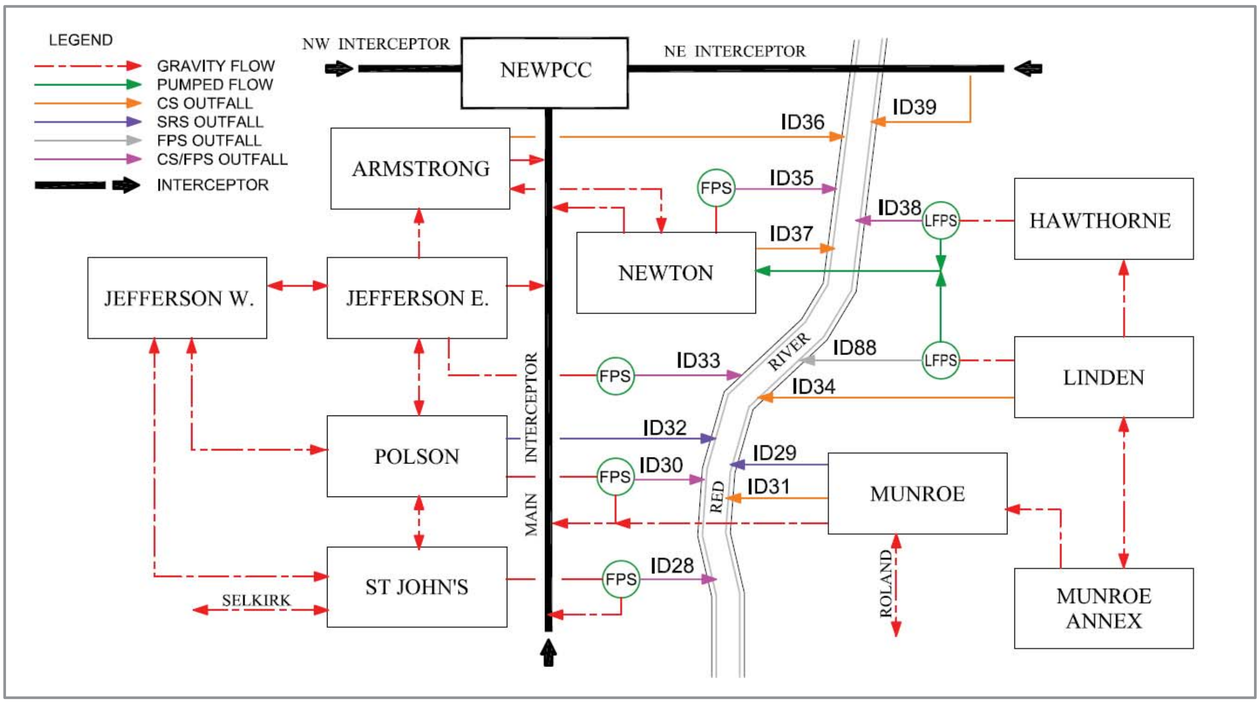

Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 18 and listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID38)	S-CO70033943.1	S-MA70062167	2100 mm	Red River Invert: 222.19 m
Flood Pumping Outfall (ID38)	S-CO70033943.1	S-MA70062167	2100 mm	Red River Invert: 222.19 m

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Other Overflows	N/A	N/A	N/A	
Main Trunk	S-TE40000580.1	S-MA40003335 S-MA40002190	1650 mm 1350 mm	Invert: 223.73 m Invert: 223.86 m
SRS Outfalls	N/A	N/A	N/A	No SRS within the district.
SRS Interconnections	N/A	N/A	N/A	No SRS within the district.
Main Trunk Flap Gate	S-TE70026151.2	S-CG00000954	1650 mm	Invert: 223.74 m
Main Trunk Sluice Gate	S-CG00000813.1	S-CG00000813	1500 x 1500 mm	Invert: 223.43 m
Off-Take	HAWTHORNE_WEIR.1	S-MA70021133	525 mm	223.76 m
Dry Well	N/A	N/A	N/A	
Lift Station Total Capacity	N/A	N/A	0.116 m^3/s	2 x 0.058 m^3/s
ADWF	N/A	N/A	0.054 m^3/s	
Lift Station Force Main	S-RE70009952.1	S-MA70021119	250 mm	Upstream invert: 223.40 m
Flood Pump Station Total Capacity	N/A	N/A	2 x 0.58 m^3/s	
Pass Forward Flow – First Overflow	N/A	N/A	0.159 m^3/s	

Notes:

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Hawthorne – 223.64
2	Trunk Invert at Off-Take	223.76
3	Top of Weir	224.27
4	Relief Outfall Invert at Flap Gate	N/A
5	Low Relief Interconnection	N/A
6	Sewer District Interconnection (Newton)	226.67 m
7	Low Basement	225.40
8	Flood Protection Level (Munroe, Linden, Hawthorne)	229.04

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The LDS system was installed in the late 1970s. The most recent study completed in Hawthorne was the *Linden and Hawthorne Districts Combined Sewer Relief Study Conceptual Design Report* (Wardrop Engineering Inc., 1994). The study's purpose was to develop a sewer relief system to protect the Linden and Hawthorne districts against basement flooding to a 5-year and 10-year level of service. An analysis to reduce overflows from the CS system to the Red River was also completed. No other studies have been completed on the district sewer system since that time.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Hawthorne CS district was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations have a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Expected Completion
18 – Hawthorne	1994	2015 Summer Flow Monitoring Campaign	2013	Conceptual Study Complete	N/A

Source: Report on *Linden and Hawthorne Districts combined sewer relief study*, 1994

1.5 Ongoing Investment Work

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Hawthorne district. This consists of monthly site visits in confined entry spaces to verify that physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

Repair and investigation work is ongoing within part of the LDS system, which flows through what was previously McLeod Creek, in the northwestern corner of Hawthorne District. This work includes repairing collapsed sewers, cross connections, and other issues found within this LDS system.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Hawthorne sewer district are listed in Table 1-4. The proposed CSO control projects will include in-line storage via a control gate, gravity flow control, and floatable management via screening. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	-	-	-	✓	✓	-	-	-	✓	✓	✓

Notes:

- = not included
✓ = included

The existing CS system is suitable for use as in-line storage. These control options will take advantage of the existing CS pipe networks for additional storage volume. Existing DWF from the collection system will remain the same, and overall district operations will remain the same. The installation of a control gate will provide the mechanism for capture of the additional in-line storage.

Floatable control will be necessary to capture any undesirable floatables in the sewage. Floatables will be captured with all implemented control options to some extent, but screening may be added as required to reach the desired level of capture. A screen will be installed on the primary outfall located at the west end of Hawthorne Avenue. The control gate utilized for in-line storage will also be required to provide the necessary hydraulic head for the screen operation.

GI and RTC will be applied within each district on a system-wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.1 In-Line Storage

In-line storage has been proposed as a CSO control for Hawthorne district. In-line storage will require the installation of a control gate at the CS outfall. The gate will increase the storage level in the existing CS and provide an overall higher volume capture and provide additional hydraulic head for screening operations. The existing lift section of the LFPS will provide the dewatering for the in-line storage.

A standard design was assumed for the control gate, as described in Part 3C. A standard approach was used for conceptual gate sizing by assuming it to be the lesser of the height of half of the site-specific trunk diameter or the maximum height of the gate available. The design criteria for the in-line storage are listed in Table 1-5.

Table 1-5. In-Line Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	223.73 m	
Trunk Diameter	1650 mm	
Gate Height	0.33 m	Gate height based on half trunk diameter assumption
Top of Gate Elevation	224.60 m	
Bypass Weir Elevation	224.50 m	
Maximum Storage Volume	565 m^3	
Nominal Dewatering Rate	0.116 m^3/s	Based on existing CS LS capacity
RTC Operational Rate	TBD	Future RTC/dewatering review on assessment

Note:
RTC = Real Time Control

TBD = to be determined

It should be noted that while the in-line storage arrangement design will only provide a minor additional volume capture, this performance is still acceptable for the solution to be considered cost effective compared to other control options for the district.

The proposed control gate will cause combined sewage to back-up within the collection system to the extent shown on Figure 18. The extent of the in-line storage and volume is related to the top elevation of the bypass side weir. The level of the top of the bypass side weir and adjacent control gate level are determined in relation to the critical performance level in the system for basement flooding protection: when the system level increases the flow overtops the bypass weir and is screened prior to discharging to the river. If the system level continues to rise, it will reach the critical level where the control gate drops out of the way. This allows for a free discharge as per existing system conditions and all excess CS would flow over the weir and discharge to the river. After the level in the system drops back below the bypass side weir critical performance level, the control gate moves back to its original position to capture the receding limb of the WWF event. The CS LS will continue with its current operation while the control gate is in either position , with all DWF being diverted to the river crossing via pumping. The CS LS will further dewater the in-line storage provided during a WWF event as downstream capacity becomes available.

Figure 18-01 provides an overview of the conceptual location and configuration of the control gate and screening chambers. The proposed control gate will be installed in a new chamber within the existing trunk sewer alignment downstream from the off-take pipe that connects to the LFPS and upstream of the existing outfall gate chamber. The dimensions of a new chamber to provide an allowance for a side weir for floatables control are 5.0 m in length and 3.0 m in width. The existing sewer configuration including the off-take and the force main may have to be modified to accommodate the new chamber. This will be confirmed in future design assessments. It is envisaged that the construction of the gate and screen chambers will be within the City owned land around the existing Hawthorne LS. There would be minimal disruptions to the local area from the proposed construction activities, as this would involve access via local minor residential streets.

The Larchdale wastewater LS connects into the CS system along the length that will be used for in-line storage. The operation and interaction of this lift station with the in-line storage will not be affected by the in-line storage extent due to the higher level of the force main connection level with the existing CS sewer. This assessment would be further confirmed/evaluated during the next stage of design although not expected to influence any changes to the system.

The nominal rate for dewatering is set at the existing LS capacity. This allows dewatering through the existing interceptor system within 24 hours following the runoff event, allowing it to recover in time for a subsequent event. Any future considerations, for RTC improvements, would be completed with spatial rainfall as any reduction to the existing pipe capacity/LS operation for large events will adversely affect the overflows at this district. This future RTC control will provide the ability to capture and treat more volume for localized storms by using the excess interceptor capacity where the runoff is less.

1.6.2 Floatables Management

Floatables management will require installation of a screening system to capture floatable materials. ,The off-line screens would be designed to maintain the current level of basement flooding protection.

The type and size of screens depend on the specific station configurations and the hydraulic head available for operation. A standard design was assumed for screening and is described in Part 3C. The design criteria for screening with gate control implemented, are listed in Table 1-6.

Table 1-6. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Top of Gate	224.60 m	
Bypass Weir Crest	224.50 m	
NSWL	223.64 m	
Maximum Screen Head	0.86 m	
Peak Screening Rate	0.35 m^3/s	
Screen Size	1.5 m x 1.0 m	Modelled Screen Size

The proposed side overflow weir and screening chamber will be located adjacent to the proposed control gate and the existing CS, as shown on Figure 18-01. The screens will operate with the control gate in its raised position. A side bypass weir upstream of the gate will direct the overflow to the screens located in the new screening chamber, with screened flow discharged to the downstream side of the gate to the river. The screening chamber will include screenings pumps with a discharge returning the screened material back to the CS system and on to the NEWPCC for removal. As the screening chamber would be constructed with the control gate chamber, the construction activities will be similar in that minimal disruption with the location being on City owned land have been envisaged.

The dimensions for the screen chamber to accommodate influent from the side weir, the screen area, and the routing of discharge downstream of the gate are 3.0 m in length and 3.0 m in width. The existing sewer configuration may have to be modified to accommodate the new chamber.

1.6.3 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district will be reviewed to identify the most applicable GI controls.

Hawthorne has been classified as a medium GI potential district. Land use in Hawthorne is residential with portions of commercial and greenspace. The west end of the district is bounded by the Red River. This district would be an ideal location for cisterns/rain barrels, and rain garden bioretention within the residential areas. Commercial areas are suitable to green roofs and parking lot areas are ideal for paved porous pavement.

1.6.4 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

In-line storage will impact the existing sewer and will require the addition of a new chamber and a moving gate at the outfall. In-line storage dewatering will be controlled with the existing Clifton CS LS, which will require more frequent and longer duration pump run times. Lower velocities will occur in the CS trunk in the vicinity of the control gate due to lower pass forward flows, and may create additional debris deposition requiring cleaning. Additional system monitoring, and level controls will be installed, which will require regular scheduled maintenance.

Floatable control with outfall screening will require the addition of another chamber with screening equipment installed. The chamber will be installed adjacent to the control gate chamber and will operate in conjunction with it. Screening operation will occur during WWF events that surpass the in-line storage control level. WWF will be directed from the main CS trunk, over the side weir in the control gate chamber and through the screens to discharge into the river. The screens will operate intermittently during wet weather events and will likely require operations review and maintenance after each event. The frequency of a screened event will correlate to the number overflows identified for the district. Having the screenings pumped back to the interceptor system via a small LS and force main will be required. The screenings return will require O&M inspection after each event to assess the performance of the return pump system.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. Two versions of the sewer system model were created and used to measure system performance. The 2013 Baseline model represents the sewer system baseline in the year 2013 and the 2037 Master Plan – Control Option 1 model, which includes the proposed control options in the year 2037. A summary of relevant model data is provided in Table 1-7.

Table 1-7. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	238	238	8,886	15	N/A
2037 Master Plan – Control Option 1	238	238	8,886	15	IS,

Notes:

IS = In-line Storage

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City Of Winnipeg GIS Records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-8 are for the hydraulic model simulations using the year-round 1992 representative year. The table lists the results for the Baseline, for each individual control option and

for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. The table also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-8. Performance Summary – Control Option 1

Control Option	Preliminary Proposal	Master Plan			
	Annual Overflow Volume (m^3)	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [a]
Baseline (2013)	33,395	33,245	-	18	0.159 m^3/s
In-Line Storage	26,616	30,493	2,752	17	0.159 m^3/s
Control Option 1	**26,616**	**30,493**	**2,752**	**17**	**0.159 m^3/s**

[a] Pass forward flows assessed on the 1-year design rainfall event

The percent capture performance measure is not included in Table 1-8, as it is applicable to the entire CS system and not for each district individually.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in **Error! Reference source not found.**. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-9. Cost Estimate – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period)
Separation	$144,110,000	N/A [a]	N/A	N/A
In-Line Storage	N/A [b]	$2,650,000 [c]	$44,000	$940,000
Screening		$1,990,000 [d]	$50,000	$1,080,000
Subtotal	**$144,110,000**	**$4,640,000**	**$94,000**	**$2,020,000**
Opportunities	N/A	$460,000	$9,000	$200,000
District Total	**$144,110,000 [b]**	**$5,100,000**	**$103,000**	**$2,220,000**

a Sewer Separation recommendation as part of Preliminary Proposal was eliminated during the Master Plan percent capture assessment

[b] Solution developed as refinement to Preliminary Proposal work following submission of Preliminary Proposal costs. Preliminary Proposal recommended in-line storage and screening for CO1 PP. Costs for these items of work found to be $2,010,000 in 2014 dollars

[c] Costs associated with new off-take construction, as required, to accommodate control gate and screening chambers in location and allow intercepted CS flow to reach existing Hawthorne CS LS was not included in Master Plan

[d] Cost for bespoke screenings return/force main not included in Master Plan as will depend on selection of screen and type of screening return system selected

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional cost for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014-dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019-dollar values:
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-10.

Table 1-10. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Removal Of Separation	Determined to not be required to achieve the capture requirement during the Master Plan assessments.	
	In-Line Storage	A control gate was not included in the preliminary estimate.	Added for the MP to further reduce overflows and optimize existing in-line storage.
	Screening	Screening was not included in the Preliminary Proposal estimate.	Added in conjunction with the Control Gate.
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecyle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values, based on an assumed value of 3 percent for construction inflation	Preliminary estimates were based on 2014-dollar values	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, the future performance target is 98 percent capture for the representative year measured on a system-wide basis. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-11 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified for Control Option 1.

Overall the Hawthorne district would be classified as a low potential for implementation of complete sewer separation as the only feasible approach to achieve the 98 percent capture future performance target in the representative year. The City however has previously identified Hawthorne as a district where sewer separation would be preferable. This is due to existing land drainage runoff concerns surrounding the McLeod Creek, previous basement risks, and operational issues with the lift station and outfall structure. The modelled existing overflow volume overall though indicates that a more cost-effective solution would involve off-line tank or tunnel storage. The provision for opportunistic sewer separation within a portion of the district may be completed in conjunction with other major infrastructure work to address future performance targets. In addition, green infrastructure may be utilized in key locations to provide additional storage and increase capture volume to meet future performance targets.

Table 1-11. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Opportunistic sewer separation • Increased GI • Off-line Storage (Tank/Tunnel)

The control options selected for the Hawthorne district have been aligned for the 85 percent capture performance target based on the system wide basis. The expandability of this district to meet the 98 percent capture would not be aligned if the district went to complete separation based on the City's potential preferred separation district nominations. However, this district could also be considered for recommendation to the alternative floatables management approach, where this is achieved by targeting floatables source control as a replacement to screening facilities.

The cost for upgrading to meet an enhanced performance target depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-12.

Table 1-12. Control Option 1 Significant Risks and Opportunities

ID Number	Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	R	-	-	-	-	-	-
2	Existing Lift Station	-	R	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	-	-	-	-
4	Construction Disruption	-	-	-	-	-	-	-	-
5	Implementation Schedule	-	-	-	-	-	-	R	-
6	Sewer Condition	-	R	-	-	-	-	-	-
7	Sewer Conflicts	-	R	-	-	-	-	-	-
8	Program Cost	-	O	-	-	-	-	-	O
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	-	-	-	-	-	O	O	-
12	Operations and Maintenance	-	R	-	-	-	R	O	R
13	Volume Capture Performance	-	O	-	-	-	O	O	-
14	Treatment	-	R	-	-	-	O	O	R

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

Wardrop Engineering Inc, TetrES Consultants Inc. 1994. *Linden and Hawthorne Districts Combined Sewer Relief Study Conceptual Design Report.* Prepared for the City of Winnipeg, Waterworks, Waster and Disposal Department. May.

LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Low CS Manhole

Inter-System Connection
- CS - WWS

District Boundary Crossing
- CS
- WWS

- Interceptor Sewer
- Force Main
- Street

- District Boundary
- Watercourse
- Greenspace

CSO MASTER PLAN PROPOSED SOLUTIONS

- Proposed Control Gate
- Extent of In-line Storage
- Sewer Separation - Complete

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 18
District Overview Map
Sewer District: Hawthorne
City of Winnipeg
Combined Sewer Overflow Master Plan

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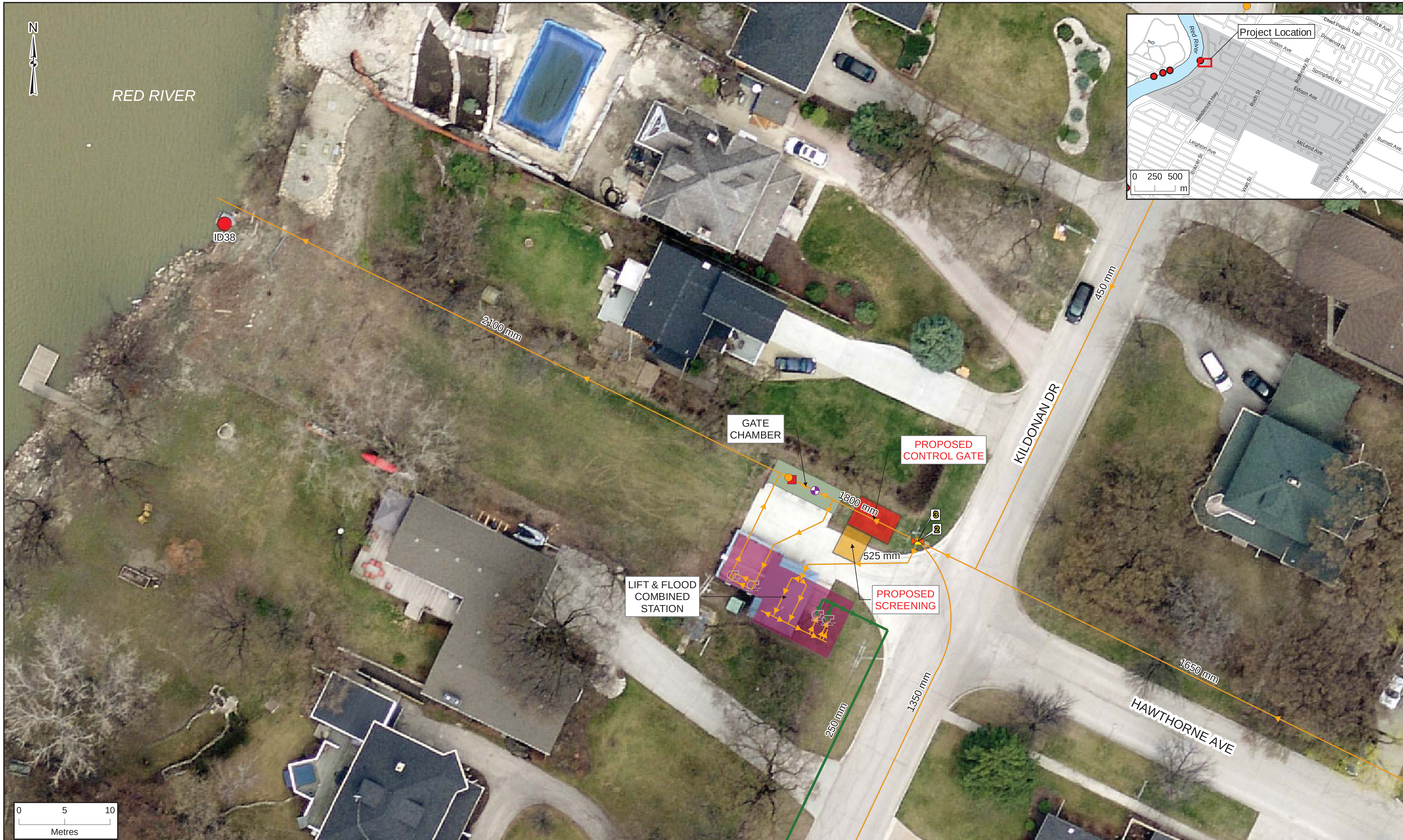

LEGEND

Primary Weir	Flap Gate	Force Main	Sewer By Type	Control Structure Type	Pump Station Type
Critical Elevation	Sluice Gate		CS	Gate Chamber	Lift & Flood Combined Station
CSO Outfall	Pump Location		WWS		
Manhole					

CSO MASTER PLAN
PROPOSED SOLUTIONS

- Control Gate
- Screening

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 18-01
Flood Pumping Station
Sewer District: Hawthorne
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Jefferson East District Plan

August 2019

City of Winnipeg

CSO Master Plan

Project No: 470010CH
Document Title: Jefferson East District Plan
Revision: 03
Date: August 20, 2019
Client Name: City of Winnipeg
Project Manager: John Berry
Author: Jack Tinker
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Document History and Status

Revision	Date	Description	By	Review	Approved
0	09/14/2018	DRAFT for City Comment	JT	SB, MF, SG	
1	06/2019	Draft 2 for City Review	JT	MF	MF
2	08/12/2019	Final Draft Submission	DT	MF	MF
3	08/20/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

Tables

Figure

1. Jefferson East District

1.1 District Description

Jefferson East district is located in the northern portion of the combined sewer (CS) area and west of the Red River. This district is approximately bounded by Kingsbury Avenue to the north, McPhillips Street to the West, Carruthers Avenue and McAdam Avenue to the south, and the Red River to the east.

Jefferson East district is primarily residential including single-family land use throughout the district. Commercial areas within Jefferson East are found along the major transportation routes including Main Street and McPhillips Street. Regional transportation routes passing through Jefferson East include McPhillips Street, Main Street, Jefferson Avenue, and Inkster Boulevard. Greenspace is found scattered throughout the district. Approximately 18 ha is identified as greenspace; this includes Aster/Dahlia Park, school yards, playgrounds, and community areas.

1.2 Development

A portion of Main Street is located within the Jefferson East District. Main Street is identified as Regional Mixed Use Corridor as part of the OurWinnipeg future development plans. As such, focused intensification along Main Street is to be promoted in the future.

1.3 Existing Sewer System

The Jefferson East district has an approximate area of 445 hectares (ha)[1] based on the district boundary. There is approximately 10 percent by area (44 ha) separation ready and 45 percent by area (199 ha) where separation development is planned/underway.

The CS system includes two primary weirs, three offtake structures, a flood pump station (FPS), and an outfall gate chamber. The CS system drains towards the diversion structure and primary weir located along Jefferson Avenue immediately east of Main Street. There is also a small section of SRS pipe that runs through Jefferson East district from the Polson district along Inkster Boulevard. There are four main flow paths for the CS system to connect to the north Main interceptor. The main 2850 mm by 4270 mm CS trunk flows from the Jefferson West district along Inkster Boulevard and connects to Jefferson Avenue along Sinclair Street. This main CS trunk services the areas west of Main Street which includes the Jefferson West district; a 450 mm CS trunk flows south on Main Street, servicing a small area north on Main Street interconnecting with the Armstrong CS system; and a 300 mm CS trunk flows north on Main Street servicing a small area south on Main Street.

During dry weather flow (DWF), sanitary sewage flows into the diversion structure located at the intersection of Jefferson Avenue and Main Street upstream of the CS outfall. Note that sanitary sewage collection from the adjacent Jefferson West district is collected at this point. The sanitary sewage is diverted by the primary weir to a 1520 mm secondary interceptor pipe via a 525 mm offtake and then into the north Main Interceptor. Sewage from the areas east of Main Street during DWF is conveyed directly to the Main Interceptor without being intercepted by the primary weir. This is accomplished by either wastewater flow to the secondary interceptor on Jefferson Avenue, or via a direct connection to the Main Interceptor on Seven Oaks Avenue. The sanitary sewage from the Jefferson East and Jefferson West districts within the Main Interceptor then flows by gravity to the North End Sewage Treatment Plant (NEWPCC) for treatment.

During wet weather flow (WWF), any flows that exceed the primary weir at Jefferson Avenue and Main Street flows and is intercepted by a second primary weir at Jefferson Ave and Scotia street. This second

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System and in Section 1.8 Performance Estimate may occur.

weir is remainder from the CS arrangement in the district prior to recent sewer separation work underway. As a result of this second weir the excess CS then backs up once more within the outfall trunk. A secondary 450mm offtake is then located within this outfall trunk, near the intersection of Jefferson Avenue and Jones Street. A portion of the excess CS may then flow in this secondary offtake and may be intercepted and treated once more. The excess CS under WWF events which then spills over the second Scotia Street primary weir is discharged into the Red River by gravity. Sluice and flap gates are installed on the CS outfall to prevent river water from backing up into the CS system under high river level conditions on the Red River. Under these high river level conditions gravity discharge is not possible, and excess flow is pumped by the Jefferson FPS to an alternate outfall flow path, which allows it to by-pass the flap and sluice gates and be discharged directly to the river via the same outfall. The Jefferson outfall and adjacent Scotia Street weir however are quite low and often below the river level, which can require significant surcharge conditions to trigger an overflow event or activation of the flood pumps.

Additionally, the CS outfall may act as a high-level relief overflow for the Main Interceptor. There is a third 2280 x 1520 egg shaped offtake and diversion structure immediately west of the main 525 mm offtake pipe at Jefferson Avenue and Main Street. A flap gate is installed on this offtake, which allows surcharged flow in the Main Interceptor to flow south back into the CS system, but does not allow this offtake to divert intercepted CS into the interceptor system.

The majority of the district east of Main Street is a separation ready sewer system, as part of previous sewer separation works. Wastewater is conveyed either to the diversion structure on Jefferson Avenue and Main Street, or conveyed to a new WWS pipe on Seven Oaks Avenue which discharges directly into the Main Interceptor. The LDS system for the portion of the district east of Main Street reconnects to the Jefferson CS outfall trunk downstream of the main 525mm primary weir at two locations: along Scotia Street; at Seven Oaks Avenue, and St Anthony Avenue. Currently, with wet weather events, the land drainage flow is restricted from overflowing by the second weir located at the outfall at the intersection of Jefferson Avenue and Scotia Street. This excess land drainage flow then intercepted by the secondary 525mm offtake and is ultimately treated at the NEWPCC.

The one outfall (CS) to the Red River is as follows:

- ID33 (S-MA70007473) – Jefferson CS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Jefferson East and the surrounding districts. Each interconnection is shown on Figure 19 and shows locations where gravity flow can cross from one district to another. Each interconnection is listed as follows:

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

Newton

- The 2250 mm Main Interceptor pipe flows north by gravity out of Jefferson East district:
  - Invert at Jefferson East district boundary 217.61 m (S-MA00017587)

1.3.1.2 Interceptor Connections – Upstream of Primary Weir

Polson

- The 2250 mm Main Interceptor flows by gravity on Main Street from Polson district into Jefferson East district:
  - Invert at Jefferson East district boundary 218.03 m (S-MA70008112)

1.3.1.3 District Interconnections

Polson

<u>CS to CS</u>

- High point manhole:
  - Polson Avenue – 229.11 m (S-MH00009095)
- High sewer overflow:
  - McGregor Street at Carruthers Avenue – 228.60 m (S-MH00006709)

<u>CS to SRS</u>

- An 1800 mm SRS relieves the main CS trunk on Polson Avenue and flows by gravity northbound on Airlies Street from Polson district to Jefferson East district. It connects with the Jefferson East CS network at the corner of Inkster Boulevard and Airlies Street before continuing onto Inkster Boulevard:
  - Invert at Jefferson East district boundary 224.01 m (S-MA00011342)

<u>SRS to SRS</u>

- A 2950 mm SRS flows by gravity on Inkster Boulevard from Jefferson East district into Polson district:
  - Invert at Polson district boundary 223.00 m (S-MA00008238)

Jefferson West

<u>CS to CS</u>

- The 2400 mm CS pipe flows by gravity east on Inkster Boulevard into Jefferson East district:
  - Inkster Boulevard at McPhillips Street – 224.53 m (S-MH00009032)
- The 450 mm CS pipe flows by gravity west on Polson Avenue into Jefferson West district:
  - Invert at Jefferson West district 225.27 m (S-MA00007321)
- The 375 mm CS pipe flows west by gravity on Lansdowne Avenue into Jefferson West district:
  - Invert at Jefferson West district boundary 227.02 m (S-MA00011271)

Armstrong

<u>CS to CS</u>

- The 300 mm CS pipe flows south by gravity on Powers Street from Armstrong district into Jefferson East district:
  - Invert at Jefferson East district 227.31 m (S-MA00001541)

Newton

<u>CS to CS</u>

- The 375 mm CS pipe flows south by gravity on Main Street into Jefferson East district:
  - Invert at Newton district boundary 226.90 m (S-MA00017220)
- The 250 mm CS pipe flows east by gravity on Kingsbury Avenue into Jefferson East district:
  - Invert at Newton district boundary 226.59 m (S-MA00017588)
- The 225 mm CS pipe flows west by gravity on Burrin Avenue into Jefferson East district:

– Invert at Newton district boundary 228.68 m (S-MA00001001)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing district.

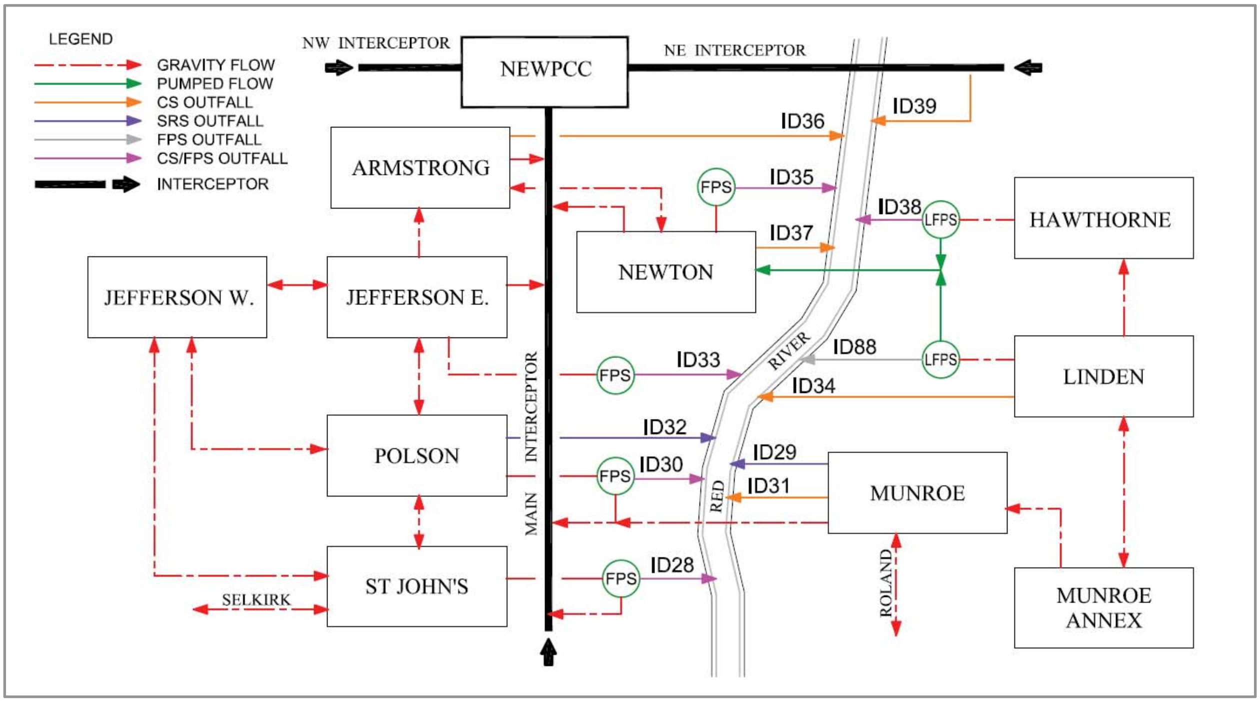


Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 19 and listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID33)	S-TE70003093.1	S-MA70007473	3350 mm	Red River Invert: 222.88 m
Flood Pumping Outfall (ID33)	S-TE70003093.1	S-MA70007473	3350 mm	Red River Invert: 222.88 m
Other Overflows	N/A	N/A	N/A	
Main Trunk	S-MH00006000.1	S-MA00008944	2850 x 4270 mm	Egg shaped Invert: 223.16 m
SRS Outfalls	N/A	N/A	N/A	
SRS Interconnections	S-MH70015794	S-MH70015794	N/A	Combined Invert: 224.78 m
Main Trunk Flap Gate	S-AC70007929.1	S-CG00000814	3000 mm	Invert: 223.29 m Circular
Main Trunk Sluice Gate	S-AC70007969.1	S-CG00000815	3000 x 3000 mm	Invert: 223.08 m
Offtake	JEFFERSON_WEIR1.1	S-MA70017216	525 mm	Invert: 223.06 m

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
	S-TE00005277.2	S-MA70017296	1520 mm	Invert: 224.16 m
Dry Well	N/A	N/A	N/A	
Lift Station Total Capacity	N/A	S-MA70017216 (1)	525 mm (1)	0.195 m3/s (1)
ADWF	N/A	N/A	0.208 m^3/s	
Lift Station Force Main	N/A	N/A	N/A	
Flood Pump Station Total Capacity	N/A	N/A	6.85 m^3/s	3 x 1.35 m^3/s 2 x 1.4 m^3/s
Pass Forward Flow – First Overflow	N/A	N/A	1.059 m^3/s	

Notes:

(1) – Gravity pipe replacing Lift Station as Jefferson East is a gravity discharge district

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification

N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m) [a]
1	Normal Summer River Level	Jefferson – 223.66
2	Trunk Invert at Offtake	223.06
3	Top of Weir	Weir at FPS: 223.75
4	Relief Outfall Invert at Flap Gate	N/A
5	Low Relief Interconnection (S-MH70015794)	Invert – 224.78
6	Sewer District Interconnection (Polson)	223.00
7	Low Basement	226.47
8	Flood Protection Level (Jefferson East)	228.92

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed in Jefferson East was the *Jefferson Combined Sewer Districts Sewer Relief and CSO Abatement Study* (AECOM Canada Ltd, 2009). The study's purpose was to determine the most cost-effective means to upgrade the hydraulic capacity of the combined sewer system to reduce basement flooding during extreme rainfall events. Works ongoing now include implementation of many of the recommendations of this 2009 study.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Jefferson East Combined Sewer District was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations has a combination of inflow and overflow level meters and flap gate inclinometers if available.

From 2012 to 2016, the Jefferson East Sewer Relief project work has been completed within the majority of the area to the east of Main Street, to align with the 2009 AECOM study. Four separation construction contracts have been completed during this time with a construction cost of approximately $11.5 Million spent to date.

- The Jefferson East Relief Sewer Contracts 1 to 3 involved the installation of LDS pipes to collect runoff from the catch basins within the majority of the area (Kilbride Avenue still to be separated).
  - The LDS system reconnects to the existing CS system at two locations along Scotia Street; at Seven Oaks Avenue and St Anthony Avenue.
  - At each reconnection point, a new WWS pipe diverts wastewater flows from the existing CS system immediately upstream of both locations, these flow into the new WWS pipes to connect to the Main Interceptor pipe.
- Contract 4 involved the construction of a new LDS gate chamber and 2100 mm diameter outfall pipe.
  - The outfall pipe and gate chamber is located within the adjacent Newton district and on the City land near Scotia Street and Semple Avenue, within the Newton district.
  - It is proposed that the new LDS system will connect to the new LDS gate chamber within future contracts.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Planned Completion
19 – Jefferson E	2009	Future Work – Following Sewer Separation	2013	Construction Underway	TBD

1.5 Ongoing Investment Work

As part of the Jefferson East Sewer Relief work, a further six Contracts are planned (AECOM Canada Ltd, 2009). The six Contracts are estimated to cost approximately $35 Million (AACE Class 3, 2011 estimate). This work includes sewer separation of the area between Main Street and the C.P.R. Winnipeg Beach Rail Line (i.e. east of rail line). This work has been recommended as part of the solutions to meet Control Option 1 for this district (see Section 1.6).

The City has also developed a conceptual sewer separation plan for the area west of the Winnipeg Beach Rail Line (201 ha). The sewer separation work in this part of the district is estimated to cost $45 Million (AACE Class 3, 2011 estimate). The City however has not committed to having this work west of the rail line completed, and it has not been recommended as part of the solutions to meet Control Option 1.

The City is also currently investigating multiple items of work to improve the performance of this district. These have been summarized below:

- The potential to remove the second Scotia Street weir just upstream of the FPS. The recent sewer separation work allows all wastewater flows to be diverted out of this section of the CS system. Therefore, the existing weir is only holding back LDS flow and excess CS during WWF events at present. The weir located at the primary diversion adjacent to the main 525mm offtake will then be treated as the new critical overflow location.
- Due to the Jefferson outfall being very low, the river level is often higher than the current weir, and to keep the Jefferson outfall drained the secondary 450mm offtake is left open. This however also results in the unnecessary collection and treatment of land drainage flow backed up by the second Scotia Street. As a result, the closure of the secondary diversion 450mm offtake on Jefferson Avenue is also to be investigated.

- The proposed work identified in the points above would result in the requirement for a portion of the existing permanent CSO instrumentation to be relocated. New instrumentation upstream and downstream of the new primary diversion weir would need to be installed.
- The flood pumping arrangements are under review by the City, so that the closure of the secondary offtake mentioned above can be evaluated. The aim would be for the FPS to be reclassified as a land drainage flood pumping station as this would more accurately reflect the upstream system. Any CSO overflow volume would have to be modelled, estimated, and verified based on the new instrumentation at the new primary weir and not the outfall in order to separate the portion of CS and LDS flow.
- The primary 525mm offtake is potentially undersized and should also be reviewed as part of the work tasks listed above. The completion of the reminder of the partial sewer separation work planned in the district may result in a sufficient reduction in the wet weather response from the district such that this offtake is appropriately sized.

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Jefferson East district. This consists of monthly site visits in confined entry spaces to verify that physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Jefferson East sewer district are listed in Table 1-4. The proposed CSO control projects will include partial sewer separation, in-line storage via control gate, and floatables management via screening. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage	Storage / Transport Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	-	-	✓	✓	✓	-	-	✓	✓	✓	✓

Notes:

- = not included
✓ = included

Jefferson East has been identified for partial sewer separation. This work is underway and will continue as part of the CSO Master Plan. The potential for stepped sewer separation of the remainder of the district was also investigated, but found that more cost effective measures such as in-line storage could achieve the remaining volume capture required from the district. As the remainder of the district is not currently prioritized for separation as part of the BFR program, it has not been recommended as part of the CSO Master Plan.

A gravity flow controller is proposed on the CS system to optimize and monitor the dewatering rate from the district back into the Main Interceptor. A second controller is not proposed for the new Seven Oaks Avenue WWS direct connection to the Main Interceptor, due to the relatively small catchment area.

The existing CS system is suitable for use as in-line storage. This control option will take advantage of the existing CS system for additional storage volume. The Jefferson East district has a large volume of potential in-line storage capacity due in part to the interconnection with upstream Jefferson West district and the large diameter pipes conveying flows from West to East.

Floatable control will be necessary to capture any undesirable floatables in the sewage. Floatables will be captured with all implemented control options to some extent, but screening may be added as required to reach the desired level of capture. Screens will be on the primary CS outfall near the intersection of Jefferson Avenue and Scotia street.

GI and RTC will be applied within each district on a system wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Sewer Separation

Partial sewer separation is currently underway for the Jefferson East district and is proposed to continue as part of the CSO Master Plan. Sewer separation will free up capacity in the CS trunk and reduce the overflows from this district. A subsequent impact is that the additional capacity can then be utilized as storage in the form of in-line storage to help balance flow to the Main Street interceptor, and ultimately to the NEWPCC.

The area east of Main Street has undergone LDS separation work including installation of a separate LDS system to collect overland drainage. At present, the new LDS collects flows from area between Main Street and Scotia Avenue from Smithfield Avenue to Hartford Avenue. A new LDS outfall was constructed on Scotia Avenue and will be connected to the new LDS in the future. . Continued LDS separation work is proposed up to the C.P.R. Winnipeg Beach Rail Line that divides the district. This will reduce overall flow to the outfall and reduce CSOs. Partial sewer separation will also increase the available capacity for in-line storage and would reduce the sewage flow being diverted at the primary weir.

1.6.3 In-Line Storage

In-line storage has been proposed as a CSO control for Jefferson East district. The in-line storage will require the installation of a control gate at the CS outfall. The gate will increase the storage level in the existing CS to provide an overall higher volume capture. The control gate will provide a secondary benefit by increasing the hydraulic head necessary for screening operations. Note that the flows from the upstream Jefferson West district also discharges directly to the Jefferson East district, and will be additionally captured by this in-line storage arrangement.

It should be noted that due to only partial separation being completed in the Jefferson East district, in combination with the Jefferson West combined district also discharging into this district, that the in-line storage measures are being recommended. If complete separation was pursued for the remainder of this district and for the Jefferson West district, this recommendation would no longer be required.

A standard design was assumed for the control gate, as described in Part 3C. A standard approach was used for conceptual gate sizing by assuming it to be the lesser of the height of half of the site-specific trunk diameter or the maximum height of the gate available. The design criteria for in-line storage are listed in Table 1-5.

Table 1-5. In-Line Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	223.16 m	
Trunk Diameter	2850 x 4270 mm	
Gate Height	1.47 m	Gate height based on half trunk diameter assumption

Table 1-5. In-Line Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Top of Gate Elevation	225.22 m	
Maximum Storage Volume	12335 m^3	
Nominal Dewatering Rate	0.195 m^3/s	Based on pipe pass forward flow at Jefferson diversion chamber
RTC Operational Rate	TBD	Future RTC / dewatering review on performance

Note:
TBD = to be determined

RTC – Real Time Control

The control gate will cause combined sewage to back-up within the collection system to the extent shown on Figure 19. The extent of the in-line storage and volume is related to the top elevation of the gate. The level of the top of the bypass side weir and adjacent control gate level are determined in relation to the critical performance levels in the system for basement flooding protection. When the system level increases above the bypass weir crest and proceeds above the top of the control gate during high flow events, the gate drops out of the way. At this point, the district will only provide its original interception capacity via the primary weir for the district, and all excess CS would flow over the weir and eventually discharge to the river. After the sewer levels in the system drops back below the bypass side weir critical performance level, the control gate moves back to its original position to capture the receding limb of the WWF event. The existing DWF diversion rate will continue with its current operation, with all DWF being diverted to the Main Interceptor. The area east of Main Street within the Jefferson East district will continue to divert into the Main Interceptor via the Seven Oaks Avenue WWS pipe.

Figure 19-01 provides an overview of the conceptual location and configuration of the control gate, bypass weir and screening chambers. The proposed control gate will be installed in a new chamber within the trunk sewer alignment. The dimensions of a new chamber to provide an allowance for a side weir for floatables control are 6 m in length and 4.5 m in width. The existing diversion chamber and weir may be impacted by the construction of the chambers and require some reconfiguration. The physical requirements for a modification to existing diversion chamber have not been considered in detail, but they will be required in the future as part of removal of the secondary offtake that the City is currently investigating. The removal of this secondary offtake would allow more space for these chambers. The physical location will cause disruptions due to being located adjacent to a main road interception (Jefferson Avenue and Main Street) and potential to move further away from the interconnection would be considered in the next stage.

The nominal rate for dewatering is determined by the performance of the existing pipe capacity as the district is a gravity discharge district. As such the flows will vary over the duration of a rainfall event and has been nominated for a gravity flow control device. Any future consideration, for RTC improvements, would be completed with spatial rainfall as any reduction to the existing pipe capacity/operation for large events will adversely affect the overflow at this district. The control device would be set to a rate similar to the existing pipe full capacity to allow the set limit to be known. This would allow the future RTC to control the ability to capture and treat more volume for localized storms in other districts by using the excess interceptor capacity made available by restricting the pass forward flows through the control device where the runoff is less.

1.6.4 Gravity Flow Control

Jefferson East district does not include a LS and discharges to the Main Interceptor by gravity. A flow control device will be required to control the diversion rate at the main diversion pipe on Jefferson Avenue for future RTC. The flow controller will include flow measurement and a gate to control the discharge flow rate. A standard flow control device was selected as described in Part 3C. The small contributing area associated with the second WWS pipe directly connecting to the Main Interceptor sewer from Seven Oaks Avenue will not require a flow controller.

It should be noted that due to only partial separation being completed in the Jefferson East district, in combination with the Jefferson West combined district also discharging into this district, that gravity flow control is still required. If complete separation was pursued for the remainder of this district and for the Jefferson West district, this recommendation would no longer be required.

The flow control would be installed at an optimal location on the connecting sewer between the proposed in-line control and existing diversion chamber. A small chamber or manhole with access for cleaning and maintenance will be required. The flow controller will operate independently and require minimal operation interaction.

A gravity flow controller has been included as a consideration in developing a fully optimized CS system as part of the City's long-term objectives. The operation and configuration of the gravity flow controller will have to be further reviewed for additional flow and rainfall scenarios.

1.6.5 Floatables Management

Floatables management will require installation of a screening system to capture floatable materials from the Jefferson East district. The off-line screens would be proposed to maintain the current level of basement flooding protection.

It should be noted that due to only partial separation being completed in the Jefferson East district, in combination with the Jefferson West combined district also discharging into this district, that floatables management of CSO events is still required. If complete separation was pursued for the remainder of this district and for the Jefferson West district, this recommendation would no longer be required.

The type and size of screens depend on the hydraulic head available for operation. A generic design was assumed for screening and is described in Part 3C. The design criteria for screening with gate control implemented, are listed in Table 1-6.

Table 1-6. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Top of Gate	225.22 m	
Bypass Weir Crest	225.12 m	
NSWL	223.66 m	
Maximum Screen Head	1.455 m	
Peak Screening Rate	0.89 m^3/s	
Screen Size	1.5 m wide x 1 m high	Modelled Screen Size

The proposed bypass side overflow weir and screening chamber will be located adjacent to the existing combined trunk sewer, as shown on Figure 19-01. The screens will operate once levels within the sewer surpassed the in-line control elevation. A bypass side weir upstream of the gate will direct the initial overflow to the screens located in the new screening chamber, with screened flow discharged to the downstream side of the gate to the river. The screening chamber may include screenings pumps with a discharge returning the screened material back to the interceptor and on to the NEWPCC for removal. The provision of screening pumps is dependent on final level assessment within the existing infrastructure and the Jefferson trunk has potential for gravity screening return to occur. This would be confirmed during the future assessment stage.

The dimensions for the screen chamber to accommodate influent from the side weir, the screen area, and the routing of discharge downstream of the gate are 4 m in length and 3.5 m in width. The impact of this chamber was defined in the in-line storage section.

1.6.6 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district will be reviewed to identify applicable GI controls.

Jefferson East has been classified as a medium GI potential district. Jefferson East district is primarily residential including single-family land use throughout the district. Commercial areas within Jefferson East are found along the major transportation routes including Main Street and McPhillips Street. This means the district would be an ideal location for bioswales, permeable paved roadways, cisterns/rain barrels, and rain gardens. There are a few flat roof commercial buildings in the district which make an ideal location for green roofs.

1.6.7 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

Sewer separation will include the installation of additional sewers that will require inspection, cleaning and rehabilitation. This will result in additional maintenance costs over the long term, but operational costs will be minimal. The existing larger CS pipes within the district may also receive insufficient flows with the separation work for proper scouring velocities in the sewer pipes. This could result in solids settling within the sewers and requiring more frequent cleaning operations. The impacts of the reduced flows in larger CS pipes will be evaluated as part of the sewer separation design for the districts.

In-line storage will impact the existing sewer and will require the addition of a new chamber and a moving gate at the outfall. In-line storage dewatering will be controlled with the existing Clifton CS LS, which will require more frequent and longer duration pump run times. Lower velocities will occur in the CS trunk in the vicinity of the control gate due to lower pass forward flows, and may create additional debris deposition requiring cleaning. Additional system monitoring, and level controls will be installed, which will require regular scheduled maintenance.

The flow controller will require the installation of a chamber and flow control equipment. Monitoring and control instrumentation will be required. The flow controller will operate independently and require minimal operation interaction. Regular maintenance of the flow controller chamber and appurtenances will be required.

Floatable control with outfall screening will require the addition of another chamber with screening equipment installed. The chamber will be installed adjacent to the control gate chamber and will operate in conjunction with it. Screening operation will occur during WWF events that surpass the in-line storage control level. WWF will be directed from the main CS trunk, over the side weir in the control gate chamber and through the screens to discharge into the river. The screens will operate intermittently during wet weather events and will likely require operations review and maintenance after each event. The frequency of a screened event will correlate to the number overflows identified for the district. Having the screenings pumped back to the interceptor system via a small LS and force main will be required. The screenings return will require O&M inspection after each event to assess the performance of the return pump system.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. An individual model was created to represent the sewer system baseline as represented in the year 2013 and a model for the CSO Master Plan with the control options implemented in the year 2037. A summary of relevant model data is summarized in Table 1-7.

Table 1-7. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Added To Model
2013 Baseline	444	444	13,614	59	N/A
2037 Master Plan – Control Option 1	444	250	13,614	59	IS, SC, SEP

Notes:

IS = In-line Storage
SC = Screening
SEP = Sewer Separation

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System and in Section 1.8 Performance Estimate may occur.

The performance results for Control Option 1 as shown in Table 1-8 are based on the hydraulic model simulations using the year-round 1992 representative year applied uniformly. The table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan – Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. The table also includes overflow volumes specific to each individual control option when simulation was completed: these are listed to provide an indication of benefit gained only and are independent volume reductions unless noted otherwise.

Table 1-8. District Performance Summary – Control Option 1

	Preliminary Proposal	Master Plan			
Control Option	Annual Overflow Volume (m^3)	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [b]
Baseline (2013)	274,354	287,466	-	20	0.730 m^3/s
In-Line Storage	89,720 [a]	101,217	186,249	18	0.730 m^3/s
In-line Storage & Partial Sewer Separation		47,252	53,965	11	1.059 m^3/s
Offline Storage, Partial Separation & In-line Storage	48	N/A [c]	N/A [c]	N/A [c]	N/A [c]

Table 1-8. District Performance Summary – Control Option 1

Control Option	Preliminary Proposal	Master Plan			
	Annual Overflow Volume (m^3)	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [b]
Control Option 1	**48**	**47,252**	**240,214**	**11**	**1.059 m^3/s**

[a] Partial Separation and In-line Storage were not simulated independently during the Preliminary Proposal assessment.
[b] Pass forward flows assessed on the 1-year design rainfall event
[c] Off-line storage solution proposed during Preliminary Proposal, but not carried forward as part of Master Plan recommendations.

The control options proposed for the CSO Master Plan were based on the more focused district assessment and provision to achieve the system-wide 85 percent capture target. The off-line storage facility was not necessary to achieve this percent capture target and a stepped approach for the provision of sewer separation was assessed to be a more cost-effective approach for Control Option No.1. The percent capture performance measure is not included in Table 1-8, as it is applicable to the entire CS system and not for each district individually.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-9. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-9. District Cost Estimate – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period)
Separation	**-** [a]	$145,510,000	$87,000	$1,860,000
Screening	$7,740,000 [b]	$2,890,000 [f]	$33,000	$710,000
In-Line Storage Control Gate		$3,130,000	$44,000	$940,000
Gravity Flow Control	N/A [d]	$1,280,000	$34,000	$740,000
Off-line Storage	$25,820,000 [c]	N/A [e]	N/A [e]	N/A [e]
Subtotal	**$33,560,00**	**$152,810,000**	$198,000	**$4,250,000**
Opportunities	N/A	$15,280,000	$20,000	$430,000
District Total	**$33,560,00**	**$168,090,000**	$218,000	**$4,680,000**

[a] Separation cost not included in Preliminary Proposal. Solution developed as refinement to Preliminary Proposal costs. Costs for the partial separation item of work found to be $101,700,000 in 2014 dollars.
[b] Screening and In-Line Storage Control Gate cost combined in the Preliminary Proposal cost estimates.

Table 1-9. District Cost Estimate – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period)

[c] Solution was refined following initial Preliminary Proposal cost submission of $25,820,000. Updated costs for this item of work estimated at $67,550,000 in 2014 dollars.

[d] Gravity Flow Control recommendation developed as part of Master Plan, and was not part of the Preliminary Proposal.

[e] Off-line storage solution proposed during Preliminary Proposal, but not carried forward as part of Master Plan recommendations.

[f] Cost for bespoke screenings return pump not included in Master Plan as will depend on selection of screen and type of screening return system selected

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional costs for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014-dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019-dollar values.
- The 2019 Total Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of alternative plans, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-10.

Table 1-10. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	In-line Storage Control Gate	Preliminary estimate was based on a standard cost per district, which has been updated to a site-specific cost estimate.	The change may result in significant changes to individual districts but balances out over the entire CS area.
	Screening	Preliminary estimate was based on a standard cost per district, which has been updated to a site-specific cost estimate.	The change may result in significant changes to individual districts but balances out over the entire CS area.

Table 1-10. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
	Removal Of Off-line Storage	Not included in the Master Plan	Removed through marginal analysis
	Separation	Not included in Preliminary Proposal Estimate	
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management Approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation.	Preliminary estimates were based on 2014-dollar values.	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, a future performance target of 98 percent capture for the representative year measured on a system-wide basis was evaluated. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-11 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified for Control Option No.1.

Overall the Jefferson East district would be classified with medium potential for implementation of complete sewer separation as the only feasible approach to achieve the 98 percent capture in the representative year future performance target. The cost comparison indicated that due to the potential storage capacity within the existing system, in-line storage would be a cost-effective interim solution. However, if the planned sewer separation of the remainder of the Jefferson East district was pursued, there would no longer be the requirement the in-line storage to be constructed. At this point the separation of the remaining Jefferson West district would need to be completed before the solutions recommended to meet Control Option 1 would not be required.

If complete separation is not pursued, green infrastructure and off-line tank or tunnel storage may be utilized in key locations to provide additional storage and increase capture volume to meet future performance targets.

Table 1-11. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Separation of remaining Jefferson East district • Increase use of GI • Off-line storage facilities

The control options selected for the Jefferson East district have been aligned with the City's Basement Flood Relief program that was ongoing prior to the development of the CSO Master Plan. The 85 percent capture performance target is achieved on a system wide basis and the interactions with the adjacent districts (Jefferson West discharges directly to Jefferson East) did not require sewer separation of the entire Jefferson East district. As a result, the construction of a control gate and screening facility are still required for floatables management. The gate and screening installation would restrict the expandability of the control arrangement in this district. Reduced expandability may limit the district's contribution towards achieving the 98 percent capture performance target if not assessed on a system wide basis.

The cost for upgrading to meet an enhanced performance target depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-12.

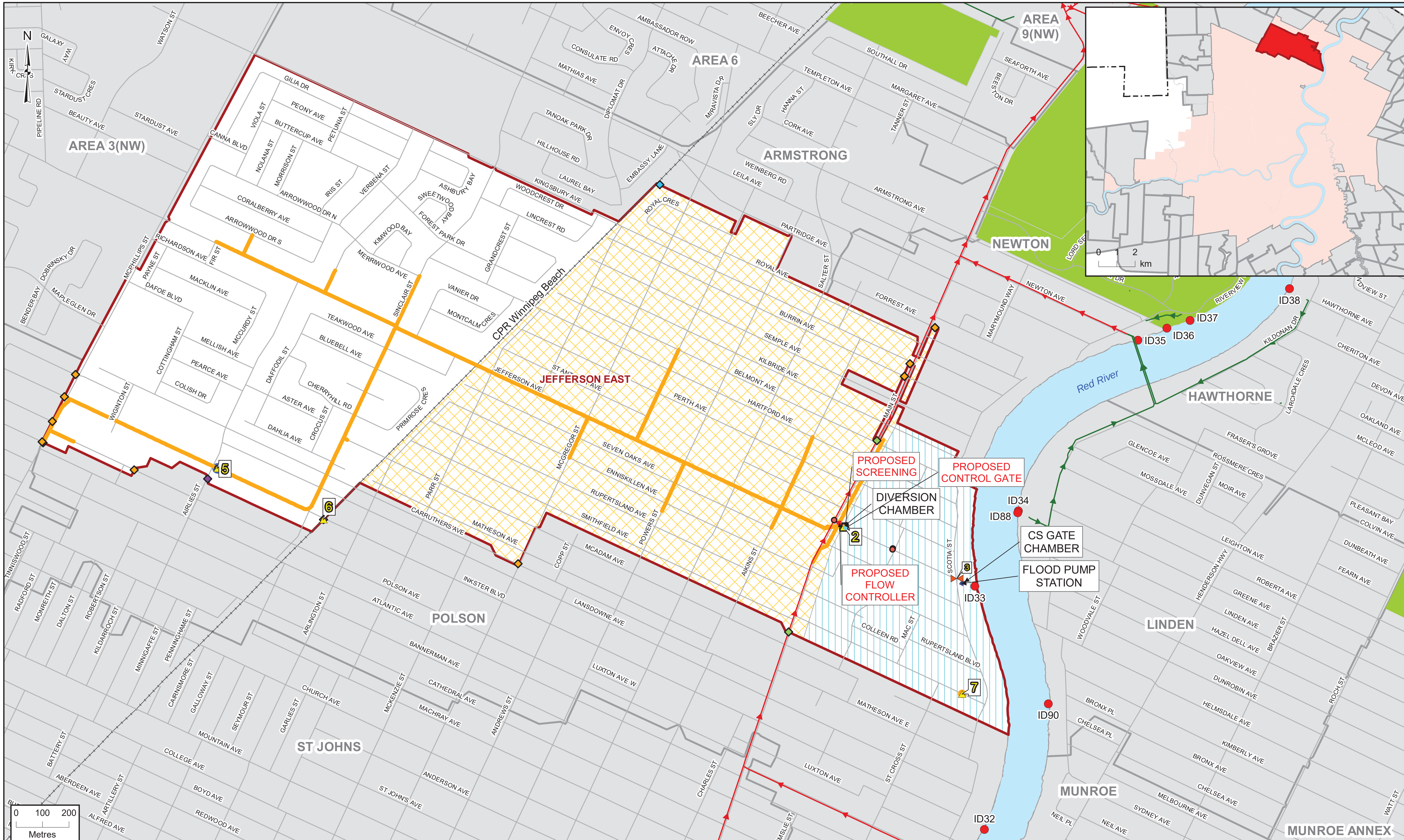
Table 1-12. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	R	-	-	O	-	-	-
2	Existing Lift Station	-	R	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	O	-	-	-
4	Construction Disruption	-	-	-	-	R	-	-	-
5	Implementation Schedule	-	-	-	-	R	-	R	-
6	Sewer Condition	-	R	-	-	-	-	-	-
7	Sewer Conflicts	-	R	-	-	R	-	-	-
8	Program Cost	-	O	-	-	R	-	-	O
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	-	-	-	-	O	O	O	-
12	Operations and Maintenance	-	R	-	-	R / O	R	O	R
13	Volume Capture Performance	-	O	-	-	-	O	O	-
14	Treatment	-	R	-	-	O	O	O	R

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

AECOM Canada Ltd. 2009. *Jefferson Combined Sewer Districts Sewer Relief and CSO Abatement Study.* Prepared for the City of Winnipeg, Waterworks, Waster and Disposal Department. March.



LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Low CS Manhole
- Low SRS Connection

Inter-System Connection

- CS - WWS
- SRS - CS

District Boundary Crossing

- CS
- LDS
- SRS
- WWS

- Interceptor Sewer
- Force Main
- Street
- Railway

- District Boundary
- Watercourse
- Greenspace

CSO MASTER PLAN PROPOSED SOLUTIONS

- Proposed Control Gate
- Extent of In-line Storage
- Sewer Separation - Underway
- Sewer Separation - Complete

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 19
District Overview Map
Sewer District: Jefferson East
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- Critical Elevation
- Manhole
- Flap Gate

Sewer By Type
- CS
- WWS

Pump Station Type
- Diversion Chamber

- Land Parcel

CSO MASTER PLAN
PROPOSED SOLUTIONS
- Control Gate
- Screening
- Flow Controller

ALL PROPOSED SOLUTIONS
SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg
THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 19-01
Control Gate, Screening, and Flow Controller
Sewer District: Jefferson East
City of Winnipeg
Combined Sewer Overflow Master Plan

CSO Master Plan

Jefferson West District Plan

August 2019

City of Winnipeg

CSO Master Plan

Project No: 470010CH
Document Title: Jefferson West District Plan
Revision: 03
Date: August 20, 2019
Client Name: City of Winnipeg
Project Manager: John Berry
Author: Jack Tinker
File Name: JeffersonW_Plan_Fianl_CO1MO_08202019

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Document History and Status

Revision	Date	Description	By	Review	Approved
0	09/14/2018	DRAFT for City Comment	DT	SB, MF, SG	
1	02/15/2019	DRAFT 2 for City Review	JT	SG	MF
2	08/12/2019	Final Draft Submission	DT	MF	MF
3	08/20/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

Tables

Figure

1. Jefferson West District

1.1 District Description

Jefferson West district is located towards the northwestern section of the combined sewer (CS) area. This district is approximately bounded by McPhillips Street to the east, The Canadian Pacific Railway (CPR) Winnipeg Yards to the south, Keewatin Street to the west, and Inkster Boulevard to the north.

Jefferson West primarily includes industrial land use with a mix of commercial, residential, and greenspace within the district. The industrial land includes general and heavy manufacturing with the general manufacturing facilities located north of Burrows Avenue and west of Fife Street, while the heavy manufacturing includes the CPR Winnipeg Yards on the southern perimeter of Jefferson West district. The residential area includes both single and multi-family residential buildings, with the majority of multi-family buildings located on Burrows Avenue. The single-family residential homes are located between Selkirk Avenue and Burrows Avenue and east of Fife Street. The commercial businesses can be found along Keewatin Street and McPhillips Street.

The southern end of the CPR Winnipeg Beach passes through Jefferson West and the CPR Arborg passes through the industrial sections of the district. McPhillips Street, Keewatin Street, and Inkster Boulevard are the major transportation routes within Jefferson West. Approximately 44 ha is identified as greenspace: this includes Shaughnessy Park, Northwood Park, and Fort Whyte Park.

1.2 Development

There are several areas within the Jefferson West combined sewer district which have been identified as a General Manufacturing Lands as part of OurWinnipeg. Focused intensification within these areas is to be promoted in the future, with a particular focus on mixed use development. This is to ensure adequate employment lands available to support future population growth.

1.3 Existing Sewer System

The Jefferson West district has an approximate area of 600 hectares (ha)[1] based on the GIS district boundary data. This district does not include any areas identified as land drainage sewer (LDS) separated or separation-ready.

The CS system is connected to the Jefferson East CS network, which includes a diversion structure, flood pump station (FPS), and outfall gate chamber. The CS system drains along the main CS trunk on Inkster Boulevard with combined sewers from the northern and western portions of the district connecting to the main trunk. The remainder of CS system in the Jefferson West district connects to the large CS on McPhillips Street, which in turn flows north and connects to the main trunk on Inkster Boulevard. These describe the two main paths that the combined sewage flows to connect to Jefferson East district.

During dry weather flow (DWF), the system flows by gravity throughout the district, where it connects to the Jefferson East CS system. Within the Jefferson East CS system, sanitary sewage flows into the diversion chamber located at the intersection of Jefferson Avenue and Main Street upstream of the CS outfall. The sanitary sewage is diverted by the weir to a 1520 mm interceptor pipe and into the Main Interceptor. Sewage from the areas east of Main Street flow to the FPS weir and is allowed to back up until reaching the diversion chamber at Jefferson Avenue and Jones Street. This diversion has a 450 mm off-take pipe, which connects into the Main Street diversion and the 1520 mm off-take pipe to the North End Sewage Treatment Plant (NEWPCC) for treatment.

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[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

During wet weather flow (WWF), any flows from the Jefferson West district which reaches the Jefferson East outfall and exceeds the diversion capacity will overtop the weir and is discharged into the Red River. Sluice and flap gates are installed on the Jefferson East CS outfall to prevent river water from backing up into the CS system. When the river level is high such as this gravity discharge from the CS outfall is not possible; under these conditions the excess flow is pumped by the Jefferson FPS to a point downstream of the flap gate to allow gravity discharge to the river once more.

Additionally, during WWF the SRS system provides relief to the southern CS system in the Jefferson West district. The SRS system extends through certain routes and has multiple interconnections with the CS system. Most catch basins are still connected to the CS system, so no partial separation has been completed. The SRS system connects to the 2150 mm SRS on Burrows Avenue. The SRS on Burrows then connects to the St. Johns SRS system on Burrows Avenue and ultimately uses the SRS outfall in the Selkirk district to discharge directly the Red River. A flap gate is located on this SRS outfall pipe to prevent river water from backing up into the SRS system.

There is also an overflow weir arrangement on the McPhillips CS trunk sewer that relieves the overall CS system from the Jefferson West district, and ties to the Inkster SRS system in the Polson district. This SRS system discharges directly to the Red River through the Inkster SRS outfall located near the intersection of Inkster Boulevard and Scotia Street. Upstream of the Inkster SRS outfall is an SRS off-take pipe, which will divert all collected CS in the SRS system into the Polson secondary interceptor and back into the CS system, under DWF and minor WWF conditions.

There are no CS outfalls in the Jefferson East district.

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Jefferson West and the surrounding districts. Each interconnection is shown on Figure 19 and shows locations where gravity flow can cross from one district to another. Each interconnection is listed as follows:

St. Johns

<u>SRS to SRS</u>

- A 2900 mm SRS trunk flows by gravity from Jefferson West district into St Johns district on Mountain Avenue and connects to the SRS network in St Johns district:
  - Invert at St Johns district boundary 224.78 m (S-MA00010486)
- A 2150 mm SRS diverts from the CS system in Jefferson West district and flows eastbound by gravity on Burrows Avenue into St. Johns district:
  - Invert at Jefferson West district boundary 224.50 m (S-MA70015831)
- High sewer overflow:
  - Selkirk Avenue and McPhillips Street – 229.68 m (S-MH00008715)
  - Manitoba Avenue and McPhillips Street – 229.43 m (S-MH00008744)
  - Alfred Avenue and McPhillips Street – 229.49 m (S-MH00008303)
  - Aberdeen Avenue and McPhillips Street – 229.19 m (S-MH00008304)
  - McPhillips Street and Mountain Avenue – 225.46 m (S-MH00008426)
  - McPhillips Street and Mountain Avenue – 225.43 m (S-MH00008425)

Jefferson East

<u>CS to CS</u>

- The 2400 mm CS pipe flows by gravity east on Inkster Boulevard into Jefferson East district:

  - Inkster Boulevard at McPhillips Street 224.53 m (S-MH00009032)
- The 450 mm CS pipe flows by gravity west on Polson Avenue into Jefferson West district:
  - Invert at Jefferson West district 225.27 m (S-MA00007321)
- The 375 mm CS pipe flows west by gravity on Lansdowne Avenue into Jefferson West district:
  - Invert at Jefferson West district boundary 227.02 m (S-MA00011271)

Manitoba

WWS to WWS

- High Point manhole:
  - Selkirk Avenue at Arrow Street – 230.16 m (S-MH00007585)

Burrows

LDS to CS

- A 375 mm LDS overflows by gravity along Burrows Avenue from Burrows district into the 900 mm CS on Burrows Avenue:
  - Invert at Jefferson West district boundary 227.77 m (S-MA00006842)

King Edward

LDS to LDS

- A 750 mm LDS flows by gravity on Inkster Boulevard from Jefferson West district into King Edward district:
  - Invert at King Edward district boundary 228.44 (S-MA70106301)

Polson

CS to CS

- High Point manhole:
  - Machray Avenue at McPhillips Street – 228.74 m (S-MH00007230)

A district interconnection schematic is included as Figure 1-1**Error! Reference source not found.**. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing system.

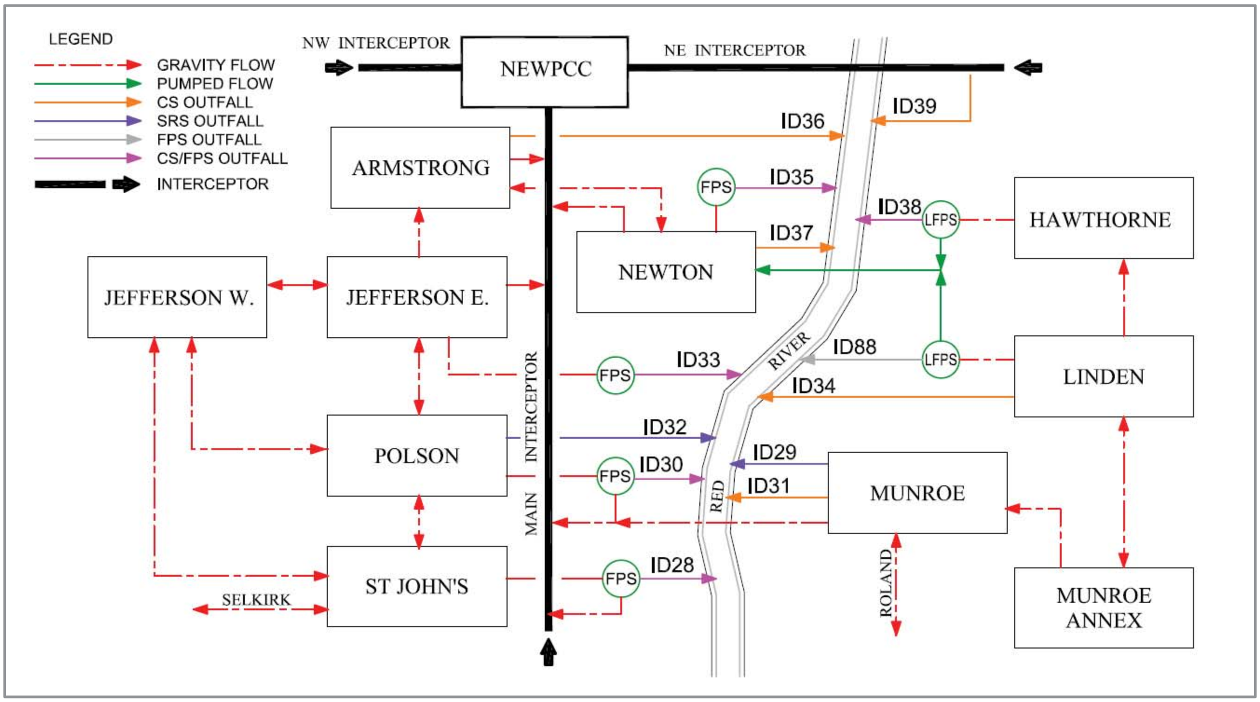


Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 20 and listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall	N/A	N/A	N/A	No CS outfall within the district.
Flood Pumping Outfall	N/A	N/A	N/A	No flood pump station within the district.
Other Overflows	N/A	N/A	N/A	
Main Trunk	S-MH00007387.1	S-MA00007312	2400 mm	Circular CS as it enters Jefferson East Invert: 224.53 m
SRS Outfalls	N/A	N/A	N/A	
SRS Interconnections	N/A	N/A	N/A	29 SRS-CS
Main Trunk Flap Gate	N/A	N/A	N/A	No CS outfall within the district.
Main Trunk Sluice Gate	N/A	N/A	N/A	No CS outfall within the district.
Off-Take	N/A	N/A	N/A	No CS outfall within the district.
Dry Well	N/A	N/A	N/A	
Lift Station Total Capacity	N/A	S-MA00011232 (1)	2400 mm (1)	3.7 m^3/s (1)

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
ADWF	N/A	N/A	0.2075 m^3/s	
Lift Station Force Main	N/A	N/A	N/A	No Lift station within the district.
Flood Pump Station Total Capacity	N/A	N/A	N/A	No flood pump station within the district.
Pass Forward Flow – First Overflow	N/A	N/A	No spill	No CS outfall and primary overflow arrangement within the district.

Notes:

(1) – Gravity pipe replacing Lift Station as Jefferson West gravity discharge district

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m) [a]
1	Normal Summer River Level	N/A
2	Trunk Invert at Off-Take	N/A
3	Top of Weir	N/A
4	Relief Outfall Invert at Flap Gate	N/A
5	Low Relief Interconnection (S-MH00008425 & S-MH00008426)	Invert – 225.46
6	Sewer District Interconnection (St Johns)	224.50
7	Low Basement	226.47
8	Flood Protection Level (Jefferson East)	228.92

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed in Jefferson West was the *Jefferson Combined Sewer Districts Sewer Relief and CSO Abatement Study* (AECOM Canada Ltd, 2009). The study's purpose was to determine the most cost-effective means to upgrade the hydraulic capacity of the combined sewer system to reduce basement flooding during extreme rainfall events. No other study or district evaluation work has been completed on the district sewer system since that time.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Expected Completion
20 – Jefferson West	2009	Future Work – Following Sewer Separation	2013	Study Complete	N/A

Source: Report on *Jefferson Combined Sewer Districts Sewer Relief and CSO Abatement Study*, 2009

1.5 Ongoing Investment Work

There is not any current or proposed CSO or sewer relief investment work occurring in Jefferson West district.

1.6 Control Option 1 Projects

1.6.1 Project Selection

There are no proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Jefferson West sewer district. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable as part of the Jefferson East district performance.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage	Storage / Transport Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	-	-	-	-	-	-	-	-	✓	✓	-

Notes:

- = not included
✓ = included

A portion of the existing CS trunk for Jefferson East extends into Jefferson West and will be impacted by the proposed in-line storage project recommended for Jefferson East. The in-line storage extends upstream from the control gate within Jefferson East and into the CS trunk in Jefferson West as shown in Figure 20.

GI and RTC will be applied within each district on a system-wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

Floatable controls with screening will not be required. Inter-system floatables management programs like catch basin cleaning and public education programs would impact this district.

1.6.2 In-Line Storage

The proposed in-line storage in Jefferson East extends into Jefferson West district. The design criteria for the in-line storage can be found in the Jefferson East plan. The amount of storage that extends into Jefferson West is 8815 m^3. The proposed extent of the in-line storage is shown on Figure 19-01 and Figure 20.

The physical requirements for the off-take and station sizing for a modification to pumping capacity have not been considered in detail, but they will be required in the future as part of an RTC program or LS rehabilitation or replacement project.

1.6.3 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography, and soil classification for the district will be reviewed to identify applicable GI controls.

Jefferson West has been classified as a medium GI potential district. Land use in Jefferson West primarily includes industrial land use with a mix of commercial, residential, and greenspace within the district. This means the district would be an ideal location for bioswales, permeable paved roadways, cisterns/rain barrels. The flat roof commercial buildings make for an ideal location for green roofs.

1.6.4 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

The impact of the in-line storage proposed in Jefferson East may impact the existing sewers in Jefferson West. Additional system monitoring, and level controls will be installed which will require regular scheduled maintenance.

It is noted that the current pipe configuration associated with the Mountain SRS system has attributed to O&M issues. This SRS system includes interconnections between the Jefferson West and the St Johns districts, at manholes S-MH00008425 and S-MH00008426. The location is problematic and has led to frequent DWF flows entering the Mountain SRS due to siphon blockages. The system allows the DWF flows to be diverted back to the Main Interceptor system, but it is noted as not ideal. Any proposed work in the Jefferson West district as part of the CSO Master Plan should also investigation the operation of this SRS system, and correct this to reduce the operational burden on the City.

1.8 Performance Estimate

1.8.1 InfoWorks Model

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. An individual model was created to represent the sewer system baseline as represented in the year 2013 and a second model was created for the CSO Master Plan evaluation purposes, with all the control options recommended for the district to meet Control Option 1 implemented in the year 2037. A summary of relevant model data is provided in Table 1-5.

Table 1-5. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	528	528	7,277	68	N/A
2037 Master Plan – Control Option 1	528	528	7,277	68	N/A

Notes:

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City Of Winnipeg GIS Records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance of this district has been included in the Jefferson East district engineering plan, as this district does not have an overflow discharge point directly to the river.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each relevant control option with overall program costs summarized and described in Section 3.4 of Part 3A of the CSO Master Plan. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-6. The cost estimates are a Class 5 planning level estimate with a level of accuracy range of minus 50 percent to plus 100 percent.

Table 1-6: Cost Estimates – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost [a]	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period) [a]
Subtotal	**$0**	**$0**	**$0**	**$0**
Opportunities	N/A	$0	$0	$0
District Total	**$0**	**$0**	**$0**	**$0**

[a] No work is proposed in the Jefferson West district and therefore zero costs have been included for the Master Plan capital cost and O&M costs.

The estimates include updated construction costs based on level of completion of work to date. The calculations for the CSO Master Plan cost estimate include the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional costs for RTC. As there are no capital costs allocated to this district as the work to align with the CSO Master Plan is complete, there has also been no capital costs in this district allocated to GI or RTC opportunities.
- The Preliminary Proposal capital cost is in 2014-dollar values.

- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-7.

Table 1-7. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	No costs allocated opportunities as capital costs for district removed.
Lifecycle Costs	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation	Preliminary Proposal estimates were based on 2014-dollar values	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, the future performance target is 98 percent capture for the representative year measured on a system-wide basis. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-8 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified for Control Option 1.

Overall the Jefferson West district would be classified as a low potential for implementation of complete sewer separation as the only feasible approach to achieve the 98 percent capture future performance target in the representative year. However, opportunistic sewer separation within a portion of the district may be completed in conjunction with other major infrastructure work to address future performance targets. In addition, green infrastructure and off-line tank or tunnel storage may be utilized in key locations to provide additional storage and increase capture volume to meet future performance targets.

Table 1-8. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Opportunistic Separation • Increased use of GI

The control options selected for the Jefferson West district were aligned for the system wide target of 85 percent capture and covered the downstream district of Jefferson East. The migration of the control options to meet the 98 percent capture target will be in conjunction with the requirements of Jefferson East and on a system wide basis. The existing SRS systems that extent into this district may be able to be utilized for opportunistic future sewer separation. A further investigation into the performance of these SRS pipes would be needed prior to increasing the runoff flows to these systems.

The district performance and cost for upgrading to 98 percent capture will depend on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of master planning. The approach to moving the program to an increased level of performance to meet regulatory requirements will be presented in detail in the CSO Master Plan update due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-9.

A specific acceptable risk for the Jefferson West district is associated with no proposed work measures being required for this district. As a result, no costs for GI opportunities have been allocated, since this cost is a percentage of future capital costs. However, this does not restrict any GI or RTC opportunities from occurring in this district, as in this situation the 10% allowance attributed to other districts will be utilized.

Table 1-9. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate [a]	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	R	-	-	-	-	-	-
2	Existing Lift Station	-	R	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	-	-	-	-
4	Construction Disruption	-	-	-	-	-	-	-	-
5	Implementation Schedule	-	-	-	-	-	-	R	-
6	Sewer Condition	-	R	-	-	-	-	-	-
7	Sewer Conflicts	-	R	-	-	-	-	-	-
8	Program Cost	-	O	-	-	-	-	-	-
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	-	-	-	-	-	O	O	-

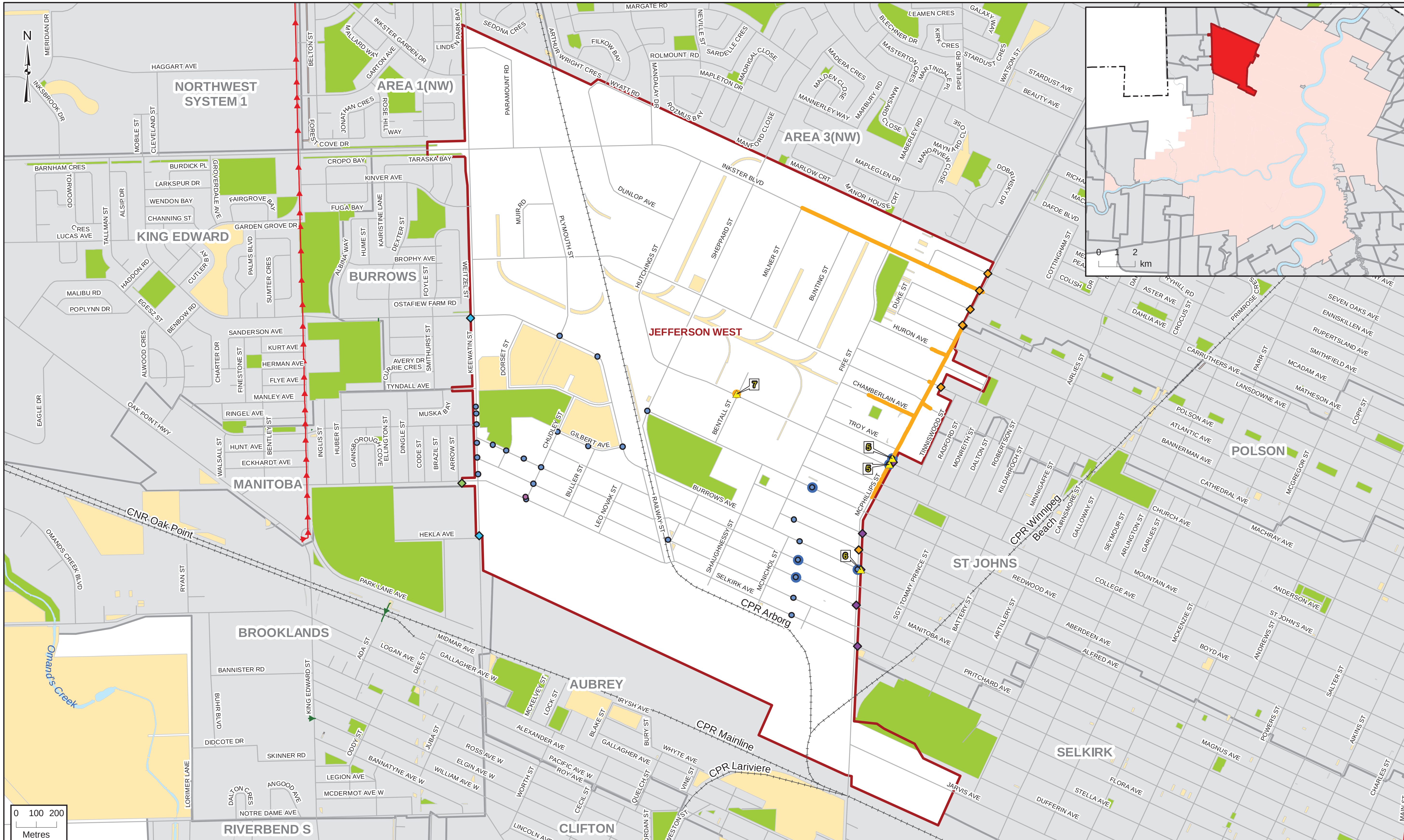
Table 1-9. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate [a]	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
12	Operations and Maintenance	-	R	-	-	-	R	O	-
13	Volume Capture Performance	-	O	-	-	-	O	O	-
14	Treatment	-	R	-	-	-	O	O	-

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

AECOM Canada Ltd. 2009. *Jefferson Combined Sewer Districts Sewer Relief and CSO Abatement Study.* Prepared for the City of Winnipeg, Waterworks, Waster and Disposal Department. March.



LEGEND

- Critical Elevation
- Low CS Manhole
- Low SRS Connection

Inter-System Connection
- SRS - CS
- SRS - LDS

District Boundary Crossing
- CS
- LDS
- SRS
- WWS

- Interceptor Sewer
- Force Main
- Street
- Railway

- District Boundary
- Watercourse
- Greenspace
- City Owned Land

CSO MASTER PLAN PROPOSED SOLUTIONS

- Extent of In-line Storage

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 20
District Overview Map
Sewer District: Jefferson West
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Jessie District Plan

August 2019

City of Winnipeg

CSO Master Plan

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Document History and Status

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0	08/2018	DRAFT for City Comment	SG	ES	
1	11/2018	DRAFT 2 for City Review	JT	SG / MF	
2	05/2019	Final Draft Submission	JT	MF / SG	MF
3	07/2019	Revised Final Draft Submission	JT	SG / MF	MF
4	08/20/2019	Final Submission For CSO Master Plan	MF	MF	SG

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Tables

Figure

1. Jessie District

1.1 District Description

Jessie district is located in the southwest of the combined sewer (CS) area, south of the Assiniboine River and west of the Red River. Jessie is bounded by the River district to the northeast, Cockburn and Baltimore districts to the south, and Ash district to the west. Figure 34 provides an overview of the sewer district and the location of the proposed Combined Sewer Overflow (CSO) Master Plan control options.

Regional roadways in Jessie include Pembina Highway, Grant Avenue, Corydon Avenue, and Taylor Avenue. The Southwest Transitway is located near the eastern boundary and parallel to Pembina Highway.

The district contains mostly residential land use with commercial land parcels around major transportation routes of Corydon Avenue and Pembina Highway. A small area of industrial land is located near the Red River. Development in the district is mainly the conversion of single family homes to multi-family and the addition of new developments around the Southwest Transit Corridor. Non-residential use in the area is the Winnipeg Transit Fort Rouge Garage, the Deaf Centre Manitoba institute on Pembina Highway, and Earl Grey Community Centre.

1.2 Development

A portion of Pembina Highway is located within the Jessie District. Pembina Highway is identified as Regional Mixed Use Corridor as part of the OurWinnipeg future development plans. As such, focused intensification along Pembina Highway is to be promoted in the future.

1.3 Existing Sewer System

The Jessie district has an approximate area of 397 ha[1] and is serviced within Jessie district with a mix of storm relief sewer (SRS) and combined sewer (CS) pipe. There is no existing separation and none of the district is separation ready. Most of the combined system was constructed between 1900 and 1960. The SRS system was added in the 1970s to provide additional capacity and relieve the CS system.

The CS system includes a lift station (LS), flood pump station (FPS) and one combined CS/FPS outfall. The CS system drains towards the Jessie outfall, located at the east end of Jessie Avenue at the Assiniboine River. The main collector sewer is egg-shaped and is aligned down Jessie Avenue. This sewer varies in size from 1350 by 1800 mm to 1800 by 2400 mm. At the outfall, flow is diverted to the Jessie CS lift station (LS) where it is pumped through River district, across the Assiniboine River and to the Main Interceptor. Otherwise, flow may overflow the diversion weir to the outfall and flow by gravity to the Assiniboine River.

The SRS system extends throughout the district and has multiple interconnections with the CS system. The SRS system provides relief and extra capacity during high flow event and allows the CS to overflow into the SRS. When CS capacity is regained, the SRS drains back into the CS system. Most catch basins are still connected to the CS system, so partial separation has not been completed throughout most of the district. The northwest portion of Jessie includes a SRS system with an independent outfall. A 1350 mm SRS is installed along Grosvenor Avenue and flows to the Assiniboine River off Wellington Crescent. A flap gate and sluice gate are installed on the outfall pipe to control backflow into the SRS system under high river level conditions in the Red River.

During dry weather flow (DWF), the existing weir diverts flow to the Jessie CS LS through two 600 mm off-take pipes and is pumped through two 300 mm force mains to the River district, then travel via a 600

[1] City Of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System and in Section 1.8 Performance Estimate may occur.

mm interceptor pipe to the River CS LS and river crossing to the Assiniboine district and on to the North End Sewage Treatment Plant (NEWPCC). During wet weather flow (WWF), any flows that exceeds the diversion capacity of the primary weir is discharged to the river. Sluice and flap gates are installed on the CS outfall to prevent back-up of the Red River into the CS system under high river level conditions. Under high river level conditions when gravity flow is not available, Jessie FPS pumps flow to the river through the outfall pipe.

The combined CS and FPS outfall to the Red River is as follows:

- ID10 (S-MA70016174) – Jessie CS/FPS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Jessie, Ash, Cockburn, Baltimore, and River districts. Each interconnection is shown on Figure 34, and this figure shows gravity and pumped flow from one district to another. The interconnections are as follows:

1.3.1.1 Interceptor Connections – Downstream Of Primary Weir

River

- The Jessie CS LS discharges into a force main that separates into two 250 mm pipes that flow north into River district:
  - Dual 250 mm force mains

1.3.1.2 District Interconnections

Ash

CS to CS

- High Point Manhole (Flow is directed into both districts from this manhole)
  - Corydon Avenue and Cambridge Street – 229.50 m (S-MH60009462)

Cockburn

CS to CS

- High Point Manhole (flow is directed into both districts from this manhole)
  - Ebby Avenue and Wentworth Street – 228.93 m (S-MH60010140)
- A 300 mm CS sewer acts as an overflow pipe from the Cockburn CS system into the Jessie CS system.
  - Jackson Avenue and Stafford Avenue – 229.29 m (S-MH60010066)

Baltimore

LDS to LDS

- A 1350 mm LDS trunk conveys flow from the Fort Rouge Yards development area in Cockburn to an LDS outfall discharging to the Red River by gravity flow in the Jessie sewer district.

River

SRS to CS

- A 450mm SRS discharges into Jessie district CS system at the intersection of Jessie Avenue, between Pembina Highway and Osborne Street:
  - Southern River District SRS Tie-In – 224.35 m (S-MH60009040)
- A 350mm SRS in the River district discharges into Jessie CS system by gravity flow at the intersection of Corydon Avenue and Daly Street:
  - Corydon Avenue SRS Tie-In – 228.353 m
- A 250mm SRS in the River district discharges into Jessie CS system by gravity flow at the intersection of McMillan Avenue and Daly Street:
  - McMillan Avenue SRS Tie-In – 228.32 m (S-MH70016737)
- High Sewer Overflow 250mm SRS overflow pipe connects River's CS to Jessie's CS system).
  - Wellington Crescent & Gertrude - 229.06 m (S-MH60017449)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing system.

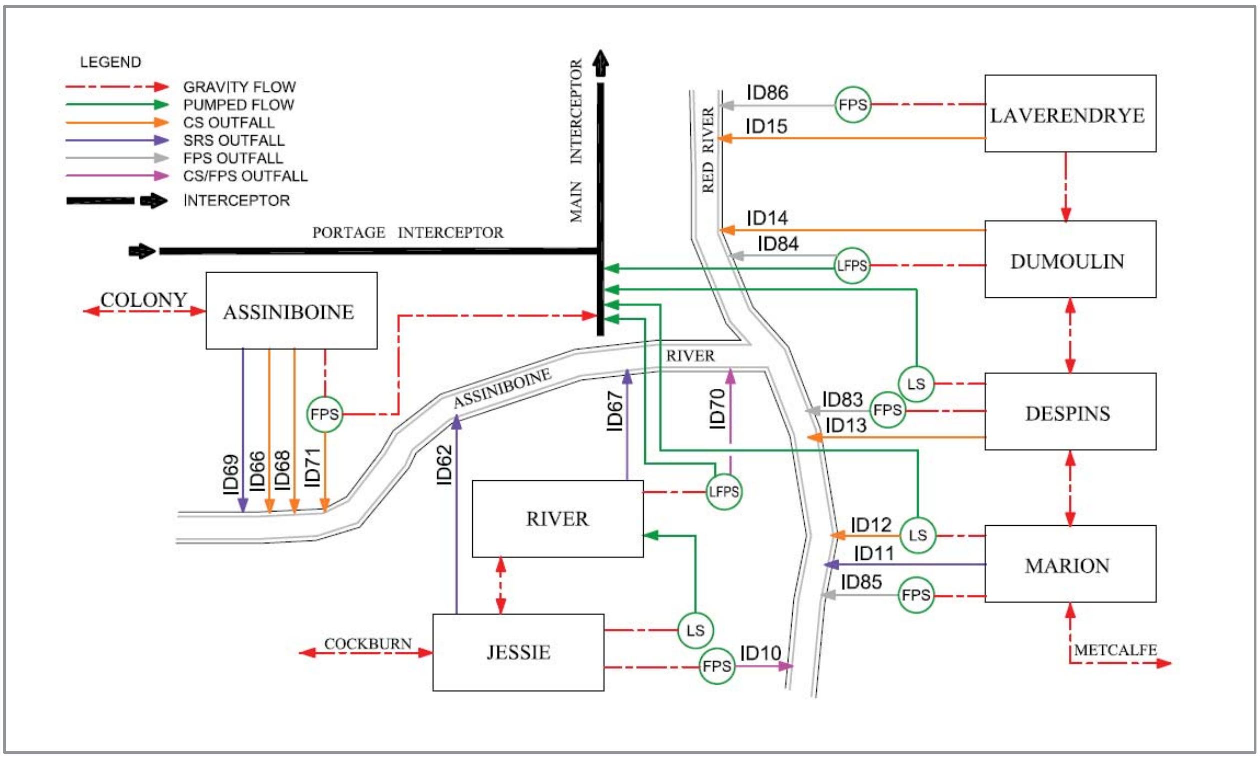

Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 21 and are listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall	S-CO70007409.1	S-MA70016174	2130 mm	Circular Invert: 221.91
Flood Pumping Outfall	S-CO70007409.1	S-MA70016174	2130 mm	Circular Invert: 221.91
Other Overflows	N/A	N/A	N/A	N/A
Main Trunk	S-TE70007799.1	S-MA70016174	1800 x 2400 mm	Egg-shaped Invert: 222.65m
SRS Outfalls (ID62)	S-CO70003029.1	S-MA70002491	1400 mm	Circular Invert: 224.81
SRS Interconnections	N/A	N/A	N/A	25 SRS - CS (also 4 district interconnections)
Main Trunk Flap Gate	S-CG00000817.1	S-CG00000817	1800 x 2100 mm	Square shaped Invert: 222.78
Main Trunk Sluice Gate	S-CG00000816.1	S-CG00000816	1800 x 2100 mm	Square shaped Invert: 222.78
Off-Take	S-TE70007800.2 S-TE70007799.2	S-MA70003857	600 mm	Invert: 222.78 Invert: 222.87
Dry Well	N/A	N/A	N/A	
Lift Station Total Capacity	N/A	N/A	0.27 m^3/s	2 pumps at 0.135 m3/s
Lift Station ADWF	N/A	N/A	0.088 m^3/s	
Lift Station Force Main	S-YY70021068.2 S-BE70025982.1	S-MA70003857	250 mm	2 x 250 mm Invert: 230.58
Flood Pump Station Total Capacity	N/A	N/A	3.12 m^3/s	2 pumps at 1.156 m^3/s, 1 x 0.808 m^3/s
Pass Forward Flow – First Overflow	N/A	N/A	0.261 m^3/s	

Note:
ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Jessie – 223.73 Grosvenor – 223.84
2	Trunk Invert at Off-Take Pipes	222.78 – West Offtake 222.87 – East Offtake
3	Top of Weir	223.11
4	Relief Outfall Invert at Flap Gate	Grosvenor – 224.83

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
5	Low Relief Interconnection	226.03[1]
6	Sewer District Low Interconnection (River Combined Sewer District)	224.35
7	Low Basement	230.89
8	Flood Protection Level	230.14

[a] City of Winnipeg Data, 2013

[1]This relief interconnection height is based on an assumed weir structure at this location, with a weir height equal to half of the connecting pipe diameter. This assumption was applied to all locations where SRS overflow pipes are indicated, but based on GIS records an overflow height is not provided.

1.4 Previous Investment Work

The most recent study of Jessie district was completed in 1974 (MacLaren, 1974). This study led to the design and construction of the SRS system to add discharge capacity and increase the level of service for basement flood protection. South East (SE) Jessie was included with the Cockburn sewer relief project, Cockburn Preliminary Design Report (KGS, 2010), and is planned for complete separation. Table 1-3 provides a summary of the district status in terms of data capture and study.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Jessie Combined Sewer District was included as part of this program. Instruments installed at each of the thirty nine primary CSO outfall locations has a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District ID	District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Expected Completion
21	Jessie	1974 - Conceptual	Future Work	2013	Study Complete	N/A
21	SE Jessie	2010 - PDR	Future Work	2013	Under Construction (SE Jessie Only)	TBD

Note:
TBD = To Be Determined

1.5 Ongoing Investment Work

As part of the Cockburn BFR program, an LDS system within southeast Jessie will be completed and provide complete road drainage separation.

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Jessie district. This consists of monthly site visits in confined entry spaces to ensure physical readings concur with displayed transmitted readings, and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Jessie sewer district are listed in Table 1-4. The proposed CSO control projects will include partial sewer separation and an alternative floatable management approach. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-Line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85% Capture in a Representative Year	-	-	-	-	-	-	-	✓	✓	✓	✓

Notes:
- = not included
✓ = included

The existing CS system is not fully suitable for use as in-line storage as the relative low level of the CS LS and associated CS outfall results in the NSWL level being at a similar level to the recommended control gate level (within 100mm) during the 1992 representative year assessment. An area within SE Jessie is undergoing separation in conjunction with the Cockburn district sewer relief project, and will provide the required benefits to the overall CSO Master Plan to meet Control Option 1.

Floatable control will be necessary to capture any undesirable floatables in the sewage overflows. Floatables are typically captured via a screening facility, however, the hydraulic constraints within the Jessie district do not allow sufficient positive head to be achieved and an alternative floatables management approach will be necessary.

The SRS system does not fully allow a cost effective installation of the latent storage option due to minor overflow volume reduction during the 1992 representative year and has not been proposed in this district.

GI and RTC will be applied within each district on a system wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Sewer Separation

The SE portion of the Jessie district is programmed to be separated as part of the Cockburn BFR project, this will provide some benefits to the CSO program when complete.

The flows to be collected from the Jessie separation will be as follows:

- Dry weather flows will remain the same for the Jessie district.
- Jessie wet weather flow (WWF) from this separation area will consist of sanitary sewage combined with foundation drainage.
- The majority of Jessie will remain as combined sewage.

This will result in a reduction in the combined sewage flow received at the Jessie CS LS and FPS after the separation project is complete.

1.6.3 Floatables Management

Floatables management for the Jessie district, due to the existing hydraulic constraints, is proposed to be an alternative floatables management approach. This approach is to ensure that the proposed required floatable management requirements outlined within the Environment Act Licence 3042 can be maintained.

This alternative approach to floatables management will be achieved by targeting floatables source control. This will be achieved by implementing more focused efforts towards street cleaning and catch-basin cleaning, to remove floatable material from surface runoff before it enters the combined sewer system. The second broad component of this alternative approach will focus on public education in an effort to reduce the sanitary components from ever entering plumbing systems. This is expected to achieve similar or better results while eliminating the end-of-pipe screening. The proposed approach will be similar to the program currently carried out in the City of Ottawa to meet their CSO mitigation requirements.

The alternative approach will be further investigated and demonstrated during the interim period between the submission of the CSO Master Plan (August 2019) and the revised CSO Master Plan submission (April 2030), and is discussed in further detail in Part 2 of the CSO Master Plan. It is recommended that as part of this work these measures will be undertaken in the Jessie district, due to screening limitations mentioned above.

1.6.4 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography, and soil classification for the district will be reviewed to identify applicable GI controls.

Jessie has been classified as a medium GI potential district. Land use in Jessie is mostly single-family residential. Corydon Avenue includes a mix of commercial businesses. This means the district would be an ideal location for bioswales, permeable paved roadways, cistern/rain barrels, and rain gardens. The flat roof commercial buildings along Corydon Avenue make would be an ideal location for green roofs.

1.6.5 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term considerations for implementation on a system wide basis.

1.7 System Operations and Maintenance

Systems operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

Sewer separation will include the installation of additional sewers that will require inspection, cleaning and rehabilitation. This will result in additional maintenance costs over the long term, but operational costs will be minimal. The existing larger CS pipes within the district may also receive insufficient flow with the separation work for proper scouring velocities in the sewer pipes. This could result in solids settling within the sewers, and requiring more frequent cleaning operations. The impacts of the reduced flows in larger CS pipes will be evaluated as part of the sewer separation design for the district. The alternative floatable management control is based on implementing additional operating and maintenance measures, in an effort to match the performance of the capital construction projects to meet the floatables management requirements. As such dedicated additional operating and maintenance costs should be allocated to this district. The goal however is for this work to overall be more cost effective from a life cycle perspective, considering the upfront capital and operating and maintenance costs associated with screening facilities.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. Two versions of the sewer system model were created and used to measure system performance. The 2013 Baseline model represents the sewer system baseline in the year 2013 and the 2037 Master Plan – Control Option 1 model, which includes the proposed control options in the year 2037. A summary of relevant model data is provided in Table 1-5.

Table 1-5. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	389	382	14,129	36	N/A
2037 Master Plan – Control Option 1	389	374	14,129	32	SEP

Notes:

SEP - Separation

No change to the future population was completed as from a wastewater generation perspective from the update to the 2012 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district.

City of Winnipeg hydraulic model relied upon for area statics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-6 are for the hydraulic model simulations using the year-round 1992 representative year. The table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. The table also includes overflow volumes specific to each individual control option when simulations were completed; these are listed to provide an indication of benefit gained only and are independent volume reductions unless noted otherwise.

Table 1-6. District Performance Summary – Control Option 1

	Preliminary Proposal	Master Plan			
Control Option	Annual Overflow Volume (m^3)	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [a]
Baseline	189,233	187,594	-	21	0.261 m^3/s
In-Line Storage	189,233	N/A	N/A	N/A	N/A
Latent Storage	189,008	N/A	N/A	N/A	N/A
Separation	161,801	164,392	23,202	21	0.266 m^3/s
Control Option 1	**189,008** [b]	**164,392**	**23,202**	**21**	**0.266 m^3/s**

Note:

[a] Pass forward flows assessed on the 1-year design rainfall event

[b] Incorrect volume taken forward for Preliminary Proposal assessment due to interim solution results. Small reduction due to latent storage component of PP assessment.

The predicted small overflow volume reduction of approximately 400 m^3 for the MP proposed latent storage option at the Grosvenor SRS system was not taken forward due to the relatively high cost component.

Percent capture is not included in the table above, as it is reported for the entire CS collection system and not for each district individually.

1.9 Cost Estimates

The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-7. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-7. District Cost Estimate – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period)
Separation	$ - [a]	$25,900,000	$15,000	$330,000
Latent Storage	$2,020,000	N/A [b]	N/A	N/A
In-Line Storage (incl. screening)	$ - [a]	N/A [b]	N/A	N/A
Floatables Management Allowance	N/A	$2,540,000 [c]	$45,000 [c]	$960,000
Subtotal	**$2,020,000**	**$28,440,000**	**$60,000**	**$1,290,000**
Opportunities	N/A	$2,840,000	$6,000	$130,000
District Total	**$2,020,000**	**$31,280,000**	**$66,000**	**$1,420,000**

Notes:

[a] Solution developed as refinement to Preliminary Proposal work following submission of Preliminary Proposal costs. Costs for the Separation item of work found to be $16,120,000 and for In-Line Storage (including screening) item of work to be $5,840,000, both in 2014 dollars

b

[b] Latent storage and In-line storage (incl. screening) not taken forward in Master Plan costing

[c] Cost allowance to account for the alternative floatable management measures. This allowance is based on a typical district control gate cost.

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional cost for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014-dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019-dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019. Each of these values include equipment replacement and O&M costs.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.

- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-8.

Table 1-8. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Floatables Management	Control Gate and screening were not included in the Preliminary Proposal estimate. Screening later determined to not be feasible due to hydraulic constraints. Added to Master Plan cost, assumed to be comparable to typical control gate projected cost.	
	Removal of Latent Storage	The Master Plan assessment found that latent storage not a preferred control solution.	
	Removal of In-Line Storage	The Master Plan assessment found that in-line storage not a preferred control solution.	
	Sewer Separation	Revised unit costs for separation work.	Refer to Cockburn PP costs for the Jessie separation costs
Opportunities	A fixed allowance of 10 percent has been included for program opportunities such as Green Infrastructure	Preliminary Proposal estimate did not include a cost for opportunities.	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management Approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation	Preliminary Proposal estimates were based on 2014-dollar values.	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, the future performance target is 98 percent capture for the representative year measured on a system-wide basis. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-9 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified for Control Option 1.

Overall the Jessie district would be classified as a low potential for implementation of complete sewer separation as the only feasible approach to achieve the 98 percent capture in the representative year future performance target. Opportunistic separation of portions of the district may be achieved with synergies with other major infrastructure work to address future performance targets. In addition, green infrastructure and off-line storage tank or tunnel storage may be utilized in key locations to provide additional storage and increase capture volume.

Table 1-9. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Opportunistic Separation • Off-line Storage (Tunnel / Tank) • Increased GI

The control options for Jessie district have been aligned to meet the 85 percent capture performance target based on the system wide basis. The expandability of this district to meet 98 percent capture target would be based on the system wide basis analysis and the results of the alternative floatables management approach.

The cost for upgrading to meet an enhanced performance target depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of master planning. The “Phase In” approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-10.

Table 1-10. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	-	-	-	O	-	-	-
2	Existing Lift Station	-	-	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	O	-	-	-
4	Construction Disruption	-	-	-	-	R	-	-	-
5	Implementation Schedule	-	-	-	-	R	-	-	-
6	Sewer Condition	-	-	-	-	-	-	-	-
7	Sewer Conflicts	-	-	-	-	R	-	-	-
8	Program Cost	-	-	-	-	R	-	-	O
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-

Table 1-10. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
11	Technology Assumptions	-	-	-	-	-	O	O	R
12	Operations and Maintenance	-	-	-	-	-	R	R / O	R
13	Volume Capture Performance	-	-	-	-	-	O	O	-
14	Treatment	-	-	-	-	O	O	O	R

Risks and opportunities will require further review and actions at the time of project implementation

1.12 References

KGS Group. 2015. *Cockburn and Calrossie Combined Sewer Relief Works Preliminary Design Report.* Prepared for the City of Winnipeg, Waterworks, Waster and Disposal Department. June.

LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Low CS Manhole
- Low SRS Connection

Inter-System Connection
- SRS - CS

District Boundary Crossing
- CS
- LDS
- SRS
- WWS

- Extent of Existing In-line Storage
- Interceptor Sewer
- Force Main
- Street
- Railway
- District Boundary
- Watercourse
- Greenspace
- City Owned Land

CSO MASTER PLAN PROPOSED SOLUTIONS

- Sewer Separation - Underway

Note: Alternative Floatables Management Approach to be tested prior to implementation.

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

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FIGURE 34
District Overview Map
Sewer District: Jessie
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

La Verendrye District Plan

August 2019

City of Winnipeg

CSO Master Plan

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1. La Verendrye District

1.1 District Description

La Verendrye district is located near the centre of the combined sewer (CS) area in the northern section of St. Boniface community. La Verendrye is bounded by Mission district to the east, Dumoulin district to the south, and the Red River to the north and west. Notre Dame Street forms the southern boundary, and the Seine River runs along the eastern boundary.

The Canadian National Railway (CNR) Mainline and CNR Sprague railway pass through the district. The CNR Mainline passes east-west and crosses the Red River to the west. The CNR Sprague railway splits from the CNR Mainline and travels south parallel with Thibault Street into Dumoulin district.

The land use in La Verendrye district is a split between residential and parks and recreation with some commercial businesses interspersed throughout the district. The residential area is located on the western and southern areas of the district and consists of mainly single-family homes with some two-family residences. Most of the district consists of greenspace located along the edge of the Red River. Approximately 40 ha of the district is classified as greenspace. Lagimodiere-Gaboury Park and Whittier Park can be found in La Verendrye district and are divided by the CNR Mainline.

1.2 Development

There is limited land area available for new development within La Verendrye district due to its location and residential land use. As such, no significant developments that would impact the Combined Sewer Overflow (CSO) Master Plan are expected.

1.3 Existing Sewer System

La Verendrye district encompasses an area of 81 ha[1] based on the GIS district boundary information and includes combined sewer (CS), wastewater sewer (WWS) and land drainage sewer (LDS) systems. As shown in Figure 22, there is approximately 84 percent (34 ha) of the district already separated and no separation-ready areas.

The La Verendrye sewer system includes the primary diversion weir, CS primary outfall, a flood pump station (FPS), FPS outfall, and a CS outfall gate chamber located adjacent to the Red River at Tache Avenue and La Verendrye Street. A flap and sluice gate are in place on the CS outfall to prevent river water from flowing into the CS under high river level conditions. There is a WWS lift station (LS) located on St. Jean Baptist Street and Thibault Street (referred to as the Thibault WWS LS) which serves a small portion of the district north of Aubert Street. Sewage flows collected in La Verendrye district converge to a single 450 mm CS trunk sewer flowing south on Tache Avenue and draining towards the outfall.

During dry weather flow (DWF), the primary diversion weir diverts flow south by gravity through a 300 mm CS off-take pipe along Taché Avenue and into the Dumoulin district. The Dumoulin primary weir then diverts the intercepted flow from the La Varendrye district in addition to the CS from the Dumoulin district to the lift section of the Dumoulin lift and flood pumping station (LFPS). The Dumoulin LFPS pumps across the Red River into the Bannatyne district and on to the North End Sewage Treatment Plant (NEWPCC).

During wet weather flow (WWF) events, a parallel 450 mm overflow pipe immediately upstream of the diversion weir diverts some of the additional WWF southbound along Tache Avenue by gravity, also entering into the Dumoulin district and being intercepted by the Dumoulin primary weir. Any flow that exceeds the diversion capacity overtops the primary weir and is discharged to the Red River via the CS

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System and in Section 1.8 Performance Estimate may occur.

outfall. When the river levels are high gravity flow is not possible in the CS outfall due to the flap gate in place, as mentioned above. Under these conditions the FPS pumps are activated, and redirect the flow which has spilt over the primary weir through the FPS outfall, at which point it can discharge by gravity into the river. The FPS outfall contains no flap or sluice gate.

An LDS system is installed throughout the majority of the district. Figure 22 shows a small section located in the northwest that remains unseparated along Herbert, Darveau, Messager Streets and Tache Avenue. Three independent LDS systems with dedicated LDS outfalls collect the surface runoff and discharge to the rivers adjacent to the district. In the southwestern portion of the district runoff flows to a 1200 mm LDS outfall located adjacent to the CS outfall at La Verendrye Street and discharges to the Red River. The eastern portion of the district flows to a 1200 mm outfall on Notre Dame Street and into the Seine River. The northwestern portion of the district with LDS installed flows through a 750 mm outfall located off Messager Street and into the Red River. Each LDS outfall includes a sluice and flap gate to prevent river water from backing up into the system under high river level conditions.

The outfalls to the Red River (one CS and one FPS) are listed as follows:

- ID15 (S-MA70017688) – La Verendrye CS Outfall
- ID86 (S-MA70017667) – La Verendrye FPS Outfall

1.3.1 District-to-District Interconnections

There are four district-to-district interconnections between La Verendrye and Dumoulin districts. Each interconnection is shown on Figure 22 and identifies locations where gravity and pumped flow can cross from one district to another. Each interconnection is listed as follows:

1.3.1.1 Interceptor Connections

No interceptor connections are found in this district.

1.3.1.2 District Interconnections

Dumoulin

<u>CS to CS</u>

- A 300 mm CS pipe carries the intercepted CS diverted by the primary weir from the La Verendrye district, and flows by gravity southbound on Tache Avenue and connects to the CS system in the Dumoulin district.
  - Tache Avenue and Dumoulin Street invert – 222.53 m (S-MH50008804)
- A 450 mm CS high overflow pipe diverts CS from the La Varendrye trunk sewer upstream of the primary weir, and flows by gravity southbound on Tache Avenue and connects to the CS system in the Dumoulin district.
  - Tache Avenue and Dumoulin Street invert – 225.49 m (S-MH50004016)

<u>WWS to CS</u>

- A 600 mm WWS overflow pipe from La Verendrye flows by gravity southbound on Langevin Street and connects into the CS system in Dumoulin district.
  - Langevin Street and Notre Dame Street overflow pipe invert – 227.09 m (S-MH-50003880)

<u>LDS to LDS</u>

- A 600 mm LDS pipe from Dumoulin district flows by gravity northbound into La Verendrye district at the intersection of Thibault Street and Notre Dame Street and is discharged into the outfall at the Seine River and does not interact with the CS system.

– Thibault Street and Notre Dame Street invert – 226.62 m (S-MH50009369)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing system.

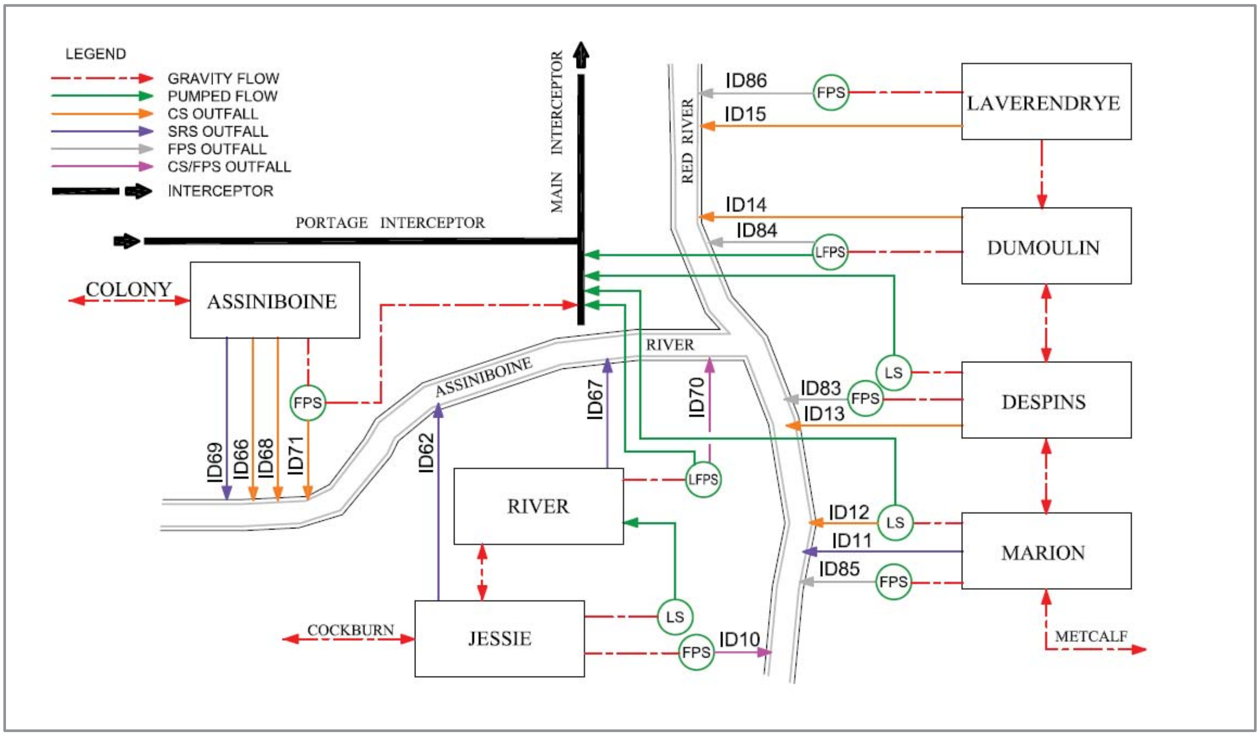


Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 22 and listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID15)	S-AC70008179.1	S-MA70017688	600 mm	Red River Invert: 221.40 m
Flood Pumping Outfall (ID86)	S-CO70017960.1	S-MA70017667	600 mm	Red River Invert: 225.65 m
Other Overflows	N/A	N/A	N/A	
Main Trunk	S-MH50003874.1	S-MA70028293	450 mm	Invert: 223.19 m
SRS Outfalls	N/A	N/A	N/A	No SRS within the district.
SRS Interconnections	N/A	N/A	N/A	No SRS within the district.
Main Trunk Flap Gate	S-AC70008178.1	S-CG00000827	750 mm	Invert: 223.00 m
Main Trunk Sluice Gate	S-CG00000828.1	S-CG00000828	750 x 750 mm	Invert: 223.00 m
Off-Take	S-MH70010257.1	S-MA50004821	300 mm	Circular Invert: 223.08 m CS that takes sewage to Dumoulin LS
Dry Well	N/A	N/A	N/A	
Lift Station Total Capacity	N/A	S-MA50004821 (1)	300 mm (1)	0.043 m3/s (1)

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
				This is based on the Thibault WWS LS
Lift Station ADWF	N/A	N/A	0.012 m^3/s	This is based on the Thibault WWS LS
Lift Station Force Main	N/A	N/A	N/A	
Flood Pump Station Total Capacity	N/A	N/A	0.24 m^3/s	1 x 0.24 m^3/s
Pass Forward Flow – First Overflow	N/A	N/A	0.017 m^3/s	

Notes:

(1) – Gravity Pipe replacing Lift Station as La Vernedrye is a gravity discharge district

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	La Verendrye – 223.73
2	Trunk Invert at Off-Take	223.08
3	Top of Weir	224.00
4	Relief Outfall Invert at Flap Gate	N/A
5	Low Relief Interconnection	N/A
6	Sewer District Low Interconnection (Dumoulin)	222.53
7	Low Basement	227.38
8	Flood Protection Level [District(s) Included]	229.72

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed in La Verendrye district was the Dumoulin and La Verendrye Districts Combined Sewer Relief Study (Wardrop, 2006). This study provided for relief works of the existing CS systems to alleviate basement flooding. The CS district relief was completed at the same time for both Dumoulin and La Verendrye districts from 2002 to 2004. No other sewer work has been completed since that time.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the La Verendrye Combined Sewer District was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations has a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Planned Completion
22 – La Verendrye	2006 - Conceptual	Future Work Following Complete Separation	2013	Study Complete	N/A

Source: Report on Dumoulin and La Verendrye Districts Combined Sewer Relief Study, 2006

1.5 Ongoing Investment Work

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the La Verendrye district. This consists of monthly site visits in confined entry spaces to verify physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The La Verendrye district has complete sewer separation and tunnel storage proposed to meet CSO Control Option 1. Table 1-4 provides an overview of the control options to be included in the 85 percent capture in a representative year option. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage	Storage / Transport Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	-	-	-	-	-	-	✓	✓	✓	✓	-

Notes:

- = not included
✓ = included

For the assessment, this district was assessed in conjunction with the downstream Dumoulin district.

The existing CS system was originally reviewed for in-line storage and found to already be in place. The existing weir level is already close to full-pipe providing in-line storage capacity. The marginal evaluation indicated that complete sewer separation will be similar to the screening option in terms of initial capital costs. The capital cost of sewer separation was similar to that required for construction a screening chamber since the majority of the La Verendrye district has already been separated. The O&M costs are reduced for the sewer separation proposed option however in comparison to the construction of screening, which therefore resulted in sewer separation having a lower overall lifecycle cost.

The hydraulic capacity downstream in the Dumoulin district is limited which increases the occurrence of CS overflows within La Verendrye. Overflows can be alleviated in La Verendrye once the proposed control options are implemented along with the Dumoulin future control options. The system wide assessment resulted in the Dumoulin control options being deferred to future conditions and this resulted in minor overflowing being predicted at the La Verendrye outfall in the interim until future work in the Dumoulin district is complete. It was found however that a static weir height raise would not be feasible to provide the necessary additional volume capture to eliminate overflows from the district. Tunnel Storage and flap gate installation on the main CS sewer to the downstream Dumoulin district was therefore proposed as an additional item for La Verendrye to eliminate the overflows from the district.

GI and RTC will be applied within each district on a system wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Sewer Separation

The sewer separation project for La Verendrye will provide immediate benefits to the CSO program when complete. Current LDS systems will be extended on Darveau Street and Herbert Street to collect road drainage. Collected stormwater runoff will be routed to the existing 750 mm LDS outfall discharging to the Red River at Messager Street. The approximate area of sewer separation is shown on Figure 22.

The flows to be collected after La Verendrye separation will be as follows:

- Dry weather flows will remain the same for La Verendrye district (and Dumoulin district).
- La Verendrye weather flow (WWF) will consist of sanitary sewage combined with foundation drainage from the existing old housing stock. All new homes will be constructed with foundation drainage disconnected from the CS system.

The separation project would provide the full reduction of overflows for the 1992 representative year when assessed as an individual district. However, based on the capacity of the downstream Dumoulin district the hydraulic model stills predicts overflowing at this district after sewer separation control option is implemented.

In addition to reducing the CSO volume, the benefits of La Verendrye separation include a reduction of pumped flows entering both the immediate downstream Dumoulin district, as well as reducing the amount of flood pumping required at the La Verendrye FPS. After further measures are implemented to eliminate the overflows from the district the FPS will be no longer be required to operate. This will provide an additional benefit to the long term operating and maintenance costs.

It is proposed that future monitoring of the district is completed to verify that the sewer separation is fully compliant with the modelled simulated elimination of all CSO overflows. If the modelled wet weather response for the district is found to be overly conservative, and the actual wet weather response is sufficient to eliminate overflows from the district, then the tunnel storage and flap gate installation items will no longer be required.

1.6.3 Tunnel Storage

Tunnel storage is proposed as a control option for the La Verendrye district to alleviate the remaining overflows found to occur after complete separation is implemented. This control option will include the addition of a sewer storage tunnel to provide additional storage capacity. Tunnel storage requires connections from the existing system into the tunnel and will be able to empty via gravity.

The design criteria for tunnel storage are listed in Table 1-5.

Table 1-5. Tunnel Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Number of Connections	2	
Diameter	900 mm	

Table 1-5. Tunnel Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Length	200 m	
Storage Volume	127 m^3	
Nominal Dewatering Rate	0.043 m^3/s	Based on existing gravity pipe capacity
RTC Operational Rate	TBD	Future RTC/ dewatering assessment

Notes:

RTC = real time control

The proposed location for the tunnel storage is shown in Figure 22. A tunnel 900 mm in diameter and approximately 200 m in length connecting at manhole S-MH50003792 along Tache Avenue at Grandin Street and La Verendrye Street and then discharges to manhole S-MH70010257. To ensure the isolation of the La Verendrye district from the downstream Dumoulin district it was also proposed to install a flap gate within manhole S-MH50008804 as part of this work.

As mentioned above, following the complete separation of the district flow monitoring of the La Verendrye district will be completed. If the modelled wet weather response for the district is found to be overly conservative, and the actual wet weather response is sufficient to eliminate overflows from the district, then the tunnel storage and flap gate work recommended will no longer be required. As well the green infrastructure and real time control opportunities may be pursued in the La Verendrye district to sufficiently eliminate any overflows remaining after complete separation is implanted. This would also remove the requirement for the off-line tunnel/flap gate work.

The nominal rate for dewatering is determined by the performance of the existing pipe capacity as the tunnel is able to discharge back into the CS system by gravity. As such the flows will vary over the duration of a rainfall event but due to the small nature of the district and interaction with the downstream Dumoulin has not been nominated for a gravity flow control device, since it discharges via lift station pumps. Any future consideration, for RTC improvements, would be assessed in conjunction with the downstream Dumoulin district.

1.6.4 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography, and soil classification for the district will be reviewed to identify applicable GI controls.

La Verendrye has been classified as a high GI potential district. Land use in the La Verendrye district is a mix of residential and commercial. The west end of the district is bounded by the Red River. This district would be an ideal location for cisterns/rain barrels, and rain garden bioretention within the residential areas. Commercial areas are suitable to green roofs and parking lot areas are ideal for paved porous pavement.

1.6.5 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

Systems operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C.

Sewer separation will include the installation of additional sewers that will require inspection, cleaning and rehabilitation. This will result in additional maintenance costs over the long term, but operational costs will be minimal. The existing larger CS pipes within the district may also receive insufficient flow with the separation work for proper scouring velocities in the sewer pipes. This could result in solids settling within the sewers, and requiring more frequent cleaning operations. The impacts of the reduced flows in larger CS pipes will be evaluated as part of the sewer separation design for the district. There will also be a future reduction on FPS operational requirements, as the overflows in the district will be greatly reduced.

Tunnel storage includes the installation of a large diameter sewer and flap gate, as well as monitoring and control instrumentation to dewater the tunnel. System monitoring and level controls will be installed which will require regular scheduled maintenance. The tunnel will operate intermittently during wet weather events and may require operational review and maintenance after each event.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. Two versions of the sewer system model were created and used to measure system performance. The 2013 Baseline model represents the sewer system baseline in the year 2013 and the 2037 Master Plan – Control Option 1 model, which includes the proposed control options in the year 2037. A summary of relevant model data is provided in Table 1-6.

Table 1-6. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	38	38	843	38	N/A
2037 Master Plan – Control Option 1	38	8	843	3	SEP, TS, FG

Notes:

SEP - Sewer Separation

TS - Tunnel Storage

FG - Flap Gate

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district. While this district is to be separated and as a result Clause 8 of Licence No. 3042 will not be in effect, the wet weather response of the district overall will still need to be assessed.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-7 are for the hydraulic model simulations using the year-round 1992 representative year. This table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options, Table 1-7 also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-7. District Performance Summary – Control Option 1

Control Option	Preliminary Proposal	Master Plan			
	Annual Overflow Volume (m^3)	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow
Baseline (2013)	14,855	13,191	-	18	0.017 m^3/s [b]
Sewer Separation	N/A [a]	722	12,469	11	0.017 m^3/s [b]
Separation & Tunnel Storage		0	722	0	0.025 m^3/s [c]
Control Option 1	**14,997**	**0**	**0**	**0**	**0.025 m3/s** [c]

[a] Separation and Tunnel Storage were not simulated during the Preliminary Proposal assessment.

[b] Pass forward flows assessed with the 1-year design rainfall event.

[c] Pass forward flows assessed with the 5-year design rainfall event.

The percent capture performance measure is not included in Table 1-7, as it is applicable to the entire CS system and not for each district individually.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-8. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-8. District Cost Estimate – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance (Over 35-year period)
Screening	$ - [a]	N/A	N/A	N/A
Sewer Separation	N/A	$2,080,000	$1,000	$30,000
Tunnel Storage		$1,060,000	$10,000	$210,000
Subtotal	**$0**	**$3,140,000**	**$11,000**	**$240,000**
Opportunities	N/A	$310,000	$1,000	$20,000
District Total	**$0**	**$3,450,000**	**$12,000**	**$260,000**

[a] Solution developed as refinement to Preliminary Proposal work following submission of Preliminary Proposal costs. Cost for this item of work found to be $550,000 in 2014 dollars.

[b] Sewer separation and tunnel storage not assessed in this district for the Preliminary Proposal

[c] Item does not include the cost for the flap gate installation

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The impacts of extending the implementation schedule to 2045 are included in are included in the program development and program summary in Section 5 of Part 3A.

The calculation of the cost estimate for the CSO Master Plan includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional cost for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014 dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019 dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-9.

Table 1-9. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Tunnel Storage	Tunnel Storage was not included in the Preliminary Proposal estimate	Added for the MP to further reduce overflows
	Sewer Separation	Sewer Separation was not included in the preliminary estimate	The Master plan identified sewer separation as the most cost effective control option over in-line storage.
	Removal of Screening	Screening was not included in the Master Plan.	With sewer separation and tunnel storage recommended all CSO events will be removed, and there will no longer be a requirement for screening.
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Costs	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation	Preliminary estimates were based on 2014 dollar values	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, the future performance target is 98 percent capture for the representative year measured on a system-wide basis. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-10 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified for Control Option 1.

Table 1-10. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Assessment of performance in conjunction with Dumoulin district

For the La Verendrye district, the complete separation option will not change if the control limit is increased from 85 percent to 98 percent capture. The full implementation of the Control Options for the 85 percent capture target (including construction of tunnel storage and a flap gate on off-line tunnel storage) will be excessive and no longer required when the Dumoulin district control options are implemented for the future 98 percent capture target. Therefore, this work should not be prioritized, and instead evaluated following the implementation of the Dumoulin work.

The cost for upgrading to 98 percent capture depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-11.

Table 1-11. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	-	-	O	O	-	-	-
2	Existing Lift Station	-	-	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	O	O	-	-	-

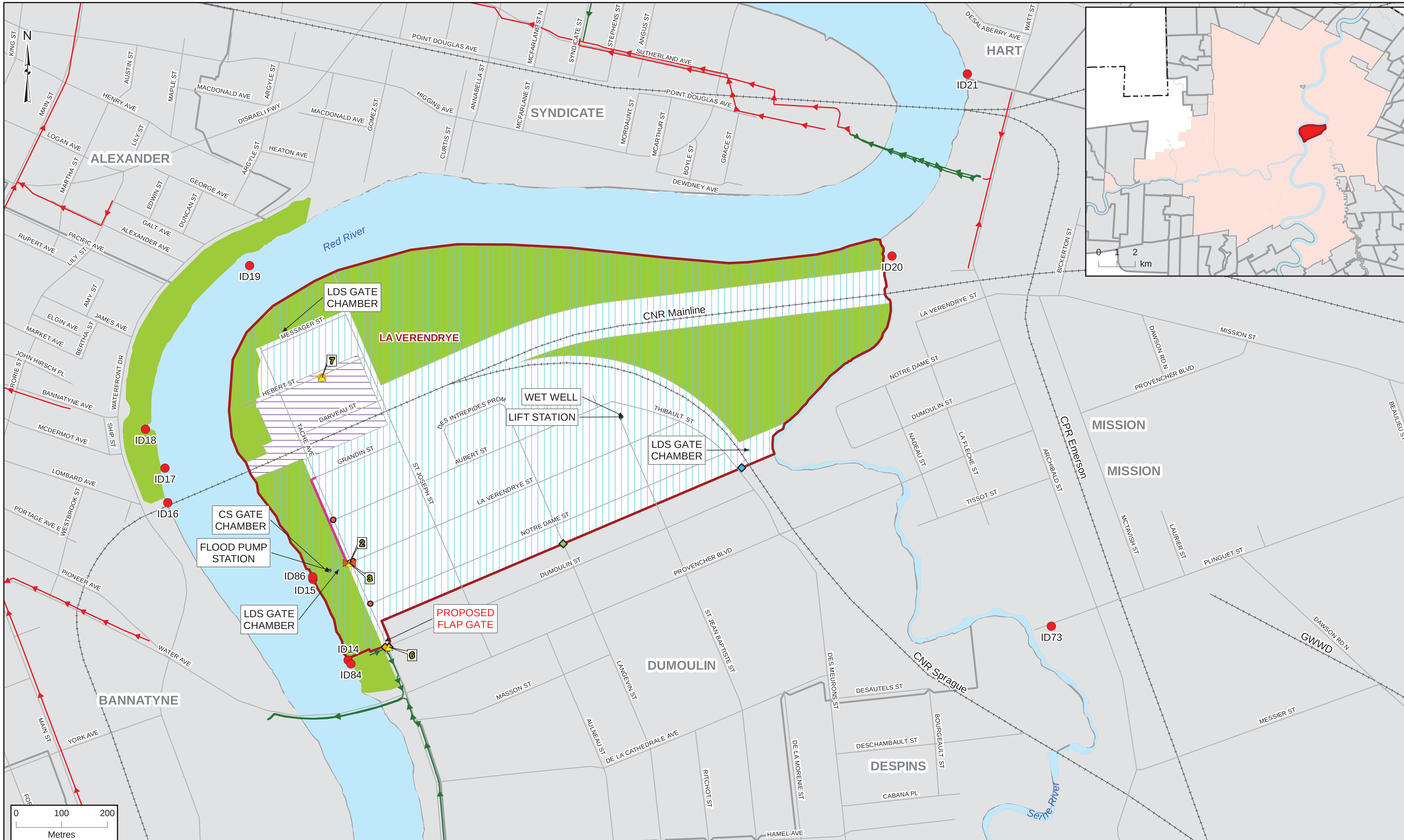
Table 1-11. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
4	Construction Disruption	-	-	-	-	R	-	-	-
5	Implementation Schedule	-	-	-	-	R	-	R	-
6	Sewer Condition	-	-	-	-	-	-	-	-
7	Sewer Conflicts	-	-	-	R	R	-	-	-
8	Program Cost	-	-	-	O	R	-	-	-
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	O	-	R	-	-
11	Technology Assumptions	-	-	-	O	O	O	O	-
12	Operations and Maintenance	-	-	-	R	R / O	R	O	-
13	Volume Capture Performance	-	-	-	O	-	O	O	-
14	Treatment	-	-	-	R	O	O	O	-

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

Wardrop Engineering Consultants. 2006. *Dumoulin and La Verendrye Districts Combined Sewer Relief Study*. Report to the City of Winnipeg. December.



LEGEND

Primary Weir	Inter-System Connection	District Boundary Crossing	Interceptor Sewer	District Boundary
Critical Elevation	CS - WWS	CS	Force Main	Watercourse
CSO Outfall		LDS	Street	Greenspace
Low CS Manhole		WWS	Railway	

CSO MASTER PLAN PROPOSED SOLUTIONS

- Tunnel Storage
- Sewer Separation - Planning
- Sewer Separation - Complete

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 22
District Overview Map
Sewer District: La Verendrye
City of Winnipeg
Combined Sewer Overflow Master Plan

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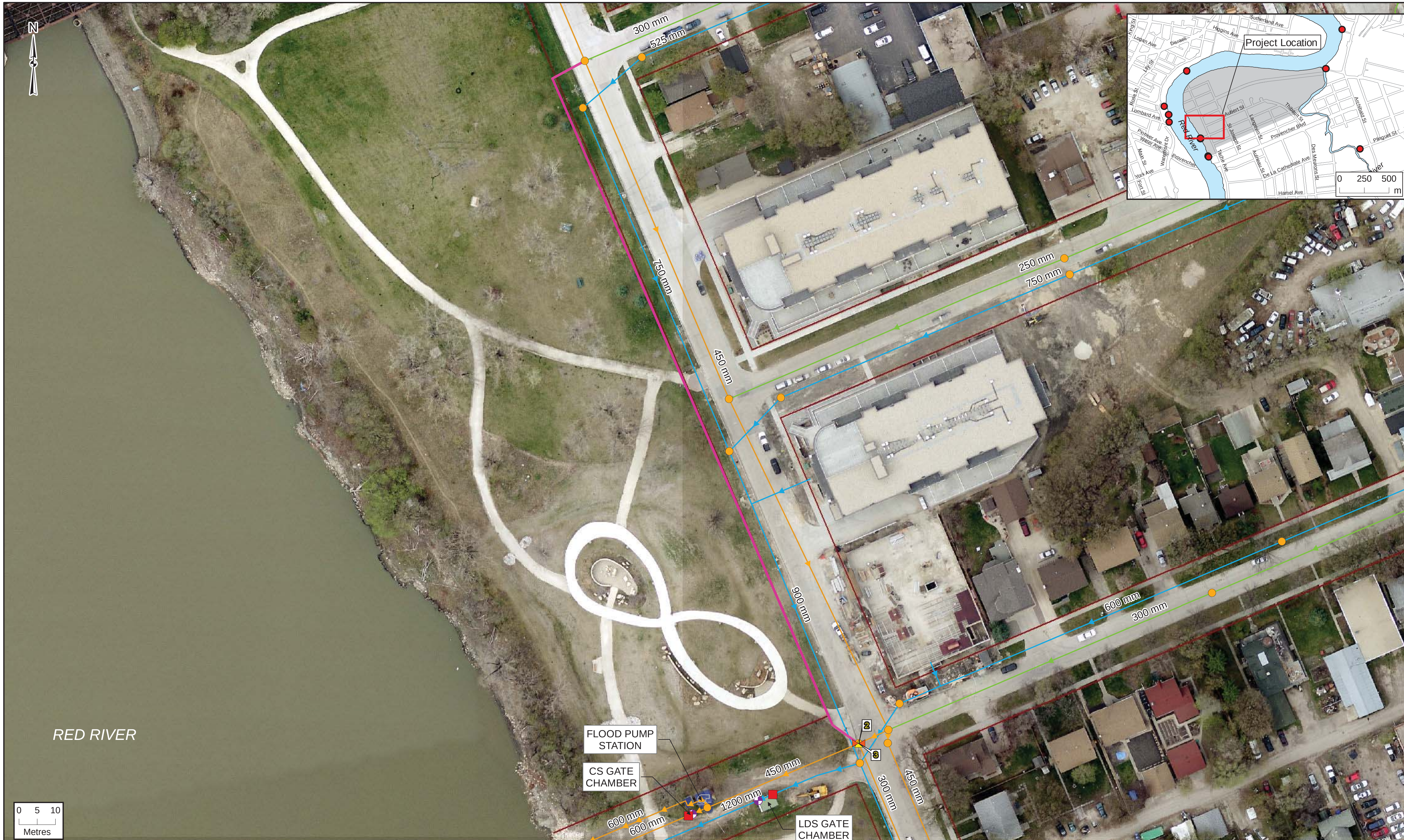

LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Manhole
- Flap Gate
- Sluice Gate
- Pump Location

Sewer By Type
- CS
- LDS
- WWS

Control Structure Type
- Gate Chamber

Pump Station Type
- Flood Pump Station

CSO MASTER PLAN PROPOSED SOLUTIONS
- Tunnel Storage

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 22-01
Tunnel Storage
Sewer District: La Verendrye
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Linden District Plan

August 2019

City of Winnipeg

CSO Master Plan

Project No:	470010CH
Document Title:	Linden District Plan
Revision:	03
Date:	August 22, 2019
Client Name:	City of Winnipeg
Project Manager:	John Berry
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Document History and Status

Revision	Date	Description	By	Review	Approved
0	10/05/2018	DRAFT for City Comment	AK, DT	SG	
1	02/22/2019	DRAFT 2 for City Review	SB	MF	MF
2	07/2019	Final Draft Submission	DT	MF	MF
3	08/19/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

Tables

Figure

1. Linden District

1.1 District Description

Linden district is located in the northeast sector of the combined sewer (CS) area to the east of the Red River and north of the Munroe district. The Linden district is approximately bounded by Melbourne Avenue to the south, Roch Street to the east, Colvin Avenue and Rossmere Crescent to the north, and the Red River to the west.

The majority of the Linden district is residential land use with a small area of commercial land use. The residential areas are primarily single-family dwellings. Commercial businesses are located along Henderson Highway. Greenspace areas include Bronx Park and various school parks, playgrounds, and community areas throughout the district.

Henderson Highway, running in a north-south direction, is the only regional roadway in the district. Other main transportation routes include Brazier Street, Roch Street, and Kildonan Drive in the north-south direction and Kimberly Avenue, Linden Avenue, Greene Avenue, and Roberta Avenue in the east-west direction.

1.2 Development

A portion of Henderson Highway is located within the Linden District. This street is identified as a Regional Mixed Use Corridors as part of the OurWinnipeg future development plans. As such, focused intensification along Henderson Highway is to be promoted in the future.

1.3 Existing Sewer System

Linden district encompasses an area of 153 ha[1] based on the GIS district boundary information and includes a CS system and a land drainage system (LDS). As shown in Figure 23, there are approximately 115 ha (75 percent) already separated and 3 ha (2 percent) identifiable as separation-ready. The Linden district does not contain an SRS system. Approximately 15 ha of the district is classified as greenspace.

The Linden sewer system includes a dual flood and lift pump station (LFPS), one CS outfall gate chamber with flap and sluice gates, and a separate FPS outfall. The CS system drains towards the Linden outfall and primary weir, located at the west end of Linden Avenue at the Red River. At the outfall, sewage is diverted by gravity to the CS LS or flows through the Linden outfall to the Red River.

A single sewer trunk collects flow from most of the district and flows to the primary weir on Linden Avenue. The 2250 mm by 3375 mm CS trunk extends from the primary weir to Kildonan Drive. Multiple secondary trunk sewers extend from the CS trunk to the east along Kildonan Drive and along Linden Avenue, branching north and south, to service the district.

During dry weather flow (DWF), sanitary sewage flow is diverted by the primary weir to a 750 mm off-take pipe, where it flows by gravity into the lift station component of the Liden LFPS. Within the lift station sewage is pumped into a force main north along Kildonan Drive. This force main then becomes a river crossing, where it crosses the Red River and connects into the secondary interceptor sewer for the Newton district. From here, the intercepted combined sewage ties into the Main Interceptor, and eventually on to the North End Sewage Treatment Plant (NEWPCC) for treatment.

During wet weather flow (WWF), any flow that exceeds the diversion capacity of the primary weir in the Linden district overtop the weir and is discharged into the Linden outfall, where it discharges to the Red

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

River by gravity. Sluice and flap gates are installed on this CS outfall to prevent back-up of the Red River into the CS system under high river level conditions. Under these high river level conditions when gravity discharge through the Linden CS outfall is not possible, the excess flow is pumped by the Linden FPS to instead discharge in a separate outfall adjacent to the CS outfall, where it will discharge by gravity to the Red River. There are no sluice or flap gates on this FPS outfall.

The LDS system extends throughout the majority of the district and has a single interconnections with the CS system. Only an area along Kildonan Drive in the southwestern corner of the district near the Red River remains as a CS system. A CS to LDS connection exists at the intersection of Linden Avenue and Woodvale Street where the CS system can overflow into the LDS. There are two dedicated LDS outfalls as part of the LDS system in the Liden district. The first LDS outfall is located near the intersection of Kildonan Drive and Chelsea Place. The second LDS outfall is located at the southern extents of Fraser's Grove Park, near the intersection of Kildonan Drive and Mossdale Avenue.

The two outfalls to the Red River (one CS and one FPS) are as follows:

- ID34 (S-MA70007427) – Linden CS Outfall
- ID88 (S-MA00017914) – Linden FPS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Linden and the surrounding districts. Each interconnection is shown on Figure 23 and shows locations where gravity flow can cross from one district to another. Each interconnection is listed as follows:

1.3.1.1 Interceptor Connections - Downstream of Primary Weir

Hawthorne

- A 300 mm force main on Kildonan Drive at Rossmere Crescent carries flow from the sewage pump station in the Linden district to the Hawthorne district, and across the Red River to the Newton district. An interconnection is present between the force mains from each district prior to the river crossing.
  - Invert at Hawthorne district boundary – 225.25 m (S-MA70016777)
  - Invert at interconnection between force mains – 225.25 m (S-MA70021120)

1.3.1.2 District Interconnections

Hawthorne

<u>CS to CS</u>

- A 300 mm CS on Brazier Avenue and Colvin Avenue is diverted into the CS system in Hawthorne from the 375 mm CS flowing by gravity westbound on Colvin Avenue:
  - Invert at Linden district boundary – 226.67 m (S-MA40001960)
- High Point Manhole:
  - Colvin Avenue and Roch Street – 227.71 m (S-MH40005627)
- A 300 mm force main on Kildonan Drive at Rossmere Crescent carries flow from the sewage pump station in the Linden district to the Hawthorne district, and across the Red River to the Newton district. An interconnection is present between the force mains from each district prior to the river crossing.
  - Invert at Hawthorne district boundary – 225.25 m (S-MA70016777)
  - Invert at interconnection between force mains – 225.25 m (S-MA70021120)

Munroe Annex

CS to CS

- High point manholes
  - 300 mm CS at Roch Street and Roberta Avenue – 228.16 m (S-MH40006178)
  - 375 mm CS at Roch Street and Linden Avenue – 226.66 m (S-MH40006068)
  - 300 mm CS at Roch Street and Oakview Avenue – 227.26 m (S-MH40006027)
  - 300 mm CS at Roch Street and Helmsdale Avenue – 227.42 m (S-MH40005973)
- A 300 mm CS flows by gravity west at the intersection of Roch Street and Bronx Avenue from Munroe Annex district into Linden district:
  - Invert at Munroe Annex district boundary – 227.76 m (S-MA40005134)

LDS to LDS

- A 300 mm LDS flows by gravity west at the intersection of Roch Street and Leighton Avenue from Munroe Annex district into Linden district:
  - Invert at Linden district boundary – 224.54 m (S-MA40006148)
- A 300 mm LDS flows by gravity west at the intersection of Roch Street and Roberta Avenue from Munroe Annex district into Linden district:
  - Invert at Linden district boundary – 224.39 m (S-MA40006749)
- A 250 mm LDS flows by gravity east at the intersection of Roch Street and Linden Avenue from Linden district into Munroe Annex district:
  - Invert at Munroe Annex district boundary – 224.40 m (S-MA40006701)
- A 250 mm LDS flows by gravity east at the intersection of Roch Street and Oakview Avenue from Linden district into Munroe Annex district:
  - Invert at Munroe Annex district boundary – 224.59 m (S-MA40006599)
- A 450 mm LDS flows by gravity west at the intersection of Roch Street and Dunrobin Avenue from Munroe Annex district into Linden district:
  - Invert at Munroe Annex district boundary – 224.56 m (S-MA40006595)
- A 300 mm LDS flows by gravity west at the intersection of Roch Street and Helmsdale Avenue from Munroe Annex district into Linden district:
  - Invert at Linden district boundary – 224.91 m (S-MA40006501)
- A 250 mm LDS flows by gravity east at the intersection of Roch Street and Kimberly Avenue from Linden district into Munroe Annex district:
  - Invert at Munroe Annex district boundary – 225.28 m (S-MA40006513)
- A 600 mm LDS trunk flows by gravity south at the intersection of Roch Street and Roberta Avenue from Linden district into Munroe Annex district:
  - Invert at Linden district boundary – 224.15 m (S-MA40006722)
- A 2100 mm LDS trunk flows by gravity west at the intersection of Roch Street and Greene Avenue from Munroe Annex district into Linden district:
  - Invert at Munroe Annex district boundary – 22.84 m (S-MA40006725)
- A 750 mm LDS trunk flows by gravity north at the intersection of Roch Street and Dunrobin Avenue from Linden district into Munroe Annex district:

  - Invert at Linden district boundary – 224.29 m (S-MA40006602)
- A 375 mm LDS flows by gravity north at the intersection of Roch Street and Helmsdale Avenue from Munroe Annex district into Linden district:
  - Invert at Linden district boundary – 224.83 m (S-MA40006509)
- A 2250 mm LDS trunk flows by gravity west at the intersection of Roch Street and Chelsea Avenue from Munroe Annex district into Linden district:
  - Invert at Munroe Annex district boundary – 222.72 m (S-MA40005093)

Munroe

CS to CS

- A 250 mm CS can overflow by gravity east on Canterbury Place into Munroe district from Linden district:
  - Invert at Linden district boundary – 230.00 m (S-MA70099421)
- High point manhole
  - 300 mm CS at Kildonan Drive – 227.18 m (S-MH40006295)

LDS to LDS

- A 450 mm LDS flows by gravity north on Brazier Street from Munroe district into Linden district:
  - Invert at Munroe district boundary – 225.93 m (S-MA40005084)
- A 2250 mm LDS truck flows by gravity west on Chelsea Avenue at Henderson Highway from Linden district into Munroe district:
  - Invert at Munroe district boundary – 222.09 m (S-MA40006395)
- A 2250 mm LDS trunk flows by gravity west on Chelsea Place at Kildonan Drive from Munroe district into Linden district:
  - Invert at Linden district boundary – 221.94 m (S-MA40006935)
- A 300 mm LDS flows by gravity north on Kildonan Drive from Munroe district into Linden district:
  - Invert at Linden district boundary – 224.53 m (S-MA40006870)
- A 250 mm LDS flows by gravity west on Canterbury Place from Munroe district into Linden district:
  - Invert at Linden district boundary 224.59 m (S-MA40006869)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, flow controls, pumping systems, and discharge points for the existing system.

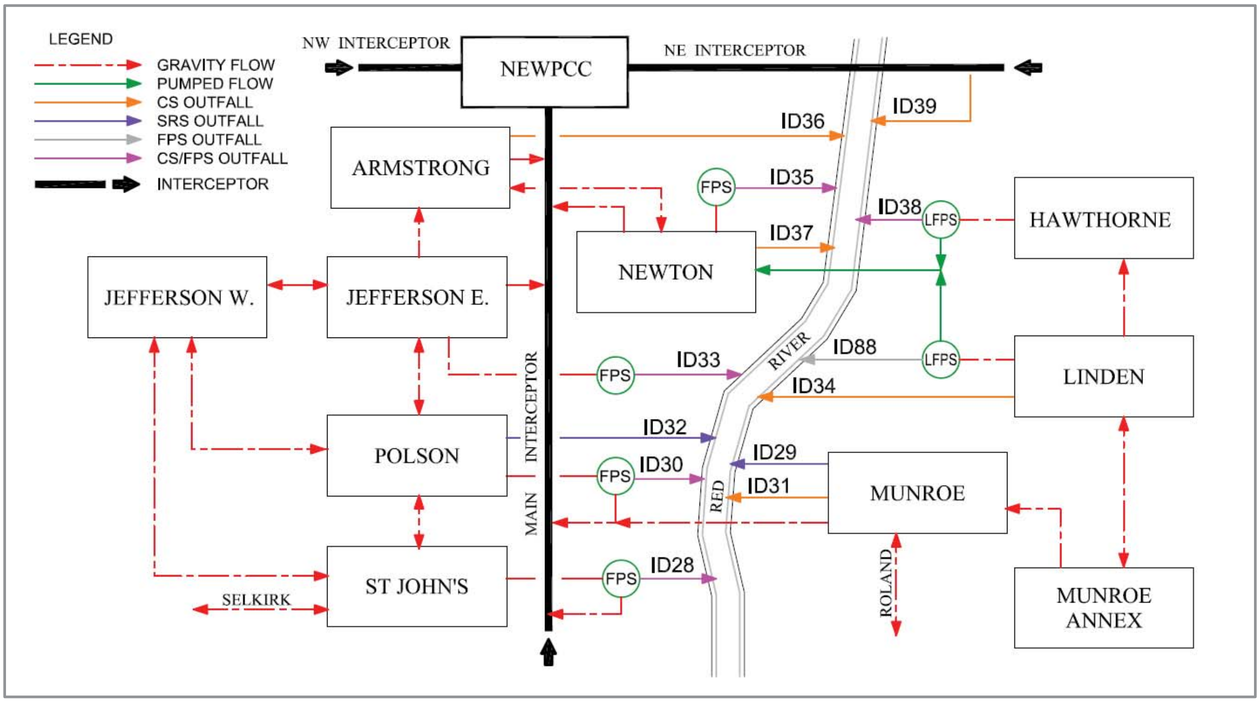


Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 23 and listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID34)	S-CO70017599.1	S-MA70016792	1,676 mm	Red River Invert: 222.47 m
Flood Pumping Outfall (ID89)	S-AC70007694.1	S-MA40001841	1525 mm	Red River Invert: 223.13 m
Main Trunk	S-TE40002177.1	S-MA70016788	2250 x 3375 mm	Invert: 223.50 m
SRS Outfalls	N/A	N/A	N/A	
SRS Interconnections	N/A	N/A	N/A	1 CS-LDS Interconnection
Main Trunk Flap Gate	S-TE70026334.2	S-CG00000990	1525 mm	Invert: 223.63 m
Main Trunk Sluice Gate	S-CG00000991.1	S-CG00000991	1800 x 1800 mm	Invert: 223.58 m
Off-Take	LINDEN_WEIR.1	S-MA70016777	750 mm	Invert: 223.47 m
Dry Well	N/A	N/A	N/A	
Lift Station Total Capacity	N/A	N/A	0.058 m^3/s	1 x 0.058 m^3
ADWF	N/A	N/A	0.012 m^3/s	
Lift Station Force Main	S-RE70007688.1	S-MA70016777	300 mm	Invert: 227.26 m
Flood Pump Station Total Capacity	N/A	N/A	2.38 m^3/s	1 x 0.97m^3/s 1 x 1.40 m^3/s
Pass Forward Flow – First Overflow	N/A	N/A	0.107 m^3/s	

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments

Notes:

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	223.66
2	Trunk Invert at Off-Take	223.47
3	Top of Weir	223.68
4	Relief Outfall Invert at Flap Gate	N/A
5	Low Relief Interconnection	227.00
6	Sewer District Interconnection (300 mm CS)	226.67
7	Low Basement	225.40
8	Flood Protection Level (Munroe, Linden, Hawthorne)	229.04

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed in Linden was the *Linden and Hawthorne Districts Combined Sewer Relief Study Conceptual Design Report* (Wardrop Engineering Canada Inc, 1994). The study's purpose was to develop sewer relief options that provide a 5-year and 10-year level of protection against basement flooding and to develop alternatives for reducing and eliminating pollutants from CSOs. A large portion of the sperate LDS system within the Linden district was installed following this study in the mid to late 1990s. No other studies have been completed on the district sewer system since that time.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Linden CS district was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations has a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Planned Completion
23 – Linden	1994	Future Work	2013	Study Complete Partial Separation Complete	N/A

Source: Report on *Linden and Hawthorne Districts Combined Sewer District*, 1994

1.5 Ongoing Investment Work

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Linden district. This consists of monthly site visits in confined entry spaces to verify that physical readings concur with displayed transmitted readings, and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a representative year for the Linden district are listed in Table 1-4. The proposed CSO control projects will include complete sewer separation. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage	Storage / Transport Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	-	-	-	-	-	-	-	✓	✓	✓	-

Notes:

- = not included
✓ = included

The existing Linden district was originally reviewed for in-line storage in conjuction with floatable management via screening. The marginal evaluation indicated that complete separation capital costs will be similar to the in-line/screening control option, as the majority of the district has already been separated. Operations and maintenance (O&M) costs required with the in-line/screening option are also talken into consideration, and this assocated O&M cost results in the selection of complete separation as the most preferable option for this district.

GI and RTC will be applied within each district on a system wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Sewer Separation

Sewer separation is proposed as part of the solution for Linden district. The existing district has a large component of partial separation, and the complete sewer separation within Linden district would remove all of the WWF overflows from the CS system. This would reduce the pass forward flow received at the existing outfall, and eliminating all CSO overflows from the district under the 1992 representaive year conditions. Separation would also eliminate the amount of flood pumping required at the Linden FPS, reducing O&M costs.

Work would include the installation of an independent LDS systems to separate the surface runoff from the CS system. It is proposed that a collector LDS pipe will be located on Kildonan Drive to collect the stormwater runoff from Kildonan Drive and adjacent local roads. This will then be routed through the new

LDS system to the Chelsea LDS outfall along the Red River. A second LDS system within the north west corner of Linden district will collect the storm flows from the area around Kildonan Drive and Mossdale Avenue will connect to the existing LDS system outfall at Fraser's Grove Park.

The flows to be collected after separation will be as follows:

- DWF will remain the same – collected flow pumped from Linden LFPS to the river crossing and interceptor system.
- WWF will consist of sanitary sewage combined with foundation drainage from existing older homes.

This will result in a reduction in combined sewage flow received at Linden LFPS after the separation project is complete. It is proposed that future monitoring of the district is completed to verify that the sewer separation is fully compliant with the modelled simulated elimination of all CSO overflows under the 1992 representative year. A static weir elevation increase may be necessary at the CS diversion to eliminate the occurrence of all CSOs. Any weir elevation raise will also be evaluated in terms of existing basement flood protection to ensure the existing level of basement flood protection remains.

Potential drawbacks of sewer separation include the high cost and the wide-spread disruption to the neighbouring residential homes. Thearea to be separated however has been greatly reduced due to previous separation work and the magnitude of these drawbacks will be reduced.

1.6.3 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district will be reviewed to identify applicable GI controls.

Linden has been classified as a medium GI potential district. Linden district is mainly residential with a small area of commercial land use. This district would be an ideal location for cisterns/rain barrels, and rain garden bioretention. There are a few commercial areas which may be suitable to green roofs and parking lot areas which would be ideal for paved porous pavement.

1.6.4 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

Sewer separation will include the installation of additional sewers that will require inspection, cleaning and rehabilitation. This will result in additional maintenance costs over the long term, but operational costs will be minimal. The existing larger CS pipes within the district may also receive insufficient flow with the separation work for proper scouring velocities in the sewer pipes. This could result in solids settling within the sewers, and requiring more frequent cleaning operations. The impacts of the reduced flows in larger CS pipes will be evaluated as part of the sewer separation design for the district.

The reduction in storm flows entering the Linden LS will reduce the requirement for operation of the FPS. It is recommended to continue to maintain and operate the flow monitoring instrumentation and assess the results after district separation work has been completed. This will allow the full understanding of the non-separated storm elements (foundation drain connections to the CS system) extent within the Linden district.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. Two versions of the sewer system model were created and used to measure system performance. The 2013 Baseline model represents the sewer system baseline in the year 2013 and the 2037 Master Plan – Control Option 1 model, which includes the proposed control options in the year 2037. A summary of relevant model data is provided in Table 1-5.

Table 1-5. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	147	147	3,885	10	N/A
2037 Master Plan – Control Option 1	147	70	3,885	3	SEP

Notes:

SEP = Sewer Separation

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district While this district is to be separated and as a result Clause 8 of Licence No. 3042 will not be in effect, the wet weather response of the district overall will still need to be assessed.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City Of Winnipeg GIS Records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-6 are for the hydraulic model simulations using the year-round 1992 representative year. This table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. Theable also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-6. District Performance Summary – Control Option 1

	Preliminary Proposal	Master Plan			
Control Option	Annual Overflow Volume (m^3)	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow (L/s) [a]
Baseline (2013)	13,903	14,033	-	18	109
In-line Storage	13,885	N/A	N/A	N/A	N/A
Sewer Separation	N/A	0	14,033	0	No overflow
Control Option 1	**13,885**	**0**	**14,033**	**0**	**No overflow**

[a] Pass forward flows assessed on the 1-year design rainfall event

The percent capture performance measure is not included in Table 1-6, as it is applicable to the entire CS system and not for each district individually. However, the predicted capture of all modelled overflows will result in a 100 percent capture rate.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-7. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-7. District Cost Estimate – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance (Over 35-year period)
Control Gate	$0 [a]	N/A	N/A	N/A
Screening	$0 [a]	N/A	N/A	N/A
Separation	N/A[b]	$10,900,000	$6,500	$140,000
Subtotal	**$0**	**$10,900,000**	**$6,500**	**$140,000**
Opportunities	N/A	$1,090,000	$500	$10,000
District Total	**$0 [a]**	**$11,990,000**	**$7,000**	**$150,000**

[a] Solutions developed as refinement to Preliminary Proposal costs. Costs for the control gate and screening work together found to be $1,290,000 in 2014 dollars.

[b] Sewer separation not assessed in this district for the Preliminary Proposal

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculation of the cost estimate for the CSO Master Plan includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional cost for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014 dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019 dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-8.

Table 1-8. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Sewer Separation	Sewer Separation was not included in the preliminary estimate	Master Plan review of suitable options and cost assessment resulted in change to control option for Linden
	Removal Of In-line Storage Control Gate	Removed from Master Plan	No longer required with complete separation work.
	Removal Of Screening	Removed from Master Plan	No longer required with complete separation work.
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years.	City of Winnipeg Asset Management approach.	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation	Preliminary estimates were based on 2014 dollar values	

1.10 Meeting Future Performance Targets

The proposed complete separation of the Linden district will achieve the 100 percent capture figure and no further work will be required to meet the future performance target.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-9.

Table 1-9. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	-	-	-	O	-	-	-
2	Existing Lift Station	-	-	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	O	-	-	-

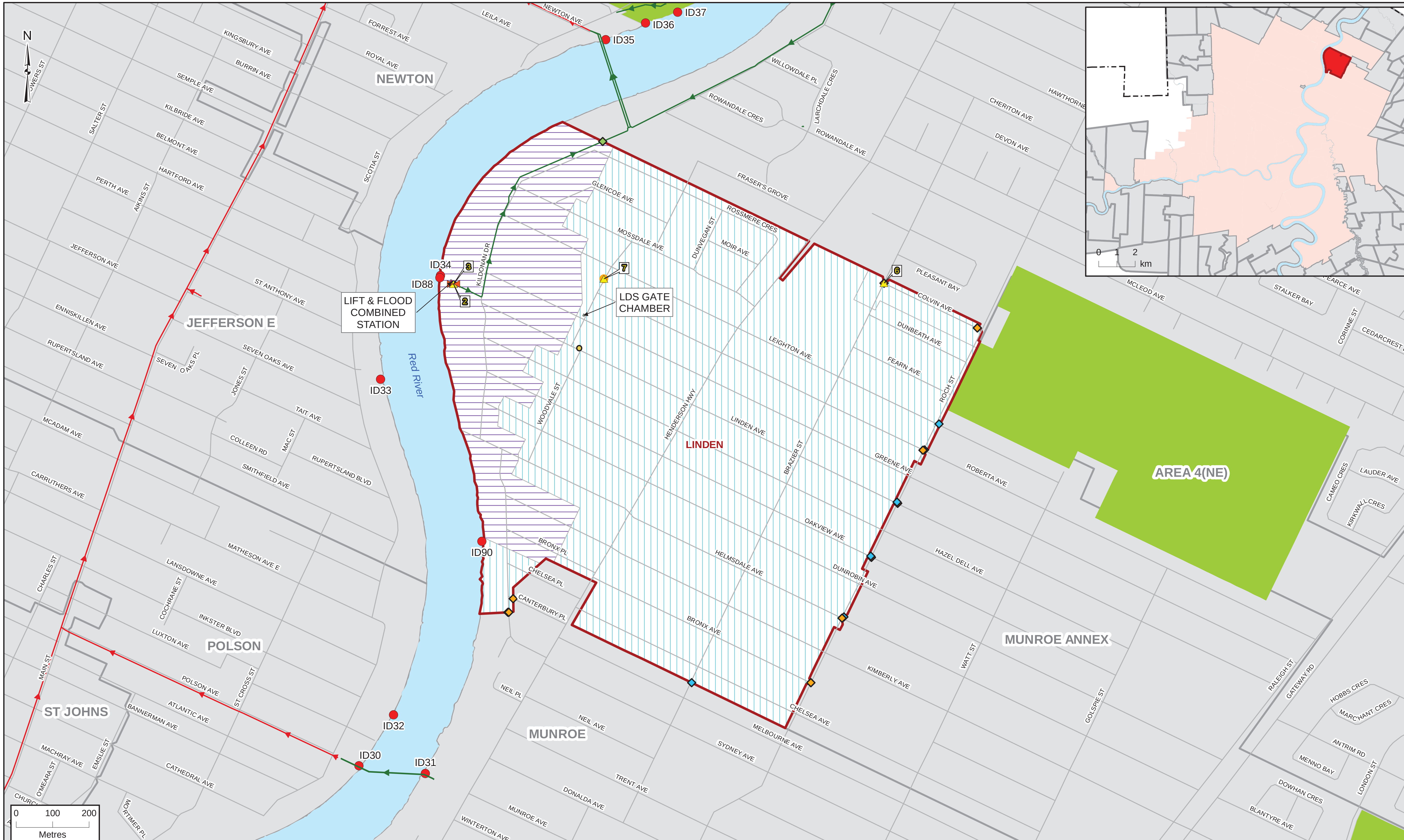
Table 1-9. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
4	Construction Disruption	-	-	-	-	R	-	-	-
5	Implementation Schedule	-	-	-	-	R	-	R	-
6	Sewer Condition	-	-	-	-	-	-	-	-
7	Sewer Conflicts	-	-	-	-	R	-	-	-
8	Program Cost	-	-	-	-	R	-	-	-
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	-	-	-	-	O	O	O	-
12	Operations and Maintenance	-	-	-	-	R / O	R	O	-
13	Volume Capture Performance	-	-	-	-	-	O	O	-
14	Treatment	-	-	-	-	O	O	O	-

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

Wardrop Engineering Inc, TetrES Consultants Inc. 1994. *Linden and Hawthorne Districts Combined Sewer Relief Study Conceptual Design Report.* Prepared for the City of Winnipeg, Waterworks, Waster and Disposal Department. May.



LEGEND

Primary Weir	Inter-System Connection	District Boundary Crossing	Interceptor Sewer	District Boundary
Critical Elevation	CS - LDS	CS	Force Main	Watercourse
CSO Outfall	CS - WWS	LDS	Street	Greenspace
Low CS Manhole		WWS		

CSO MASTER PLAN PROPOSED SOLUTIONS

- Sewer Separation - Planning
- Sewer Separation - Complete

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 23
District Overview Map
Sewer District: Linden
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Mager District Plan

August 2019

City of Winnipeg

CSO Master Plan

Project No: 470010CH
Document Title: Mager District Plan
Revision: 03
Date: August 18, 2019
Client Name: City of Winnipeg
Project Manager: John Berry
Author: Danny Tinker
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Document History and Status

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0	06/2018	Version 1 DRAFT	DT	ES / SG	
1	02/15/2019	DRAFT 2 for City Review	DT	SG	MF
2	05/2019	Final Draft Submission	DT	MF	MF
3	08/18/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

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Figure

1. Mager District

1.1 District Description

Mager district is located at the southeast limit of the combined sewer (CS) area and is included within the South End Sewage Treatment Plant (SEWPPC) catchment area. Mager is bounded by the Red River to the west, Bethune Way, Bishop Grandin Boulevard, and Worthington Avenue to the South, Carriere Avenue to the north, and the Seine River forms the eastern border from Berrydale Avenue north to Carriere Avenue. Figure 24 provides an overview of the sewer district and the location of the proposed Combined Sewer Overflow (CSO) Master Plan control options.

St. Mary's Road and St. Anne's Road are two of the major transportation routes that travel through Mager. Fermor Avenue (Trans-Canada Highway), runs east-west through the central portion of the district. Most development within the district took place in the 1950s and 1960s, and little development has taken place since.

The Mager district is highly residential with greater than 60 percent made up of residential land use and less than 10 percent commercial land use. The commercial land use is concentrated along St. Mary's Road and St. Anne's Road. Other land use in the district is park space and schools, such as Saint Vital Memorial Park and Windsor School. Approximately 100 ha of the district is classified as greenspace which includes multiple parcels spread throughout the district.

1.2 Development

A portion of St. Mary's Road and St. Anne's Road are located within the Mager district. These streets are identified as Regional Mixed Use Corridors as part of the Our Winnipeg future development plans. As such, focused intensification along St. Mary's Road and St. Anne's Road is to be promoted in the future.

1.3 Existing Sewer System

Mager district is the largest of all the combined sewer (CS) districts with an area of 768 ha[1] based on the GIS district boundary data. The sewer system contains a mix of combined sewers and separate wastewater and land drainage sewers (LDS). As shown on Figure 24, approximately 70 percent (575 ha) of the CS in Mager district has been separated and approximately 3 percent (20 ha) of the CS in Mager district is considered separation ready. The northern and central portions of the district contain combined and separation ready sewers with the western, eastern, and southern areas consisting of a separate land drainage and wastewater sewer system.

Mager district includes a small remaining CS system, with piping installed in the 1950s and 1960s. The district has since been partially separated into separate land drainage sewer and wastewater sewer systems, with the central portion of the district remaining as a CS system. For a portion of this area the separated wastewater sewers connect back into the existing CS, and would be considered separation ready.

The CS system includes a flood pump station (FPS), CS lift station (LS), one CS outfall, all located at the northern end of Mager Drive off St. Mary's Road. There is one SRS outfall beneath the St. Vital Bridge off Kingston Row, There is also a force main river crossing beneath the St. Vital Bridge, carrying all intercepted CS from the Cockburn, Calrossie, and Baltimore districts. The intercepted CS from the upstream districts is discharged into the CS system for the Mager district, such that it is intercepted once more at the primary weir for the Mager district.

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

During dry weather flow (DWF), all domestic wastewater and combined sewage flows collected in Mager district are routed to the St Mary's Road CS trunk and to the CS LS off Mager Drive. Sewage flows are directed by the primary weir to the Mager CS LS and pumped to the trunk sewer on St. Thomas Toad that flows to the interceptor on Bishop Grandin Boulevard. From Mager district, flows are transported in the South End Interceptor System to the SEWPCC.

During wet weather flow (WWF), any flows that exceeds the diversion capacity of the primary weir is discharged into the Mager outfall where it flows to the Red River by gravity. Sluice and flap gates are installed on the CS outfall to prevent back-up of the Red River into the CS system under high river level conditions. Under these high river level conditions the flap gate which restricts river level infiltration into the CS system will prevent gravity discharge through the Mager CS outfall. Excess flow trapped behind the flap gate is then pumped by the Mager FPS downstream of the flap gate through the CS outfall, where it will discharge by gravity to the Red River.

The Mager district includes large areas that include LDS and wastewater sewer (WWS) sewer networks, which as mentioned above are classified as partially separated. The LDS system as part of these separated areas includes 15 outfalls from the district to the Red River and Seine River, installed along the perimeter of the district. In these areas, catch basins connect storm weather to the LDS systems that direct flow to the specific LDS outfalls. The Pulberry LS is located on St Vital Road at the intersection of Pulberry Street, and services the wastewater sewers in southwest section of the separated area of the Mager district. The Pulberry LS lifts WW to the CS system on directly adjacent to the WWLS on St Vital Road 8 metres downstream.

The combined sewer outfalls to the Red River are as follows:

- ID04 (S-MA70007510) – Mager CS Outfall
- ID03 (S-MA50014591) – Mager SRS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Mager and the surrounding districts. There are no district boundary crossings though the Seine River to the east. Each interconnection location is shown on Figure 24 and is listed as follows:

1.3.1.1 Interceptor Connections – Upstream of Primary Weir

Baltimore

- The 450 mm Baltimore LS force main flows under pressure into Mager district at Kingston Row and Edinburgh Street:
  - Dunkirk Avenue force main at connection point to Mager CS – 226.56 m (S-MA50017754)

Metcalfe

- The 200 mm Metcalfe LS force main flows under pressure into the Mager district CS system:
  - St Mary's Road force main at connection point to Mager CS – 227.52 m (S-MA70017062)

1.3.1.2 Interceptor Connections – Downstream of Primary Weir

Area 18

- The Mager 1375 mm interceptor flows by gravity from Mager district into Area 18 and connects to the South Interceptor and onto the SEWPCC:
  - St. George Road Interceptor Invert at District Boundary – 224.36 m (S-MA50018680)

1.3.1.3 District Interconnection

Area 16

WWS to WWS

- A 250 mm WWS collecting wastewater from Hardy Bay and a 250 mm WWS from River Road overflow pipe within the Mager District flow into WW system in the Area 16 district:
  - River Road and Hardy Bay – 227.76 m (S-MA50014668)

LDS to LDS

- A 525 mm land drainage gravity sewer within River Road and Hardy Bay within the Mager District which does not interact with the Mager CS System flows into Area 16 and the nearby LDS outfall:
  - River Road LDS Invert at connecting LDS sewer- 228.08 m (S-MA50018409)

Area 17

WWS to WWS

- High point sewer manhole (flow is directed into both districts from this manhole):
  - 250 mm WWS on Bethune Way – 228.30 m (S-MH50011761)

LDS to LDS

- Gravity flows from the land drainage system in Area 17 into the LDS system in Mager district at multiple points. The LDS system in Mager as part of previous sewer separation work. This LDS flows directly to outfall to the Red River, however there is an SRS interconnection with the LDS network and WWS network at Parkville Bay and Parkville Drive
  - 750 mm LDS at Bethune Way and Glen Meadow Street, LDS Invert at District Boundary – 228.76 m (S-MA50014745)
  - 600 mm LDS at Pulberry Street, LDS Invert at District Boundary – 229.20 m (S-MA50015276)
- Gravity flow from the land drainage system in Mager district, servicing part of Bethune way and a three block stretch of St. Mary's Road flows into LDS system within the separated Area 17. This does not interconnect with the Mager CS system:
  - St. Mary's Road at Bishop Grandin LDS Invert at District Boundary – 228.70 m (S-MA50015300)

Area 18

WWS to WWS

- High point sewer manhole (flow is directed into both districts from this manhole):
  - 250 mm at Dakota Street and Chesterfield Avenue – 226.28 m (S-MH50015058)
  - 250 mm at Marlene Street – 226.75 m (S-MH50015034)

LDS to LDS

- A 900 mm LDS flows westbound on Beliveau Road from Area 18 and connects to the LDS network in Mager. This does not interconnect with the Mager CS system:
  - Beliveau Road LDS Invert at District Boundary – 227.73 m (S-MA50018013)

Marion

LDS to LDS

- A 525 mm LDS servicing a short stretch of Carriere within Marion district flows into the LDS system in Mager district and directly to outfall. There is no interaction with Mager CS system
  - Youville Street LDS Invert at District Boundary – 227.17 m (S-MA70001110)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing district.

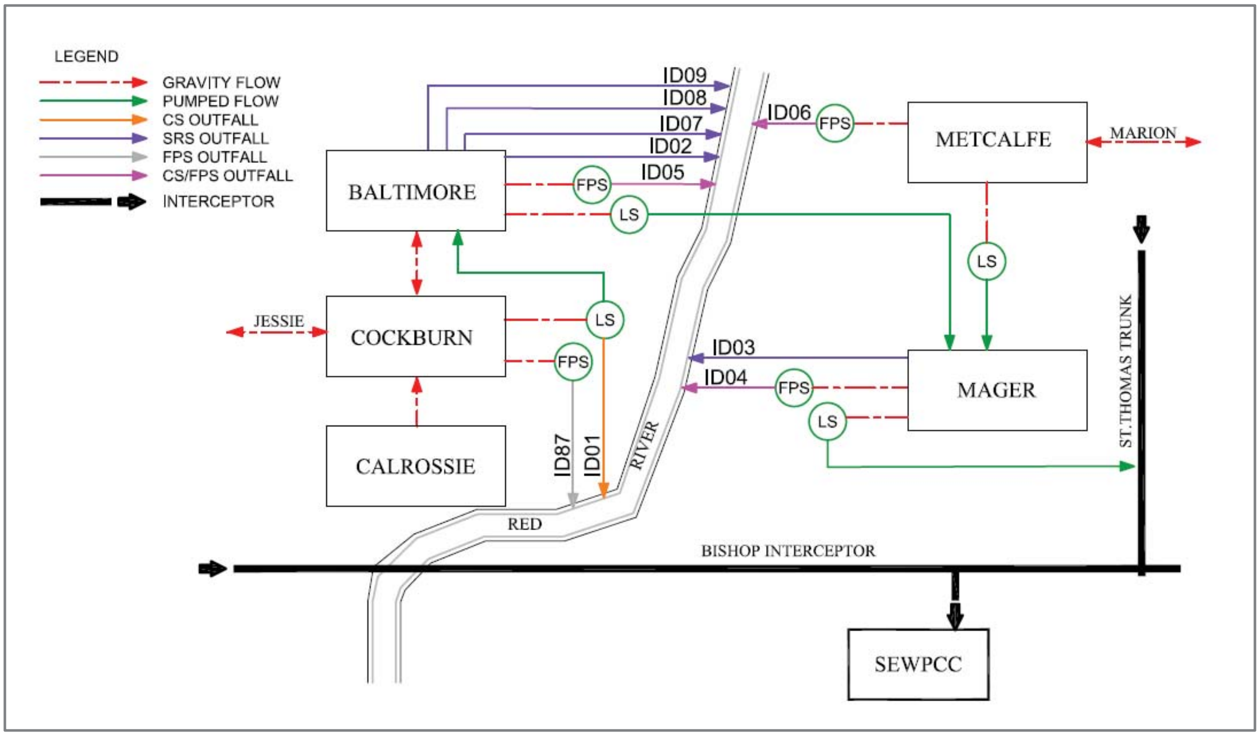

Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 24 and are listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID4)	S-YY70021073.1	S-MA70007510	1660 mm	Circular Invert: 221.72 m
Flood Pumping Outfall (ID4)	S-YY70021073.1	S-MA70007510	1660 mm	Circular Invert: 221.72 m
Other Overflows	N/A	N/A	N/A	N/A
Main Trunk	S-MH50012525.1	S-MA70018393	2250 x 3375 mm	Egg-shaped Invert: 223.92 m
SRS Outfalls (ID3)	S-CO50003092.1	S-MA50014591	800 mm	Circular Invert: 222.60 m
SRS Interconnections	S-MH50011684.1 S-MH70003108.1 S-MH70003109.1	S-MH50011684 S-MH70003108 S-MH70003109 S-TE70002942	N/A N/A N/A N/A	Invert: 226.51 m Invert: 227.88 m Invert: 228.43 m Invert: 227.25 m

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
	S-TE70002942.1 N/A N/A			
Main Trunk Flap Gate	S-TE70027658.2	S-CG00001114	2000 mm	Invert: 224.22 m
Main Trunk Sluice Gate	Mager Gate.1	S-CG00001115	2000 x 2000 mm	Invert: 224.15 m
Off-Take	S-TE70024868.2	S-MA70068576	450 mm	To lift station Invert: 223.92
Dry Well	N/A	N/A	N/A	No dry well associated with Mager LS
Lift Station Total Capacity	N/A	N/A	0.517 m^3/s	2 pumps @ 0.315 m^3/s, and 0.202 m^3/s
Lift Station ADWF	N/A	N/A	0.095 m^3/s	
Lift Station Force Main	S-TE70027636.1	S-MA70007687	600 mm	Invert: 227.91
Flood Pump Station Total Capacity	N/A	N/A	Minimum - 1.71 m^3/s Maximum - 2.15 m^3/s	Minimum - 0.58, 1.13 m^3/s for each pump Maximum - 0.71, 1.44 m^3/s for each pump
Pass Forward Flow – First Overflow	N/A	N/A	0.477 m^3/s	

Notes:

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Kingston Row – 223.75 Mager Drive – 223.75
2	Trunk Invert at Off-Take	223.92
3	Top of Weir	224.95
4	Relief Outfall Invert Immediately Upstream of Gate Chamber	225.20
5	Relief Interconnection (S-MH50011684)	226.51
6	Sewer District Interconnection (Area 18)	226.28
7	Low Basement (Mager)	226.70
8	Flood Protection Level (Mager)	230.04

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

A stormwater management study (I.D. Engineering, 1992) was completed for Mager district in 1992. The study described the potential of implementing relief alternatives and recommended an alternative to meet the 1 in 5-year and 1 in 10-year level of service for basement flooding. A portion of the Mager district was separated, but the entire district was not completed with the most recent construction in 2011. Table 1-3 provides a summary of the district status in terms of data capture and study.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Expected Completion
Mager	1992	Future Work	2013	Partially Separated	N/A

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Mager Combined Sewer District was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations have a combination of inflow and overflow level meters and flap gate inclinometers if available.

1.5 Ongoing Investment Work

There is ongoing maintenance and calibration of the permanent instruments installed within the primary outfall within the Mager district. This consists of monthly site visits in confined entry spaces to verify that physical readings concur with displayed transmitted readings and replacing desiccants where necessary

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Mager sewer district are listed in Table 1-4. The proposed CSO control projects will include in-line storage via a control gate and screening. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	-	-	-	✓	✓	-	-	-	✓	✓	✓

Notes:- = not included
✓ = included

The existing CS system is suitable for use as in-line storage. This control option will take advantage of the existing CS pipe network for additional storage volume.

The primary outfall location in the Mager district is to be screened under the current CSO control plan. Installation of a control gate will be required for the screen operation, and it will provide the mechanism for capture of additional in-line storage.

GI and RTC will be applied within each district on a system-wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 In-Line Storage

In-line storage has been proposed as a CSO control for the Mager district. The in-line storage will require the installation of a control gate at the CS outfall. The gate will increase the storage level in the existing CS to provide an overall higher volume capture. The control gate will also provide the additional hydraulic head necessary for screening operations.

A standard design was assumed for the control gate, as described in Part 3C. A standard approach was used for conceptual gate sizing by assuming it to be the lesser of the height of half of the site-specific trunk diameter or the maximum height of the gate available. The design criteria for in-line storage are listed in Table 1-5.

Table 1-5. In-Line Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	223.92 m	
Trunk Diameter	2250 x 3375 mm	Egg-shaped
Gate Height	0.76 m	Gate height based on half trunk diameter assumption
Top of Gate Elevation	225.71 m	
Bypass Weir Height	225.51 m	
Maximum Storage Volume	3,450 m^3	
Nominal Dewatering Rate	0. 517 m^3/s	Based on existing CS LS capacity
RTC Operational Rate	TBD	Future RTC / dewatering review on performance

Note:
TBD – to be determined
RTC – Real Time Control

The proposed control gate will cause combined sewage to back-up in the collection system to the extent shown on Figure 24. The extent of the in-line storage and volume is related to the elevation of the bypass weir. The level of the top of the bypass side weir and adjacent control gate level are determined in relation to the critical performance levels in the system for basement flooding protection: when the system level increases above the bypass weir crest and proceeds above the top of the control gate during high flow events, the gate drops out of the way. At this point, the district will only provide its original interception capacity via the primary weir for the district, and all excess CS would flow over the weir and discharge to the river. After the sewer levels in the CS system are reduced following wet weather events, below the bypass side weir critical performance level. the control gate moves back to its original position to provide additional in-line storage capture for future wet weather events. The CS LS will continue with its current operation while the control gate is in either position, with all DWF being diverted to the CS LS and pumped. The CS LS will further dewater the in-line storage providing during a WWF event as downstream capacity becomes available.

Figure 24-01 provides an overview of the conceptual location and configuration of the control gate, bypass side weir and screening chambers. The proposed control gate will be installed in a new chamber within the existing trunk sewer alignment near the existing FPS. The dimensions of the chamber will be 5.5 m in length and 4.0 m in width to accommodate the gate, with an allowance for a longitudinal overflow weir. Further optimization of the gate chamber size may be provided if a decision is made not to include screening. The existing sewer configuration may require the construction of an additional off-take pipe to be completed, if the future detailed design establishes that the proposed gate chamber cannot encompass the existing primary weir chamber. This will allow CS flows captured by the proposed control gate to be diverted to the Mager CS LS, ensuring that the system performs as per the existing conditions. The existing primary weir would remain in place to allow flow diversion to continue when the control gate is in its lowered position. The work required for the control gate construction is located within a residential street with minor disruptions expected.

The physical requirements for the existing off-take and station sizing for a modification to pumping capacity have not been considered in detail, but they will be required in the future as part of an RTC program or FPS rehabilitation or replacement project.

The nominal rate for dewatering is set at the existing CS LS capacity. The dewatering rate includes both the DWF and WWF components of the district flows. This allows dewatering through the existing interceptor system within 24 hours following the runoff event, allowing it to recover in time for a subsequent event. Any future considerations, for RTC improvements, would be completed with spatial rainfall as any reduction to the existing capacity for large events will adversely affect the overflows at this district. This future RTC will provide the ability to capture and treat more volume for localized storms by using the either the district in-line storage or the excess interceptor capacity where the runoff volume is less. Further assessment of the impact of the RTC and future dewatering arrangement will be necessary to review the downstream impacts.

1.6.3 Floatables Management

Floatables management will require installation of a screening system to capture floatable materials. Off-line screens will be proposed to maintain the current level of basement flooding protection.

The type and size of screens depend on the specific station configuration and the hydraulic head available for operation. A standard design was assumed for screening and is described in Part 3C. The design criteria for screening, with an in-line control gate implemented, are listed in Table 1-6.

Table 1-6. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Top of Gate	225.71 m	
Bypass Weir Crest	225.51	
Normal Summer River Level	223.75 m	
Maximum Screen Head	1.76 m	
Peak Screening Rate	0.196 m^3/s	
Screen Size	1 m high x 1.5 m wide	Modelled Screen Size

The proposed bypass side weir and screening chamber will be located adjacent to the proposed control gate and existing CS trunk, as shown on Figure 24-01. The screens will operate with the control gate in its fully raised position., diverting flows to the bypass weir. A side bypass weir upstream of the gate will direct the flow to the screens located in the new screening chamber, with screened flow discharged to the downstream side of the gate to the river. The screening chamber will include screenings pumps with a discharge returning the screened material to the CS LS for routing to the SEWPCC for removal.

The dimensions for the screen chamber to accommodate influent from the side weir, the screen area, and the routing of the discharge piping downstream of the gate are 3.0 m in length and 3.5 m in width. The existing sewer configuration including the 2250 mm by 3375 mm sewer trunk and the 450 mm off-take may have to be modified to accommodate the new chamber.

1.6.4 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district will be reviewed to identify the most applicable GI controls.

Mager has been classified as a medium GI potential district. Land use in Mager is mostly single-family residential, with the remaining consisting of commercial land use. This means the district would be an ideal location for bioswales, permeable paved roadways, cisterns/rain barrels. The flat roof commercial buildings make for an ideal location for green roofs.

1.6.5 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

In-line storage will impact the existing sewer and may require the addition of a new chamber and a moving gate at the outfall. In-line storage dewatering will be controlled with the existing CS LS which will require more frequent and longer duration pump run times. Lower velocities in the CS trunks may create additional debris deposition and require more frequent cleaning. Additional system monitoring, and level controls will be installed which will require regular scheduled maintenance.

Floatable control with outfall screening will require the addition of another chamber with screening equipment installed. The chamber will be installed adjacent to the control gate chamber and will operate in conjunction with it. Screening operation will occur during WWF events that surpass the in-line storage control level. WWF will be directed from the main CS trunk, over the side weir in the control gate chamber and through the screens to discharge into the river. The screens will operate intermittently during wet weather events and will likely require operations review and maintenance after each event. The frequency of a screened event will correlate to the number overflows identified for the district. Having the screenings pumped back to the interceptor system via a small LS and force main will be required. Additional maintenance for the pumps will be required at regular intervals in line with typical lift station maintenance and after significant screening events.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. Two versions of the sewer system model were created and used to measure system performance. The 2013 Baseline model represents the sewer system baseline in the year 2013 and the 2037 Master Plan – Control Option 1 model, which includes the proposed control options in the year 2037. A summary of relevant model data is provided in Table 1-7.

Table 1-7. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	743	743	21,429	5	N/A
2037 Master Plan – Control Option 1	743	743	21,429	5	IS, SC

Notes:

IS = In-line Storage
SC = Screening

Table 1-7. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-8 are for the hydraulic model simulations using the year-round 1992 representative year. This table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. Table 1-8 also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-8. Performance Summary – Control Option 1

	Preliminary Proposal	Master Plan			
Control Option	Annual Overflow Volume (m^3)	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [a]
Baseline (2013)	22,652	21,912	-	18	0.477 m^3/s
In-Line Storage	5,989	1,056	20,856	2	0.517 m^3/s
Control Option 1	**5,989**	**1,056**	**20,856**	**2**	**0.517 m^3/s**

Note:
[a] Pass forward flows assessed on the 1-year (baseline) and 5-year (CO1) design rainfall events

It is possible that volume capture improvement in this district is due to a combination of the reduction in flows from the upstream pumping stations and the provision of the in-line storage control option at the Mager CS LS. However, no change to the peak pumped flows from the upstream districts of Baltimore and Metcalfe was noted from the implementation of in-line storage within the Mager district. This would indicate that the in-line storage component within Mager alone provides the majority of the modelled overflow volume reduction. The percent capture performance measure is not included in Table 1-8, as it is applicable to the entire CS system and not for each district individually.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-9. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-9. Cost Estimates – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period)
In-line Control Gate	$7,740,000	$2,710,000 [b]	$41,000	$880,000
Screening		$1,590,000 [c]	$30,000	$640,000
Subtotal	**$7,740,000**	**$4,300,000**	**$71,000**	**$1,520,000**
Opportunities	N/A	$430,000	$7,000	$150,000
District Total	**$7,740,000 [a]**	**$4,730,000**	**$78,000**	**$1,670,000**

[a] Solution development as refinement to Preliminary Proposal costs, refined shortly after Preliminary Proposal submission. Revised costs for the control gate and screening work found to be $1,910,000 in 2014 dollars.

[b] Cost associated with new off-take construction, as required, to accommodate control gate location and allow intercepted CS flow to reach existing Mager LS not included.

[c] Cost for bespoke screenings return pump/force main not included in Master Plan as will depend on selection of screen and type of screening return system selected.

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional costs for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014 dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019 dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-10.

Table 1-10. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Control Gate	Unit cost updates Separation of screening and in-line	In-line and Screening included as combined cost in Preliminary Proposal

Table 1-10. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
	Screening	Unit cost updates Separation of screening and in-line	In-line and Screening included as combined cost in Preliminary Proposal
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management approach.	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation.	Preliminary Proposal estimates were based on 2014 dollar values.	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, the future performance target is 98 percent capture for the representative year measured on a system-wide basis. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-11 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified for Control Option 1.

Overall the Mager district would be classified as a low potential for implementation of complete sewer separation as the feasible approach to achieve the 98 percent capture in the representative year future performance target. The favorable performance and additional volume capture potentially available via control gate construction and in-line storage utilization was found to not require any additional measures to within this district to address future performance targets. The existing extent of sewer separation within the district has also been found to sufficient as is to meet future performance targets. Additional opportunistic separation of the portions of the district would still be recommended however, so long as there are sufficient synergies and cost savings with other major infrastructure work. In addition, focused use of green infrastructure could also be utilized to meet future performance targets.

Table 1-11. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Opportunistic additional sewer separation • Increased use of GI • Increased use of In-line

The control options for the Mager district have been aligned for the 85 percent capture performance target. The expandability of this district to meet the 98 percent capture would again involve a system wide basis analysis to be completed to determine the next phase for the district. As noted in the performance summary, this district already achieves a high level of percent capture and is impacted from the upstream districts that discharge to the Mager district. Any increases to the districts percent capture would be to eliminate overflows from this district or improve the system-wide percent capture overall target.

The cost for upgrading to meet an enhanced performance target depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of

master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-12.

Table 1-12. Control Option 1 Significant Risks and Opportunities

ID Number	Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	R	-	-	-	-	-	-
2	Existing Lift Station	-	R	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	-	-	-	-
4	Construction Disruption	-	-	-	-	-	-	-	-
5	Implementation Schedule	-	-	-	-	-	-	R	-
6	Sewer Condition	-	R	-	-	-	-	-	-
7	Sewer Conflicts	-	R	-	-	-	-	-	-
8	Program Cost	-	O	-	-	-	-	-	O
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	-	-	-	-	-	O	O	-
12	Operations and Maintenance	-	R	-	-	-	R	O	R
13	Volume Capture Performance	-	O	-	-	-	O	O	-
14	Treatment	-	R	-	-	-	O	O	R

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

I.D. Engineering Canada Inc. 1992. *Sewer Relief Study Mager Combined Sewer District*. Prepared for the City of Winnipeg, Waterworks, waste and disposal department. October.

LEGEND

- Primary Weir
- Critical Elevation
- Decommissioned Outfall
- CSO Outfall
- Low CS Manhole

Inter-System Connection
- CS - LDS
- CS - WWS
- SRS - CS
- SRS - LDS
- SRS - WWS

District Boundary Crossing
- CS
- LDS
- WWS

- Interceptor Sewer
- Force Main
- Street
- Railway
- District Boundary
- Watercourse
- Greenspace

CSO MASTER PLAN PROPOSED SOLUTIONS
- Proposed Control Gate
- Extent of In-line Storage
- Sewer Separation - Complete
- Sewer Separation - Ready

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 24
District Overview Map
Sewer District: Mager
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

Primary Weir
Critical Elevation
CSO Outfall
Manhole
Flap Gate
Sluice Gate
Pump Location
Force Main
Sewer By Type
CS
LDS
Pump Station Type
Flood Pump Station
Lift Station

CSO MASTER PLAN PROPOSED SOLUTIONS

Control Gate
Screening

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 24-01
Control Gate and Screening
Sewer District: Mager
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Marion District Plan

August 2019

City of Winnipeg

JACOBS

CSO Master Plan

Project No: 470010CH
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Document History and Status

Revision	Date	Description	By	Review	Approved
0	08/2018	Version 1 DRAFT	SG	ES	
1	03/2019	DRAFT 2 for City Review	JT	MF / SG	MF
2	07/2019	Final Draft Submission	DT	MF	MF
3	08/19/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

Tables

Figure

1. Marion District

1.1 District Description

Marion district is located along the eastern edge of the Red River and west of Seine River. The district is bounded by Despins district to the north and east, Metcalfe and Mager districts to the south, Mission district to the east, and the Red River to the west. Coniston Street, Niverville Avenue, and Carriere Avenue form the southern border, the Seine River and Des Meurons Street form the eastern border, and Bertrand Street forms the northern border.

The land use within Marion district developed gradually from 1900 to 1950 as single-family residential land. Single family housing is primarily located to the southwest of St Mary's Road and multi-family housing extends to the northwest of St. Mary's Road. Marion is mostly residential, but it has many commercial businesses on St. Mary's Road, Marion and Goulet Streets, and Taché Avenue. The area includes the St. Boniface Hospital and Research facilities, Dominion Centre, Nelson McIntyre Collegiate, the Champlain and Norwood Community Centres and a portion of the St. Boniface Golf Club.

Marion district contains numerous regional transportation routes: St. Mary's Road, Taché Avenue, and Marion and Goulet Streets. St. Mary's Road and Marion Street converge and cross the Red River at the Norwood Bridge. Approximately 20 ha of the district is classified as greenspace, which includes Coronation Park and Lyndale Drive Park.

1.2 Development

Marion is a medium density residential neighbourhood located around a commercial corridor and close to downtown. Due to its location close to the downtown however, there is a high potential for further densification via infill in the district. Redevelopment within this area could impact the CS system and will be investigated on a case-by-case basis for potential impacts to the combined sewer overflow (CSO) Master Plan. All developments within the CS districts are mandated to offset any peak combined sewage discharge by adding localized storage and flow restrictions, in order to comply with Clause 8 of the Environment Act Licence 3042.

A portion of St. Mary's Road is located within the Marion district. St. Mary's Road is identified as Regional Mixed Use Corridor as part of the OurWinnipeg future development plans. As such, focused intensification along St. Mary's Road is to be promoted in the future.

1.3 Existing Sewer System

Marion district has an approximate area of 233 ha[1] based on the district boundary. There is approximately 24 percent (55 ha) separated, 13 percent (30 ha) partial separation, and 14 percent (33 ha) separation ready areas.

The district is serviced by combined sewer (CS), storm relief sewer (SRS), land drainage sewer (LDS), and wastewater sewer (WWS) systems. There are two CS outfalls (one CS outfall to the Red River and another CS outfall to the Seine River), one flood pumping station (FPS) outfall, and one SRS outfall. The second CS outfall to the Seine River however has been disconnected from the CS system and is no longer in use. Figure 25 provides an overview of the Marion district and includes key infrastructure locations for existing sewer infrastructure and additional CSO Master Plan details.

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

Three CS trunk sewers connect to the Marion FPS and sewage pumping station (SPS) that service the district, located near the intersection of Lyndale Drive and St Marys Road. A 900 mm by 1350 mm sewer trunk and a 1650 mm trunk on St. Mary's Avenue run parallel along St. Mary's Road. The 1650 mm services the southwest area, and the 900 mm by 1350 mm services the south-central portion along St. Mary's Road. A 1650 mm trunk sewer runs along Horace Street and services the northern and eastern portions of the district. The sewer trunks converge and flow adjacent to the FPS to the Marion SPS. A portion of the collection system for the St. Boniface Hospital connects downstream of the FPS through a 450 mm sewer. Within the Marion FPS and SPS, there is a separate control structure that includes a primary weir and a 1600 mm CS outfall pipe to the Red River protected by flap and sluice gates against back-up due to high river levels. The FPS pumps directly to the river through an independent 1800 mm outfall with no flap gate or sluice gate installed. A 300 mm CS outfall was located off Dubuc Street in the eastern portion of the district to provide relief as needed. This secondary outfall has recently been disconnected from the Marion CS system, and is no longer in use.

Separate wastewater sewers (WWS) were installed in the eastern portion of the district in the early 2000s. Wastewater is collected from a portion of the district and flows by gravity along Enfield Crescent before it is pumped back into the existing CS system via a CS lift station (LS) at Enfield Crescent and St. Mary's Road. This SPS pumps into the 900 mm CS sewer on Enfield Crescent. These separate wastewater sewers in the Marion district also receive wastewater from separate sewers installed in the Despins district to the north.

The Marion SRS system includes a 1200 mm outfall to the Red River and extends as a 1500 mm SRS trunk along Walmer Street to provide relief to the CS system in the southwestern portion of the district. A disconnected upstream portion of the SRS provides some additional capacity to the south-central portion of the district by interconnecting the two trunk sewers running along St. Mary's Road. This SRS pipe connects back into the CS system.

The southwestern and eastern areas of the Marion district are partially separated, in which separate LDSs were installed. The southwestern LDS system has a separate outfall into the Red River, constructed near the intersection of Lyndale Drive and Balsam Place, and the eastern LDS system discharges to the Seine River along Edgewood Street. Both LDS outfalls have positive and flap gate protection against high river levels.

During DWF, the sewage flows by gravity through the Marion FPS and is diverted by a weir to the Marion SPS. The SPS pumps through a 500 mm force main across the Red River to the River district, across the Assiniboine River to the Assiniboine District, and ultimately to the Main Street interceptor in the Bannatyne district, which flows by gravity to the North End Sewage Treatment Plant (NEWPCC).

High flow in the system from runoff events may cause the level in the trunk sewer to increase above the outfall weir and overflow to the Red River. The FPS is available to pump excess flow in the system directly to the Red River as required.

The three outfalls to the Red River and Seine River (one CS, one SRS, and one FPS) are as follows:

- ID12 (S-MA50008337) – Marion CS Outfall
- ID85 (S-MA70105998) – Marion FPS Outfall
- ID11 (S-MA70008060) – Walmer SRS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Marion and the surrounding districts. Each interconnection is shown on Figure 25 and shows locations where gravity and pumped flow can cross from one district to another. Each interconnection is listed as follows:

1.3.1.1 **Interceptor Connections – Downstream of Primary Weir**

River

- A 500 mm force main conveys CS from Marion LS across the Red River and into the River district:
  - Queen Elizabeth Way invert at district boundary – 225.06 m (S-MA70057928)

1.3.1.2 District Interconnections

Metcalfe

CS to CS

- High Point Manholes (flow is directed into both districts from these manholes):
  - Lyndale Drive and Tache Avenue – 229.00 m (S-MH50003338)
  - Niverville Avenue and Braemar Avenue invert at district boundary – 227.28 m (S-MH50006462)
- A 300 mm CS sewer acts as an overflow pipe from the Metcalfe district to the Marion district:
  - Coniston Street and Crawford – 228.37 m (S-MH50003505)
- A 300 mm CS sewer acts as an overflow pipe from the Metcalfe district to the Marion district:
  - Coniston Street and Chandos Avenue – 228.08 m (S-MH50003573)
- A 450 mm CS sewer acts as an overflow pipe from the Marion district to the Metcalfe district:
  - Dubuc Street and Hill Street – 225.67 m (S-MH50006379)
- A 450 mm CS sewer acts as an overflow pipe from the Metcalfe district to the Marion district:
  - Dubuc Street and Des Meurons Street – 225.83 m (S-MH50006377)

SRS to SRS

- The SRS from Marion's CS system flows by gravity into Metcalfe's SRS system at the intersection of Des Meurons Street and Yardley Street, and the intersection of Des Muerons Street and Bristol Avenue. The Metcalfe SRS system then connects to the CS system in Metcalfe near the intersection of Carriere Avenue and Des Meurons:
  - 450 mm on Yardley Street, invert at Marion district boundary – 226.07 m (S-MA70026907)
  - 375 mm on St Luc Street, invert at Marion district boundary - 226 m (S-MA70026912)

Despins

CS to CS

- Common high point sewer manholes:
  - Horace Street invert at Marion invert – 226.85 m (S-MH50002230)
  - Goulet Street and Des Meurons Street invert – 227.34 m (S-MH50002282)
- A 250 mm CS pipe from Marion flows by gravity westbound into Despins CS system at the intersection of Taché Avenue and Thomas Berry Street:
  - Tache Avenue and Thomas Berry invert – 226.50 m (S-MH50002657)
- A 375 mm SRS overflow pipe from Marion flows by gravity westbound into Despins CS system during an overflow:
  - Tache Avenue and Rinella Place invert – 226.13 m (S-MH50002666)

- A 450 mm CS pipe from Marion flows by gravity eastbound into Despins CS system at the intersection of Enfield Crescent and Bertrand Street:
  - Enfield Crescent and Bertrand Street Invert – 224.56 m (S-MH50007262)
- A 1050 mm CS pipe from Despins flows by gravity westbound into Marion CS system at the intersection of Enfield Crescent and Bertrand Street:
  - Enfield Crescent and Bertrand Street Invert – 224.74 m (S-MH50002428)
- A 600 mm CS pipe from Marion flows by gravity eastbound into Despins district CS system at the intersection of Marion Street and Des Meurons Street:
  - Marion Street and Des Meurons Street Invert – 226.68 m (S-MH50002243)
- A 300 mm CS pipe from Despins flows by gravity westbound into Marion district CS system on Horace Street into the manhole near the intersection with Youville Street:
  - Horace Street near Youville Street Invert – 226.85 m (S-MH50002230)

<u>WWS to WWS</u>

- A 250 mm WWS and a 300 mm WWS flows southbound by gravity and converge at a manhole at the corner of Bertrand Street and Enfield Crescent and flow by gravity from Despins district into the localized WWS installed in the Marion district:
  - Bertrand Street and Enfield Crescent Invert – 223.00 m (S-MH70025546)

<u>LDS to LDS</u>

- A 300 mm LDS pipe from Marion flows eastbound by gravity into Despins on Horace Street, between Youville Street and Des Meurons Street:
  - Youville Street and Des Meurons Street Invert – 225.37 m (S-MH70007961)
- A 525 mm LDS pipe from Despins flows southbound along Youville Street by gravity into Marion district LDS system between Eugenie Street and Edgewood Street:
  - Invert at Marion district boundary – 224.34 m (S-MH70007984)

<u>LDS to CS</u>

- A 250 mm LDS short section of the LDS system extends from Marion and flows by gravity into Despins CS at Tache Avenue near the back alley of Thomas Berry Street:
  - Invert at Marion district boundary – 226.15 m (S-MH50002944)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing district.

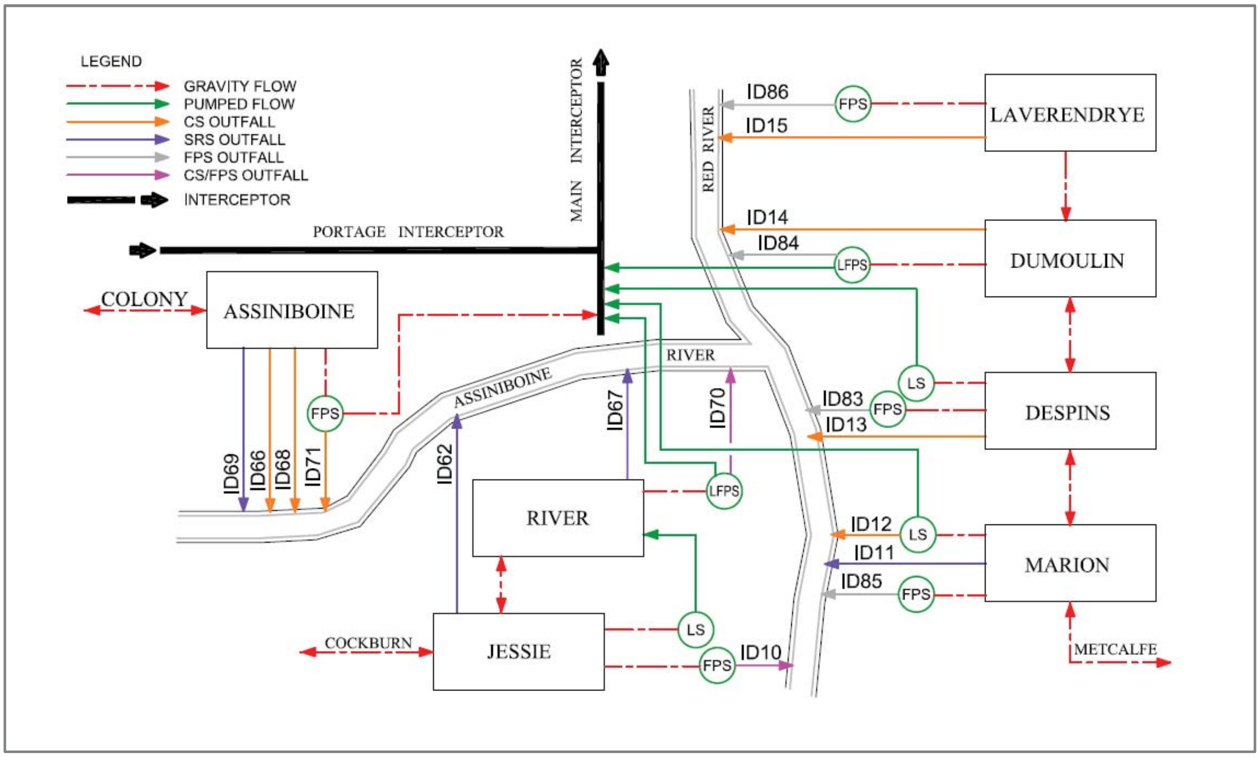

Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 25 and listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID12)	S-CO70008489.1	S-MA50008337	1600 mm	Red River Invert = 221.89 m
Flood Pumping Outfall (ID85)	S-AC70008319.1	S-MA70015955	1800 mm	Red River Invert = 222.20 m
Other Overflows	N/A	N/A	N/A	CS secondary outfall into Seine River has been disconnected.
Main Trunk	N/A	S-MA70101974	1650 mm	Circular Invert: 222.44 m
SRS Outfalls	S-RE70003431.1	S-MA70008060	1200 mm	Red River
SRS Interconnections	N/A	N/A	N/A	24 SRS - CS
Main Trunk Flap Gate	N/A	S-CG00001116	1650 mm	Invert: 222.65 m
Main Trunk Sluice Gate	N/A	S-CG00000837	1351 mm	Invert: 222.03 m
Off-Take	N/A	S-MA70040771	600 mm	Circular Invert: 222.56 m

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Dry Well	N/A	N/A	N/A	No dry well within this lift station.
Lift Station Total Capacity	N/A	N/A	0.230 m^3/s	1 x 0.120 m^3/s 1 x 0.110 m^3/s
Lift Station ADWF	N/A	N/A	0.044 m^3/s	
Lift Station Force Main	N/A	S-MA70003510	500 mm	Invert: 224.44 m
Flood Pump Station Total Capacity	N/A	N/A	3.01 m^3/s	1 x 0.79 m^3/s, 2 x 1.11 m^3/s
Pass Forward Flow – First Overflow	N/A	N/A	0.331 m^3/s	

Notes: ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Marion – 223.73 Dubuc – 225.00 Walmer – 223.73
2	Trunk Invert at Off-Take	222.56
3	Top of Weir	222.87
4	Relief Outfall Invert at Flap Gate	222.31
5	Low Relief Interconnection	224.17
6	Sewer District Interconnection (Despins)	223.00
7	Low Basement (Metcalfe, Marion, Despins)	224.64
8	Flood Protection Level (Metcalfe, Marion, Despins)	229.81

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed in Marion district was the *Marion and Despins Sewer Relief Project Preliminary Design Report* (Wardrop, 2005). The Marion and Despins CS Relief Project improved the capacity of the existing CS system to alleviate basement flooding. The CS district relief, including the separate LDS and WWS installation, was completed between 2000 and 2003. is aligned with the Wardrop Sewer Relief project. Note that the final draft of the report was issued in 2005 after the work was complete, but the original design report was prepared prior to the work taking place. No other relief or CSO related sewer work has been completed since that time.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the

Marion district was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations has a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Expected Completion
25 - Marion	2005 - Conceptual	Future Work	2013	Complete	N/A

1.5 Ongoing Investment Work

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall of the Marion district. This consists of monthly site visits in confined entry spaces to verify physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Marion sewer district are listed in Table 1-4. The proposed CSO control projects will include latent storage and an alternative floatable management approach.. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	✓	-	-	-	-	-	-	-	✓	✓	✓

Notes:- = not included
✓ = included

The existing SRS system is suitable for use as latent storage. This option would take advantage of the some of the existing pipe networks for additional storage volume. Existing DWF from the collection system would remain the same, and overall district operations would remain the same.

The existing CS system is not suitable for in-line storage as the relative low level of the SPS and associated CS outfall results in the NWSL level being at a higher level than the recommended control gate level during the 1992 representative year assessment.

Floatable control will be necessary to capture any undesirable floatables in the sewage overflows. Floatables are typically captured via a screening facility, however, the hydraulic constraints within the Marion district do not allow sufficient positive head to be achieved and an alternative floatables management approach will be necessary.

GI and RTC will be applied within each district on a system wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design. RTC is not included in detail within each plan and is described further in Section 3 of Part 3A.

1.6.2 Latent Storage

Latent storage is the first consideration for district controls and would be a suitable control option for Marion because of the existing SRS system. The latent storage level and volume would be controlled by the backpressure of the river on the Walmer SRS outfall flap gate, as explained in Part 3C. The latent storage design criteria are identified in Table 1-5.

Table 1-5. Latent Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	222.56 m	
NSWL	223.73 m	Above invert elevation
Trunk Diameter	1500 mm	
Design Depth in Trunk	1170 mm	
Maximum Storage Volume	563 m^3	
Force Main	100 mm	
Flap Gate Control	N/A	NSWL > SRS Invert at Flap Gate
Lift Station	Included	Off-line wet well
Nominal Dewatering Rate	0.02 m^3/s	Based on existing pump capacity
RTC Operational Rate	TBD	Future RTC / dewatering review on performance

Notes:
NSWL – normal summer water level
RTC – Real Time Control

The addition of latent storage pump station (LSPS) and force main that connects back to the CS system will be required for latent storage. A conceptual layout for the LSPS and force main is shown on Figure 25-01. The LSPS will be on the Walmer Street and Pinedale Avenue intersection to avoid interference with nearby residential lands and disruption to existing sewers. The latent force main will connect directly to the nearest CS manhole (S-MH50002905), which is located within the property of the Norwood Community Centre. The LSPS will operate to dewater the SRS system in preparation for the next runoff event, with the requirement that the system is ready for the next event within a 24-hour period after completion of the previous event.

Figure 25 identifies the extent of the SRS system within Marion district that would be used for latent storage. The maximum storage level is directly related to the NSWL and the size and depth of the SRS system. Once the level in the SRS exceeds the river level, the flap gate opens, and the combined sewage is discharged to the river.

As described in the standard details in Part 3C, wet well sizing will be determined based on the final pump selection, operation, and dewatering capacity required. The interconnecting piping between the new gate chamber and the pump station would be sized to provide sufficient flow to the pumps while all pumps are operating. Flap gate control was not deemed necessary for this control option. Flap gate control may be considered if additional storage is required or if he river level regularly drops below the SRS flap gate elevation. The SRS flap gate control is described in the standard details in Part 3C

1.6.3 Floatables Management

Floatables management for the Marion district, due to the existing hydraulic constraints, is proposed to be an alternative floatables management approach. This approach is to ensure that the proposed required floatable management requirements outlined within the Environment Act Licence 3042 can be maintained.

This alternative approach to floatables management will be achieved by targeting floatables source control. This will be achieved by implementing more focused efforts towards street cleaning and catch-basin cleaning, to remove floatable material from surface runoff before it enters the combined sewer system. The second broad component of this alternative approach will focus on public education in an effort to reduce the sanitary components from ever entering plumbing systems. This is expected to achieve similar or better results while eliminating the end-of-pipe screening. The proposed approach will be similar to the program currently carried out in the City of Ottawa to meet their CSO mitigation requirements.

The alternative approach will be further investigated and demonstrated during the interim period between the submission of the CSO Master Plan (August 2019) and the revised CSO Master Plan submission (April 2030), and is discussed in further detail in Part 2 of the CSO Master Plan. It is recommended that as part of this work these measures will be undertaken in the Marion district, due to screening limitations mentioned above.

1.6.4 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district was reviewed to identify the most applicable GI controls.

Marion has been classified as a medium GI potential district. Land use in Marion is mostly single-family residential, while St Mary's Road includes a mix of commercial businesses. This means the district would be an ideal location for bioswales, permeable paved roadways, cisterns/rain barrels, and rain gardens. The flat roof commercial buildings along St. Mary's Road make would be an ideal location for green roofs.

1.6.5 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

The SRS latent storage would fill by gravity during wet weather events and would be dewatered through the dedicated LSPS back to the existing CS. The latent storage would take advantage of the infrastructure already in place, and the sewer would require minimal additional maintenance. The additional LSPS would require intermittent maintenance which would depend on the frequency of operation.

The alternative floatable management control is based on implementing additional operating and maintenance measures, in an effort to match the performance of the capital construction projects to meet the floatables management requirements. As such dedicated additional operating and maintenance costs should be allocated to this district. The goal however is for this work to overall be more cost effective from a life cycle perspective, considering the upfront capital and operating and maintenance costs associated with screening facilities.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. Two versions of the sewer system model were created and used to measure system performance. The 2013 Baseline model represents the sewer system baseline in the year 2013 and the 2037 Master Plan – Control Option 1 model, which includes the proposed control options in the year 2037. A summary of relevant model data is provided in Table 1-6.

Table 1-6. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	97	97	3,652	62	N/A
2037 Master Plan – Control Option 1	97	97	3,652	62	Lat St

Notes:

Lat St = Latent Storage

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-7 are for the hydraulic model simulations using the year-round 1992 representative year. The table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. The table also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-7. District Performance Summary – Control Option 1

Control Option	Preliminary Proposal	Master Plan			
	Annual Overflow Volume (m^3)	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [b]
Baseline (2013)	34,108	51,773	-	21	0.184 m^3/s
Latent Storage	30,522 [a]	37,548	14,225	13	0.241 m^3/s
Latent & In-Line Storage		37,548	0	13	0.241 m^3/s
Control Option 1	**30,522**	**37,548**	**14,225**	**13**	**0.241 m^3/s**

Note:

[a] Preliminary Proposal did not independently separate latent and in-line storage

[b] Pass forward flows assessed on the 1-year design rainfall event.

The difference between the Preliminary and CSO Master Plan Baseline and Control Option 1 results are directly due to the update in SPS pump capacity provided via the Clear SCADA data information for the existing Marion SPS. The expected no change in overflow reduction for the in-line storage is due to the modelled NSWL being continuous for the representative year. The overflows from the Walmer SRS have been completely eliminated from the assessment.

The percent capture performance measure is not included in Table 1-7, as it is applicable to the entire CS system and not for each district individually.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-8. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-8. District Cost Estimate – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period)
Latent Storage	$1,620,000	$2,170,000	$74,000	$1,600,000
Floatables Management Allowance	N/A [a]	$2,730,000 [b]	$47,000	$1,010,000
Subtotal	**$1,620,000**	**$4,900,000**	**$121,000**	**$2,610,000**
Opportunities	N/A	$490,000	$12,000	$260,000
District Total	**$1,620,000**	**$5,390,000**	**$133,000**	**$2,870,000**

[a] Solution developed as refinement to Preliminary Proposal work following submission of Preliminary Proposal costs. Costs for In-line Storage and Screening items of work found to be $2,140,000 in 2014 dollars

[b] Cost allowance to account for the alternative floatable management measures. This allowance is based on a typical district control gate cost

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional cost for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014-dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019-dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-9.

Table 1-9. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Alternative Floatables Management	Control Gate and screening were not included in the Preliminary Proposal estimate. Screening later determined to not be feasible due to hydraulic constraints. Added to Master Plan cost, assumed to be comparable to typical control gate projected cost.	
	Removal of In-line Storage	The Master Plan assessment found that in-line storage not a preferred control solution.	
	Latent Storage	Unit costs updated for this control option	
Opportunities	A fixed allowance of 10 percent has been included for program opportunities such as GI	Preliminary Proposal estimate did not include a cost for opportunities.	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation	Preliminary Proposal estimates were based on 2014-dollar values.	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, the future performance target is 98 percent capture for the representative year measured on a system-wide basis. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-10 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified for Control Option 1.

Overall the Marion district would be classified as low potential for implementation of complete sewer separation as the only feasible approach to achieve the 98 percent capture in the representative year future performance target. Opportunistic separation of portions of the district may be achieved with synergies with other major infrastructure work to address future performance targets. The provision of an in-line control gate would provide additional storage, during periods when the actual river level is below the 1992 representative year NSWL level used in the CSO Master Plan assessment. This would provide a reduction in overflow volume for real time events although this is not reflected in the CSO Master Plan modelling assessment due to the influence of the NSWL being higher than the proposed control gate level. In addition, green infrastructure and off-line storage tank or tunnel storage may be utilized in key locations to provide additional storage and increase capture volume.

Table 1-10. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Increased In-line Storage • Opportunistic Sewer Separation • Off-line Storage (Tunnel / Tank) • Increased GI

The control options for Marion district have been optimized for the 85 percent capture performance target based on the system wide basis. The expandability of this district to meet 98 percent capture target would be based on a system wide basis analysis and the results of the alternative floatables management approach.

The cost for upgrading to meet an enhanced performance target depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-11.

Table 1-11. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	R	R	-	-	-	-	-	-
2	Existing Lift Station	-	_	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	-	-	-	-
4	Construction Disruption	-	-	-	-	-	-	-	-
5	Implementation Schedule	-	-	-	-	-	-	R	-
6	Sewer Condition	R	_	-	-	-	-	-	-
7	Sewer Conflicts	R	-	-	-	-	-	-	-
8	Program Cost	O	-	-	-	-	-	-	O
9	Approvals and Permits	-	-	-	-	-	R	-	-

Table 1-11. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	R	-	-	-	-	O	O	-
12	Operations and Maintenance	R	-	-	-	-	R	O	R
13	Volume Capture Performance	O	-	-	-	-	O	O	-
14	Treatment	R	-	-	-	-	O	O	R

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

Wardrop. 2005. *Marion and Despins Sewer Relief Project Preliminary Design Report*. Prepared for the City of Winnipeg Water and Waste Department. March.

LEGEND

- Primary Weir
- Critical Elevation
- Decommissioned Outfall
- CSO Outfall
- Low CS Manhole
- Low SRS Connection

Inter-System Connection
- CS - WWS
- SRS - CS

District Boundary Crossing
- CS
- LDS
- SRS
- WWS

- Extent of Existing In-line Storage
- Interceptor Sewer
- Force Main
- Street
- Railway

- District Boundary
- Watercourse
- Greenspace
- City Owned Land

CSO MASTER PLAN PROPOSED SOLUTIONS

- Proposed SRS Latent Storage Pump
- Latent Storage Limit
- Latent Force Main
- Sewer Separation - Complete
- Sewer Separation - Ready

Note: Alternative Floatables Management Approach to be tested prior to implementation.

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 25
District Overview Map
Sewer District: Marion
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

Critical Elevation
CSO Outfall
Manhole
Flap Gate
Sluice Gate
Sewer By Type
CS
SRS
Control Structure Type
Gate Chamber
Land Parcel

CSO MASTER PLAN
PROPOSED SOLUTIONS
Proposed Latent Force Main
Latent Pump

ALL PROPOSED SOLUTIONS
SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 25-01
Latent SRS Control
Sewer District: Marion
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Metcalfe District Plan

August 2019

City of Winnipeg

CSO Master Plan

Project No: 470010CH
Document Title: Metcalfe District Plan
Revision: 03
Date: August 18, 2019
Client Name: City of Winnipeg
Project Manager: John Berry
Author: Stephen Godon
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Revision	Date	Description	By	Review	Approved
0	08/2018	Version 1 DRAFT	DT	SG	
1	02/15/2019	DRAFT 2 for City Review	DT	MF	SG
2	05/2019	Final Draft Submission	DT	MF	MF
3	08/18/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

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Figure

1. Metcalfe District

1.1 District Description

Metcalfe district is located towards the eastern limit of the Combined Sewer (CS) area. Regional Roadways bordering the district include Coniston Street and Niverville Street to the north, Carriere Avenue to the south, Des Meurons Street to the east, and Chandos Avenue to the west. Figure 26 provides an overview of the sewer district and the location of the proposed Combined Sewer Overflow (CSO) Master Plan control options.

St. Mary's Road is the only regional transportation route that passes through the district. Lyndale Drive Park located along the Red River is the only greenspace.

Metcalfe district land use is classified primarily as residential with a small commercial area present along St. Mary's Road. Significant buildings and areas in the district include the Aria Medical Centre located on the west side of St. Mary's Road.

1.2 Development

A portion of St. Mary's Road is located within the Metcalfe District. St. Mary's Road is identified as Regional Mixed-Use Corridor as part of the OurWinnipeg future development plans. As such, focused intensification along St. Mary's Road is to be promoted in the future.

1.3 Existing Sewer System

Metcalfe district encompasses an area of 41 ha[1] based on the district boundary and consists of a CS system with one outfall. There is approximately 0.5 percent (0.2 ha) separated and no separation-ready areas.

The CS system includes a flood pump station (FPS), CS lift station (LS), and one combined CS / flood pump station (FPS) outfall. All domestic wastewater and combined sewage collected throughout the district flows to the main 1050 mm by 1600 mm sewer that connects to the Metcalfe FPS and CS outfall.

During dry weather flows (DWF), sewage is diverted past the Metcalfe outfall weir into the 300 mm off-take pipe and north to the Metcalfe sewage LS. Sewage is pumped through a 200 mm force main south down St. Mary's Road, and then ties into Mager district CS system at St Mary's Road and Fifth Avenue. From here, sewage is conveyed via gravity through the Mager District, where it is pumped to the South Interceptor sewer and ultimately transported to the South End Sewage Treatment Plant (SEWPCC). Note that prior to 1990 the intercepted CS flows from the Metcalfe district were pumped the Metcalfe LS north into the Marion district, and eventually was transported to the North End Sewage Treatment Plant (NEWPCC). The interceptor connection for the Metcalfe district into the Marion district was relocated to tie into the Mager district in 1990 to reduce the risk of failure of the interceptor pipe from riverbank stability issues experienced in the area.

During wet weather flow (WWF), any flow that exceeds the diversion capacity of the primary weir is discharged into the Metcalfe CS outfall, where it flows to the Red River by gravity. Sluice and flap gates are installed on the CS outfall to prevent back-up of the Red River into the CS system under high river level conditions. Under these high river level conditions gravity discharge through the Metcalfe CS outfall is not possible due to the flap gate in place on the outfall. In this situation the excess flow is pumped by the Metcalfe FPS, and redirected to tie into the CS outfall downstream of the flap gate, allowing gravity discharge to the Red River once more.

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[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

Metcalfe contains a section of storm relief sewer (SRS) pipe along the eastern boundary on Des Meurons Street. The SRS connects Marion district CS flow into Metcalfe's CS system. There is no dedicated SRS outfall in the Metcalfe district.

The one CS outfall to the Red River is as follows:

- ID06 (S-MA70011115) – Metcalfe CS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Metcalfe and the surrounding districts. Each interconnection is shown on Figure 26 and shows locations where gravity and pumped flow can cross from one district to another. Each interconnection is listed in the following subsections.

1.3.1.1 Interceptor Connections

No interceptor connections are found in this district.

1.3.1.2 District Interconnections

Marion

CS to CS

- High Point Manholes (flow is directed into both districts from these manholes):
  - Lyndale Drive and Tache Avenue – 229.00 m (S-MH50003338)
  - Niverville Avenue and Braemar Avenue invert at district boundary – 227.28 m (S-MH50006462)
- A 300 mm CS sewer acts as an overflow pipe from the Metcalfe district to the Marion district:
  - Coniston Street and Crawford overflow pipe invert – 228.37 m (S-MH50003505)
- A 300 mm CS sewer acts as an overflow pipe from the Metcalfe district to the Marion district:
  - Coniston Street and Chandos Avenue overflow pipe invert – 228.08 m (S-MH50003573)
- A 450 mm CS sewer acts as an overflow pipe from the Marion district to the Metcalfe district:
  - Dubuc Street and Hill Street overflow pipe invert – 225.67 m (S-MH50006379)
- A 450 mm CS sewer acts as an overflow pipe from the Metcalfe district to the Marion district:
  - Dubuc Street and Des Meurons Street overflow pipe invert – 225.83 m (S-MH50006377)

SRS to SRS

- The SRS from Marion's CS system flows by gravity into Metcalfe's SRS system at the intersection of Des Meurons Street and Yardley Street, and the intersection of Des Muerons Street and Bristol Avenue. The Metcalfe SRS system then connects to the CS system in Metcalfe near the intersection of Carriere Avenue and Des Meurons:
  - 450 mm on Yardley Street, invert at Marion district boundary – 226.07 m (S-MA70026907)
  - 375 mm on St Luc Street, invert at Marion district boundary - 226 m (S-MA70026912)

Mager

CS to CS

- The Metcalfe CS LS discharges into the Mager Interceptor, a gravity sewer beginning at St Mary's Road and Fifth Avenue that flows through the Mager district to the Mager CS LS.

- St Mary's Road and Fifth Avenue – 227.52 m (S-MH50008551)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing district.

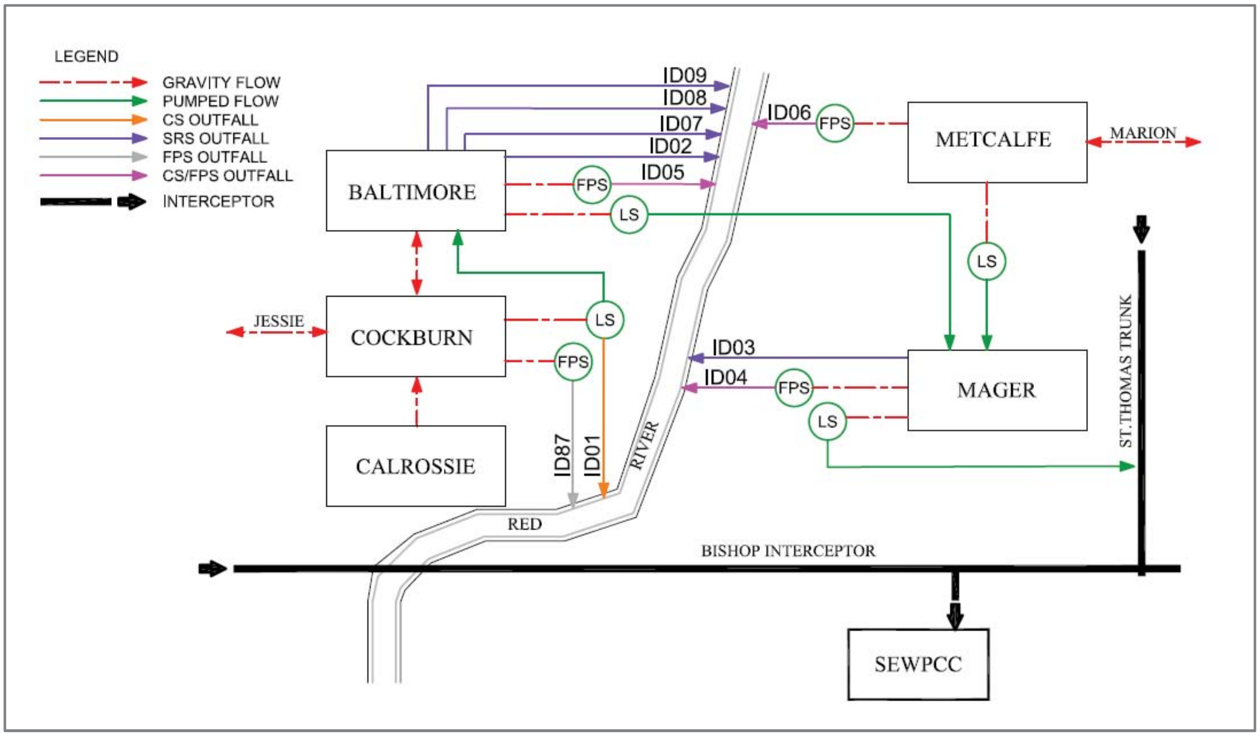


Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 26 and are listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID06)	S-CO70004641.1	S-MA70011115	2100 mm	Circular Invert: 222.23 m
Flood Pumping Outfall (ID06)	S-CO70004641.1	S-MA70011115	2100 mm	Circular Invert: 222.23 m
Other Overflows	N/A	N/A	N/A	
Main Trunk	N/A	S-MA50004337	1050 x 1600 mm	Egg-shaped Invert: 222.56 m
SRS Outfalls	N/A	N/A	N/A	No dedicated SRS outfall in this district.
SRS Interconnections	N/A	S-MA70026870 S-MA70026890 S-MA70026891 S-MA70026900	225.97 m 225.39 m 225.01 m 224.63 m	

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
		S-MA70026905	224,17 m	Flowing into CS system
Main Trunk Flap Gate	S-RE70004673.1	S-CG00000845	1375 mm	Invert: 223.14 m
Main Trunk Sluice Gate	S-CG00000846.1	S-CG00000846	1200 mm	Invert: 223.00 m
Off-Take	S-MH50003713.1	S-MA50004317	300 mm	Circular Invert: 222.99 m
Dry Well	N/A	N/A	N/A	
Lift Station Total Capacity	N/A	N/A	0.039 m^3/s	1 x 0.020 m^3/s 1 x 0.019 m^3/s
Lift Station ADWF	N/A	N/A	0.0027 m^3/s	
Lift Station Force Main	N/A	S-MA70017062	200 mm	Invert: 229.30 m
Flood Pump Station Total Capacity	N/A	N/A	1.32 m^3/s	1 x 0.67 m^3/s 1 x 0.65 m^3/s
Pass Forward Flow – First Overflow	N/A	N/A	0.032 m^3/s	

Notes:

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	223.74
2	Trunk Invert at Off-Take	222.99
3	Top of Weir	223.33
4	Relief Outfall Invert at Flap Gate	N/A
5	Low Relief Interconnection (S-MA70026905)	224.17
6	Sewer District Interconnection (Marion)	225.67
7	Low Basement (Despins, Marion, Metcalfe)	224.33
8	Flood Protection Level (Despins, Marion, Metcalfe)	229.95

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed in Metcalfe was in 1996 with the *Metcalfe Combined Sewer District Sewer Relief Study* (Reid Crowther & Partners Ltd., 1996). This study discussed the possible relief work available for Metcalfe CS. No other sewer work has been completed since that time.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Metcalfe Combined Sewer District was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations have a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Planned Completion
26 - Metcalfe	1996	Future Work	2013	Study Complete	N/A

1.5 Ongoing Investment Work

The City has proposed to rebuild the Metcalfe CS LS within the next 6 years. This construction will allow for an optimized pumping rate of combined sewage from Metcalfe district into Mager district. It is noted that this upgrade should be assessed in conjunction the proposed solutions to meet control option 1, detailed below.

There is ongoing maintenance and calibration of the permanent instruments installed within the primary outfall within the Metcalfe district. This consists of monthly site visits in confined entry spaces to verify that physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Metcalfe district are listed in Table 1-4. The proposed CSO control solution is primarily complete sewer separation. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	-	-	-	-	-	-	-	✓	✓	✓	-

Notes:

- = not included
✓ = included

The existing CS system is not fully suitable for use an in-line storage as the relative low level of the CS LS and associated CS outfall results in the NSWL level being at a similar level to the recommended control gate level (within 100mm) during the 1992 representative year assessment.

The marginal evaluation on the performance of the district for the future 98% percent capture target indicated that complete sewer separation has an advantage over any off-line storage facilities for the Metcalfe district. The initial capital costs to separate a district were found to be higher than implementing the equivalent off-line storage. However, with the implementation of a off-line storage arrangement, flotable control would also be needed as overflows would still occur under the 1992 representative year. Floatables are typically captured via a screening facility, however, the hydraulic constraints within the Metcalfe district do not allow sufficient positive head to be achieved and an alternative floatables management approach will be necessary. In addition, the implementation of complete separation would reduce the reliance on the Metcalfe FPS, further reducing long term operating costs. It is for these reasons that complete sewer separation was found to be most feasible and cost-effective solutions over a long term perspective, and was recommended over any in-line storage or off-line storage control solutions.

GI and RTC will be applied within each district on a system-wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Sewer Separation

Sewer separation is proposed for the Metcalfe district and will provide immediate benefits to the CSO program. The work includes installation of an independent LDS system to collect road drainage. Collected stormwater runoff will be routed through the new LDS to an outfall discharging to the Red River. The approximate area of sewer separation is shown on Figure 26. The flows to be collected after separation will be as follows:

- DWF will remain the same – pumped through the Metcalfe CS LS to Mager district.
- WWF will consist of sanitary sewage combined with foundation drainage.

This will result in a reduction in combined sewage flow received at Mager CS LS after the separation project is complete. The separation project will also reduce the requirements for the future upgrades to the existing LS.

In addition to added basement flood relief (BRF) and reducing the CSO volume, the benefits of separation include increasing the storage volume available in the CS system. With the implementation of separation, consideration should be given to the possibility of reducing the use of or elimination of the Metcalfe FPS. The implementation of separation at Metcalfe will also eliminate the overflows from the district, and will no longer require screening at the primary outfall for the district.

It is proposed that future monitoring of the district is completed to verify that the sewer separation is fully compliant with the modelled simulated elimination of all CSO overflows. A static weir elevation increase may be necessary at the CS primary weir to eliminate the occurrence of all CSOs. Any weir elevation raise will also be evaluated in terms of existing basement flood protection to ensure the existing level of basement flood protection remains.

1.6.3 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district will be reviewed to identify the most applicable GI controls.

Metcalfe has been classified as a high GI potential district. Metcalfe district land use is classified primarily as residential with a small commercial area present along St. Mary's Road. This means the district would be an ideal location for bioswales, permeable paved roadways, cisterns/rain barrels, rain gardens, and green roofs. The greenspace areas in the district would be ideal for bioretention garden projects.

1.6.4 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

Sewer separation will include the installation of additional sewers that will require inspection, cleaning and rehabilitation. This will result in additional maintenance costs over the long term, but operational costs will be minimal. The existing larger CS pipes within the district may also receive insufficient flow with the separation work for proper scouring velocities in the sewer pipes. This could result in solids settling within the sewers and requiring more frequent cleaning operations. The impacts of the reduced flows in larger CS pipes will be evaluated as part of the sewer separation design for the district.

The reduction in storm flows entering the downstream Metcalfe FPS will reduce the requirement for operation of the station. It is recommended to continue to maintain and operate the flow monitoring instrumentation and assess the results after district separation work has been completed. This will allow the full understanding of the non-separated storm elements (foundation drain connections to the CS system) extent within the Metcalfe district.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. An individual model was created to represent the sewer system baseline as represented in the year 2013 and a model for the CSO Master Plan with the control options implemented in the year 2037. A summary of relevant model data is summarized in Table 1-5.

Table 1-5. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	35	35	865	50	N/A
2037 Master Plan – Control Option 1	35	35	865	5	SEP

Notes:

SEP = Separation

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district. While this district is to be separated and as a result Clause 8 of Licence No. 3042 will not be in effect, the wet weather response of the district overall will still need to be assessed.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore. minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-6 are for the hydraulic model simulations using the year-round 1992 representative year. This table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options, Table 1-6 also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-6. Performance Summary – Control Option 1

Control Option	Preliminary Proposal Annual Overflow Volume (m^3)	Master Plan Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow
Baseline (2013)	10,335	12,191	-	15	0.032 m^3/s [c]
In-line Storage	12,931	N/A [b]	N/A	N/A	N/A
Separation	N/A [a]	0	12,191	0	0.038 m^3/s [d]
Control Option 1	**12,931**	**0**	**12,191**	**0**	**0.038 m^3/s [d]**

[a] Separation was not simulated during the Preliminary Proposal assessment.

[b] In-line storage not part of Master Plan Control Options

[c] Pass forward flows assessed with the 1-year design rainfall event

[d] Pass flow flows assessed with the 5-year design rainfall event

The percent capture performance measure is not included in Table 1-6, as it is applicable to the entire CS system and not for each district individually. However, the full capture of overflows volumes for the Metcalfe district would represent a 100 percent capture rate on a district level.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-7. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-7. Cost Estimates – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period)
Sewer Separation	N/A [a]	$17,430,000	$16,000	$350,000
In-line Storage	$- [b]	N/A	N/A	N/A
Screening		N/A	N/A	N/A
Subtotal	**$0**	**$17,430,000**	**$16,000**	**$350,000**
Opportunities	N/A	$1,740,000	$2,000	$40,000
District Total	**$0**	**$19,170,000**	**$18,000**	**$390,000**

[a] Separation not included in the Preliminary Proposal

[b] Solution developed as refinement to Preliminary Proposal work following submission of Preliminary Proposal costs. Costs for these items of work found to be $1,130,000 in 2014 dollars.

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The impacts of extending the implementation schedule to 2045 are included in the program development and program summary in Section 5 of Part 3A. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional cost for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014-dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019-dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019. Each of these values include equipment replacement and O&M costs.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-8.

Table 1-8. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Sewer Separation	Sewer Separation was not included in the preliminary estimate	The Master plan identified sewer separation as the most cost effective control option over in-line storage.
	Removal of In-Line Storage	In-Line Storage was not included in the Master Plan.	The Master plan identified sewer separation as the most cost effective control option.
	Removal of Screening	Screening was not included in the Master Plan.	With sewer separation recommended all CSO events will be removed, and there will no longer be a requirement for screening.
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation.	Preliminary Proposal estimates were based on 2014-dollar values.	

1.10 Meeting Future Performance Targets

The proposed complete separation of the Metcalfe district will achieve the 100 percent capture figure and no further work will be required to meet the future performance target.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-9.

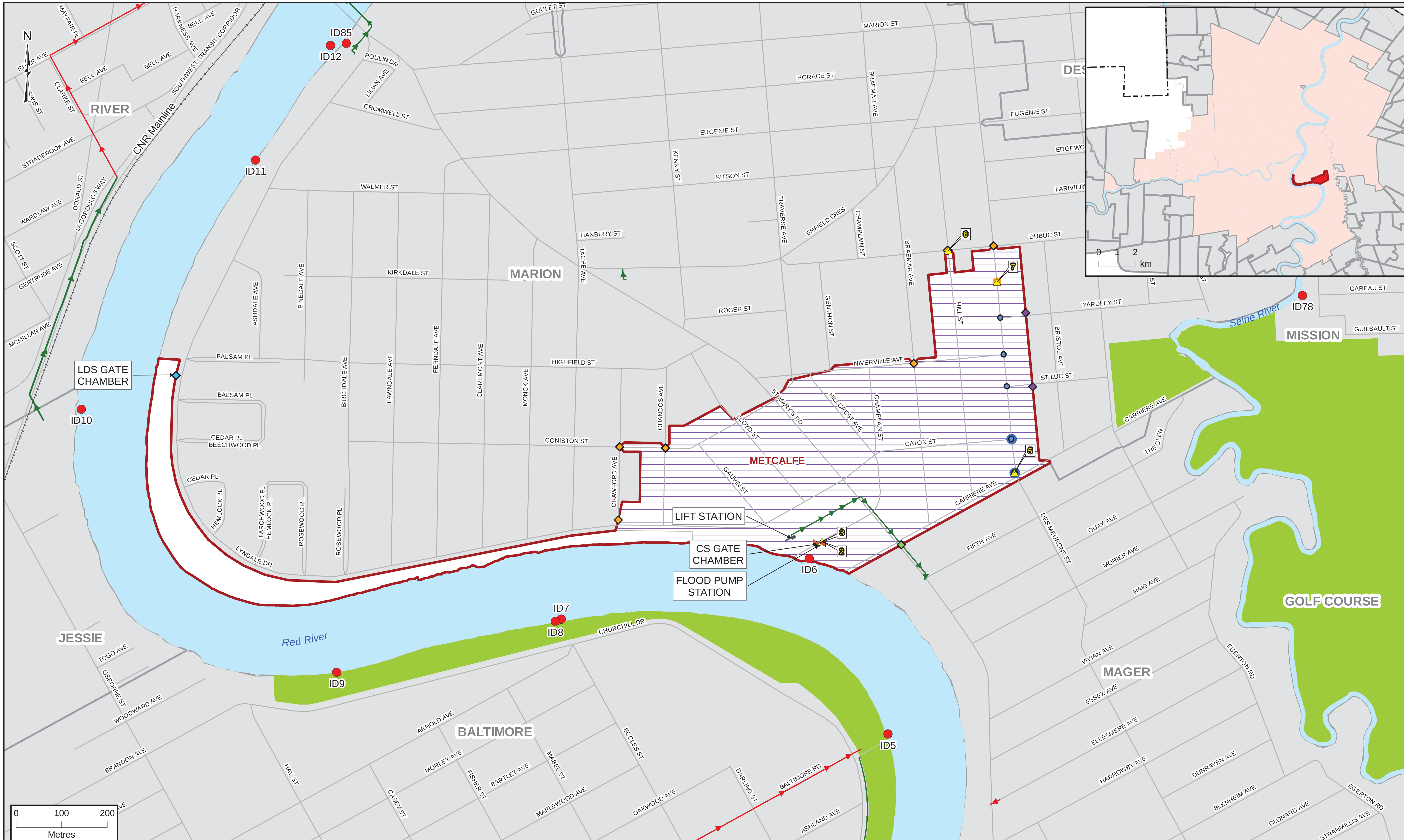
Table 1-9. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	-	-	-	O	-	-	-
2	Existing Lift Station	-	-	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	O	-	-	-
4	Construction Disruption	-	-	-	-	R	-	-	-
5	Implementation Schedule	-	-	-	-	R	-	R	-
6	Sewer Condition	-	-	-	-	-	-	-	-
7	Sewer Conflicts	-	-	-	-	R	-	-	-
8	Program Cost	-	-	-	-	R	-	-	-
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	-	-	-	-	O	O	O	-
12	Operations and Maintenance	-	-	-	-	R / O	R	O	-
13	Volume Capture Performance	-	-	-	-	-	O	O	-
14	Treatment	-	-	-	-	O	O	O	-

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

Reid Crowther & Partners Ltd. 1996. *Metcalfe Combined Sewer District Sewer Relief Study SWMM Input and Output*. Prepared for the City of Winnipeg Water and Waste Department. January.



LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Low CS Manhole
- Low SRS Connection

Inter-System Connection
- SRS - CS

District Boundary Crossing
- CS
- LDS
- SRS
- WWS

- Interceptor Sewer
- Force Main
- Street
- Railway

- District Boundary
- Watercourse
- Greenspace

CSO MASTER PLAN PROPOSED SOLUTIONS

- Sewer Separation - Planning

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 26
District Overview Map
Sewer District: Metcalfe
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Mission District Plan

August 2019

City of Winnipeg

JACOBS

CSO Master Plan

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0	08/2018	DRAFT for City Comment	SG	ES	
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2	08/13/2019	Final Draft Submission	DT	MF	MF
3	08/19/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

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Figure

1. Mission District

1.1 District Description

Mission district is located along the eastern boundary of the combined sewer (CS) area. The district is bounded by the Hart and Roland districts to the north, Area 13 and Area 22 to the east, Windsor Park to the south, and the La Verendrye, Dumoulin, Despins, and Marion districts to the west. The Seine River forms the western boundary, the northern boundary is Thomas Avenue, the eastern boundary is Lagimodière Boulevard, and Maginot Street and Berkshire Bay within the Windsor Park area form the southern boundary.

Many regional transportation routes pass through the district. Archibald Street runs north-south through the western side of the district, Marion Street runs east-west through the centre of the district, Mission Street runs east-west, and Lagimodière Boulevard runs north-south along the eastern border. Mission is a major industrial area and contains many rail lines, including the following:

- Canadian National Railway (CNR) Mainline
- Canadian Pacific Railway (CPR) Emerson
- CPR Mainline
- City-owned Greater Winnipeg Water District
- CNR Sprague
- CNR St. Bon Stocky

Mission consists mainly of industrial land with smaller commercial and residential areas spread throughout the district. The commercial land is found along the major transportation routes. Residential land use areas, including single-family, two-family, and multi-family, are located in three district areas spread throughout the district. In each case the residential land use consists of a small neighborhood. Industrial land is distributed in the Mission district and ranges from light to heavy industrial uses, with approximately 450 ha of heavy manufacturing land use classification. Greenspace in Mission district includes small areas for parks and recreational use, including Shell Canada Park and part of St. Boniface Golf Club.

1.2 Development

Mission is historically a heavy industrial neighbourhood; however, based on its location near downtown and surrounding residential areas, it is undergoing some de-industrialization. This includes the Stock Yards south of Marion Street and east of the CPR Emerson, which is identified as the Public Markets Major Redevelopment Site in OurWinnipeg. This Major Redevelopment Site is considered underused and will be prioritized to be developed into a higher density, mixed-use community.

A portion of Lagimodière Boulevard is located within the Mission District. Lagimodière Boulevard is identified as a Regional Mixed-Use Corridor as part of the OurWinnipeg future development plans. As such, focused intensification along Lagimodière Boulevard is to be promoted in the future.

A study was completed concerning Marion Street and Dugald Road to explore different options of transportation through this area in order to avoid widening or separation of these transportation routes. The *Marion Dugald Transportation Improvement Study* was developed due to the affordability and risk of the Marion Street widening and grade separation project (City of Winnipeg, 2017). This study was completed in September 2017.

Winnipeg Bus Rapid Transit could potentially impact the northern and western portions of the district. The Eastern Corridor Study (City of Winnipeg, 2018) is underway to determine the most suitable location for providing service between downtown and the eastern portion of the city. This study will include a review of drainage and utility infrastructure to determine if modifications and upgrades are required to support development and to minimize the impact to existing infrastructure. One of the options for the eastern corridor is conceptually shown as running north-south along the eastern side of the Seine River. This could also present an opportunity to coordinate sewer separation works alongside the transit corridor development.

1.3 Existing Sewer System

Mission district encompasses an area of approximately 730 hectares (ha)[1] based on the GIS district boundary information and includes combined sewer (CS), wastewater sewer (WWS) and land drainage sewer (LDS) systems. As shown in Figure 27, there is approximately 2.6 percent (19 ha) already separated and less than 1 percent (2 ha) of the total district is separation-ready. Approximately 43 ha of the district is classified as greenspace.

The Mission combined sewer system includes a CS lift station (LS) (also referred to as the Montcalm CS LS), a flood pump station (FPS), CS outfall and a gate/junction chamber. The CS system for the district ultimately drains towards Mission Street west of Archibald Street near the confluence of the Seine River with the Red River, where the FPS and primary CS outfall are located. Sewage flows collected in Mission district converge to a 1950 by 2925 mm CS trunk sewer that runs west along Mission Street towards the Mission CS outfall. An 1800 by 2700 mm CS sewer runs northwest on Dawson Road towards the Mission trunk sewer, this Dawson Road secondary trunk sewer carries the majority of the CS from the central and southeastern portions of the district. There is then a collector pipe that runs north of Archibald that carries the sewage from the primarily residential areas on the western portion of the district.

During dry weather flow (DWF), the sewage received is diverted by the primary weir, located beneath Archibald Street at the intersection of Archibald Street and Mission Street. The intercepted sewage then flows northbound by gravity via the 750 mm interceptor approximately 225 m along Archibald Street to the gate/junction chamber before entering the Montcalm CS LS. The intercepted sewage from the Roland district to the north also enters the Mission district from a 600 mm pipe flowing southbound along Archibald Street and ties into this same gate/junction chamber for the Montcalm CS LS. From there, the intercepted sewage from the Mission district and the Roland district is pumped across the Red River via two parallel 600 mm WWS force mains and into a 1200 mm CS secondary interceptor sewer in the Syndicate district. It then flows into the Main Interceptor, and eventually to the North End Sewage Treatment Plant (NEWPCC) for treatment.

During wet weather flow (WWF) events the CS flow in the system may increase the level in the sewer above the primary weir, causing an overflow which discharges by gravity through the Mission primary CS outfall into the Seine River. A flap gate and a sluice gate are installed at the outfall to prevent high river levels from entering back into the system when the Seine River levels are particularly high. However not only does the flap gate prevent river water intrusion, but it also prevents gravity discharge from the Mission CS outfall. Under these conditions the excess flow is pumped by the Mission FPS to a point in the Mission CS Outfall downstream of the flap gate, where it can be discharged to the river by gravity once more.

In addition to the Mission FPS and Montcalm LS, a small pumping station is located at the Lagimodière Boulevard underpass. This station pumps a small volume of collected runoff from the immediate catchment area into the existing CS network within Mission. A second underpass pumping station is located approximately 100 m north of the Montcalm LS. This second underpass pumping station however pumps the collected runoff into the Red River via a dedicated land drainage sewer (LDS) outfall.

The LDS system within the Mission district is scattered in various locations. Ditches and swales are present throughout the industrial areas of the district and interconnect with the CS system in multiple locations. One major LDS ditch crosses the district from east to west along Dugald Road, called the Dugald Drain. The Dugald Drain extends along the south side of Dugald Road from Murdock Road in the South Transcona area of the city to the St. Boniface Industrial Park across Lagimodière Boulevard and receives surface runoff from a significant part of east Winnipeg. This LDS drains then travels southwest of Dugald, eventually

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[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

discharging into the Seine River just south of Marion Street near Happyland Park. The Dugald Drain receives the majority of its runoff flow from the South Transcona Drainage Basin (AECOM, 2014). The Shell Terminal on Panet Road has a private LDS system that collects all internal storm water from within the Shell boundary. These flows are transferred to the existing CS system at a rate as determined by the City. The LDS systems discharge surface runoff directly to the Seine River with outfalls located at the ends of Guilbault Street, Evans Street, St. Catherine Street, Kavanagh Street, La Verendrye Street, and Dumoulin Street.

Mission district has a single storm relief sewer (SRS) interconnection located at the end of Dumoulin Street that connects the partially separated WWS to an LDS outfall. This interconnection will relieve the WWS if there is a particularly large wet weather response along this wastewater lateral sewer. All combined sewage received in this WWS during a large wet weather response would then discharge into the Seine River via this LDS outfall.

In addition to the main CS outfall, there are a number of secondary CS outfalls located along the Seine River. Each of the secondary CS outfalls act as a high level overflow within the district CS system. These will only operate under high return design storm events, and provide localized relieve to one or more laterals at the far upstream extents of the district. The City has decommissioned the Prosper CS outfall (ID76) and this is no longer operational.

The six CS outfalls to the Red River and Seine River are as follows:

- ID20 (S-MA70016004) – Mission CS Outfall (Seine River)
- ID73 (S-MA70041411) – Plinguet CS Outfall (Seine River)
- ID74 (S-MA70041464) – Cherrier CS Outfall (Seine River)
- ID75 (S-MA70041462) – Doucet CS Outfall (Seine River)
- ID76 (S-MA50002566) – Prosper CS Outfall (Seine River) - decommissioned
- ID78 (S-MA70042084) – Gareau CS Outfall (Seine River)

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Mission and the surrounding districts. Each interconnection is shown in Figure 27 and shows locations where gravity and pumped flow can cross from one district to another. Each interconnection is listed as follows:

1.3.1.1 Interceptor Connections - Downstream of Primary Weir

Roland

- A 600 mm secondary interceptor from Roland flows southbound by gravity into the Mission 600 mm interceptor sewer along Archibald Street towards the Montcalm LS gate/junction chamber. Flow is then pumped across the Red River to the North End Sewage Treatment Plant (NEWPCC) for treatment.
  - Archibald Street and Mission district boundary invert – 223.56 m (S-MA50018054)

Syndicate

- Two 600 mm force mains from the Montcalm LS pumps WWS west of Archibald Street and south of Elmwood Road, across the Red River into Syndicate district secondary interceptor:
  - Invert at Syndicate district boundary CS connection – 227.50 m (S-MH20012321)
  - Invert at Syndicate district boundary CS connection – 227.28 m (S-MH20012321)

1.3.1.2 District Interconnections

Windsor Park

<u>WWS to WWS</u>

- Common high point sanitary sewer manhole:
  - Ormiston Road invert at Windsor Park district boundary – 228.60 m (S-MH50004635)
- A 400 mm WWS force main pumps sewage from Windsor Park into the Mission district along Speers Road where it connects to the CS system:
  - Invert at WWS connection in Mission at the district boundary – 229.82 m (S-MA70020236)

<u>LDS to LDS</u>

- A 375 mm LDS collects surface runoff from Carolyn Bay and Ormiston Road, and crosses into Windsor Park district by gravity. Windsor Park is currently separated, and the LDS from Mission district flows into the LDS system in Windsor Park district:
  - Invert at Mission district boundary – 228.02 m (S-MA50011061)
- A 600 mm LDS collects surface runoff from the northeastern part of Windsor Park flows by gravity eastbound into Mission district. The LDS flows into Mission along and connects as follows:
  - Windsor Park district boundary and Maginot Street Invert – 228.49 m (S-MA70051318)
- A 750 mm LDS extends along Archibald Street from near Maginot Street to the district boundary near Autumnwood Drive. The LDS flows by gravity south on Archibald Street through Windsor Park district, where it is discharged into creeks in Niakwa Park:
  - Invert at Niakwa Park district boundary – 227.63 m (S-MA50009101)

A district interconnection schematic for the district is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing system.

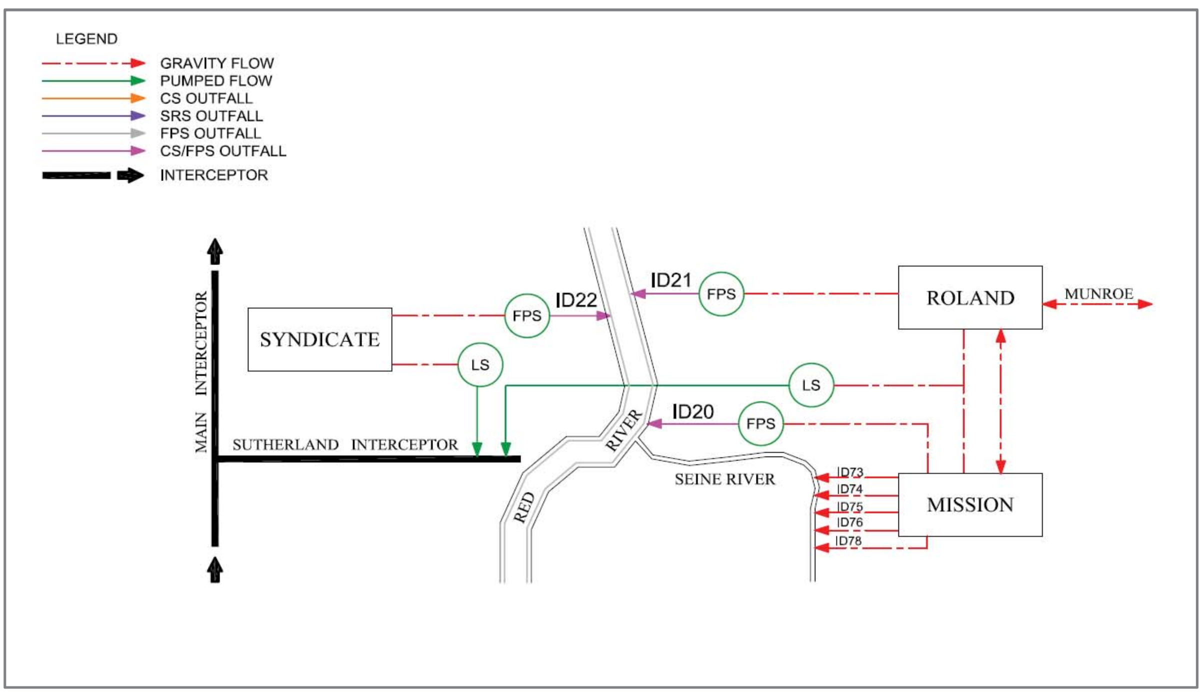


Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 27 and are listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID20)	S-MH70001112.1	S-MA70016004	2600 mm	Seine River Outfall
Flood Pumping Outfall (ID20)	S-MH70001112.1	S-MA70016004	2600 mm	Seine River Outfall
Other Overflows	364X001080.1 364X001013.1 364X001012.1 S-PL50000392.1 S-AC70015634.1	S-MA70041411 S-MA70041464 S-MA70041462 S-MA50002566 S-MA70042084	300 300 300 300 450	Seine River Outfall Seine River Outfall Seine River Outfall Seine River Outfall Seine River Outfall
Main Trunk	N/A	S-MA70019992	1950 x 2950 mm	Egg-shaped Invert: 222.50 m
SRS Outfalls	N/A	N/A	N/A	No SRS outfall within district
SRS Interconnections	S-MH50008095.2	S-MH50008095	227.39 m	SRS Overflow into Seine River. WWS connects to the CS on Archibald Street
Main Trunk Flap Gate	S-TE70026473.2	S-CG00001077	1685 mm	Invert: 222.6 9 m
Main Trunk Sluice Gate	S-CG00001078.1	S-CG00001078	1829 x 1829 mm	Invert: 222.78 m
Off-Take	S-MA-ID-70028467	S-MA70028467	750 mm	Circular Invert: 222.50 m
Dry Well	N/A	N/A	N/A	N/A
Lift Station Total Capacity	S-TE70026535.1 (P1) S-TE70026538.1 (P2) S-TE70026539.1 (P3) S-TE70026537.1 (P4)	N/A	1.037 m^3/s max discharge rate	P1 x 0.192 m^3/s P2 x 0.328 m^3/s P3 x 0.186 m^3/s P4 x 0.331 m^3/s
Lift Station ADWF	N/A	N/A	0.126 m^3/s	Montcalm CS LS includes Roland district. Mission ADWF at 0.110 m^3/s
Lift Station Force Main	North force main S-AC70017214.1 South force main S-AC70017215.1	North force main S-MA70046432 South force main S-MA70046417	600 mm 600 mm	North force main Invert: 221.04 m South force main Invert: 220.90 m
Flood Pump Station Total Capacity	N/A	N/A	2.67 m^3/s (min) 3.12 m^3/s (max)	1 x 0.710 m^3/s 1 x 0.950 m^3/s 1 x 1.010 m^3/s
Pass Forward Flow – First Overflow	N/A	N/A	0.464 m^3/s	

Notes:

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Mission – 223.71
2	Trunk Invert at Off-Take Pipe	222.77
3	Top of Weir	223.76
4	Relief Outfall Invert	N/A
5	Relief Interconnection (S-MH50008095)	227.39
6	Sewer District Interconnection (Windsor Park)	223.20
7	Low Basement	229.03
8	Flood Protection Level	229.39

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent concept design completed in Mission district was the *Mission Combined Sewer District Sewer Relief, Pollution Abatement Works and North East Interceptor Study* (AECOM, 2014). This study provides a report on design work on sewer basement flooding relief and CSO abatement for the Mission CS district, the provision of a land drainage outlets to relieve certain areas in the district, and a review of the Northeast Interceptor service area (AECOM, 2014).

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. Both the Mission and Montcalm outfall structures from the Mission Combined Sewer District were included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations have a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Planned Completion
27 - Mission	2014 - Conceptual	2018 District Flow Monitoring	2013	Planning and Design for Separation	N/A

Source: Report on Mission Combined Sewer District Sewer Relief, Pollution Abatement Works and North East Interceptor Review, 2014

1.5 Ongoing Investment Work

Study and preliminary design of the Mission district is currently underway as a result of the City's Basement Flood Relief program. It is expected that this work will progress as normal and continue through the beginning stages of the CSO Master Plan.

A flow monitoring campaign was commenced over the summer of 2018 to capture current sewer system observed flow data for future hydraulic model calibration.

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Mission district. This consists of monthly site visits in confined entry spaces to verify that physical readings concur with displayed transmitted readings, and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Mission district are listed in Table 1-4. The proposed CSO control projects will include complete sewer separation. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage	Storage / Transport Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	-	-	-	-	-	-	-	✓	✓	✓	-

Notes:- = not included
✓ = included

Mission was previously identified as a priority project as part of the City's Basement Flooding Relief program. The proposed complete sewer separation scheme includes the entire Mission district.

GI and RTC will be applied within each district on a system-wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Sewer Separation

Complete sewer separation is proposed as part as part of the CSO Master Plan. The proposed sewer separation will remove a large volume of land drainage runoff from the CS system, thereby reducing the flow at the outfall and eliminating CSO events under the 1992 representative year. A reduction of the runoff would also reduce the pass forward flow to the interceptor system. Separation would also reduce the amount of flood pumping required at the Mission FPS, potentially allowing for the FPS to be decommissioned in the future.

Work would include the installation of an independent LDS system to separate the surface runoff from the CS system. Collected storm water runoff will be routed through the new LDS system to outfalls along the Seine River.

The 2014 AECOM study, identified in Table 1-3, focused on the basement flooding issues within the Mission district. The study district indicated that complete separation could be achieved through expansion of the proposed land drainage system construction, developed originally for basement flood protection. This sewer separation design would provide basement flood protection under the 10-year MacLaren design storm. The main components of the conceptual LDS system construction proposed in this 2014 study are outlined below:

- Construction of a Plinguet Street LDS outfall proposed, with the upstream system capturing stormwater from the north west portion of the Mission district. This includes the areas surrounding Dawson Road, Archibald Street and Plinguet Street.

- Construction of an outfall structure and upstream system capturing stormwater from the northern portion of the district, collecting the area along Mission Street, west of Plinguet Street, and around Provencher Boulevard within the Mission district.

- Construction of an LDS outfall at Happyland Park immediately south of Marion Street discharging into the Seine River proposed. This outfall would service the southeast portion of the Mission district, beginning at the intersection of Dugald Road and Lagimodiere Boulevard, travelling south along Lagimodiere Boulevard, west along Dawson Road and following Marion Road up to the Seine River as the west boundary. This area is referred to as South Transcona Stormwater Trunk Service Area in the design study.

- Construction of two storm retention basins (SRB); one located southwest of Dawson Road and south of the South Transcona Stormwater Truck collecting stormwater from southeast area of the Mission district. The second pond is proposed to be located in the northeast corner of the district, north of Warman Road and east of the Lagimodiere overpass. This second pond would collect surface runoff flows from the northeast portion of the district including the areas surorunding Mission Street, Softley Road and Warman Road.

The proposed separation scheme outlined in the study focused on partial separation, associated with the existing primary weir level increases and offline storage implementation. This was based on the requirements to achieve a four-overflow target as was defined for the particular study. As the CSO Master Plan has the 85 percent capture target as the long-term goal, the complete separation proposal is now the most cost effective solution to address within the Mission district. Further investigation will be necessary to assess the proposed SRB pond and LDS system arrangement to determine what would be most beneficial to the Mission district.

The flows to be collected after separation will be as follows:

- DWF will remain the same – collected flow pumped from Montcalm CS LS to the interceptor.
- WWF will consist of sanitary sewage combined with foundation drainage from the older residential homes in the district.

This will result in a reduction in combined sewage flow received at the Montcalm CS LS after the separation project is complete. It is proposed that future monitoring of the district is completed to verify that the sewer separation is fully compliant with the goal of elimination of all CSO overflows under the 1992 representative year rainfall conditions. A static weir elevation increase may be necessary at the primary weir to eliminate the occurrence of all CSO events during the 1992 representative year. Any weir elevation raise will be further evaluated in terms of actual flow monitoring data to confirm ensure the existing level of basement flood protection remains.

1.6.3 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district will be reviewed to identify the most applicable GI controls.

Mission has been classified as a medium GI potential district. Land use in Mission is mostly industrial with some residential and commercial. Bioswales and green roofs may be suitable to the industrial areas while cisterns/rain barrels, and rain garden bioretention are suitable for the residential areas. Parking lots located in commercial areas are ideal for paved porous pavement.

1.6.4 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C.

Sewer separation will include the installation of additional sewers that will require inspection, cleaning and rehabilitation. This will result in additional maintenance costs over the long term, but operational costs will be minimal. The existing larger CS pipes within the district may also receive insufficient flow with the separation work for proper scouring velocities in the sewer pipes. This could result in solids settling within the sewers, and requiring more frequent cleaning operations. The impacts of the reduced flows in larger CS pipes will be evaluated as part of the sewer separation design for the district.

The reduction in storm flows entering the Montcalm LS will reduce the requirement for operation of the FPS. It is recommended to continue to maintain and operate the flow monitoring instrumentation and assess the results after district separation work has been completed. This will allow the full understanding of the non-separated storm elements (foundation drain connections to the CS system) extent within the Mission district.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. Two versions of the sewer system model were created and used to measure system performance. The 2013 Baseline model represents the sewer system baseline in the year 2013 and the 2037 Master Plan – Control Option 1 model, which includes the proposed control options in the year 2037. A summary of relevant model data is provided in Table 1-5.

Table 1-5. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	735	384	2,668	16	N/A
2037 Master Plan – Control Option 1	735	127	2,668	12	SEP

Notes:

Total area is based on the model subcatchment boundaries for the district.
SEP = Sewer Separation

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district. While this district is to be separated and as a result Clause 8 of Licence No. 3042 will not be in effect, the wet weather response of the district overall will still need to be assessed.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City Of Winnipeg GIS Records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-6 are for the hydraulic model simulations using the year-round 1992 representative year. This table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options, Table 1-6 also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-6. District Performance Summary – Control Option 1

Control Option	Preliminary Proposal	Master Plan			
	Annual Overflow Volume (m^3)	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow
Baseline (2013)	19,567	12,809	-	6	0.464 m^3/s [a]
Separation	0	0	12,809	0	0.434 m^3/s [b]
Control Option 1	**0**	**0**	**12,809**	**0**	**0.434 m^3/s [b]**

[a] Pass forward flows assessed with the 1-year design rainfall event

[b] Pass forward flows assessed with the 5-year design rainfall event

The percent capture performance measure is not included in Table 1-6, as it is applicable to the entire CS system and not for each district individually. However, the proposed elimination of CSO overflow results in 100 percent capture at this district.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-7. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-7. District Cost Estimate – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenanc e Cost	2019 Total Operations and Maintenance Cost (Over 35-year period)
Separation	N/A [a]	$130,320,000	$77,000	$1,660,000
Subtotal	N/A [a]	**$130,320,000**	**$77,000**	**$1,660,000**
Opportunities	N/A	$13,030,000	$8,000	$170,000
District Total	**N/A [a]**	**$143,350,000**	**$85,000**	**$1,830,000**

[a] Sewer Separation not included in the Preliminary Proposal 2015 costing. Solution developed as refinement to Preliminary Proposal work following submission of Preliminary Proposal costs. Costs for the Sewer Separation item of work found to be $77,070,000 in 2014 dollars.

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional cost for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014 dollar values.

- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019 dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-8.

Table 1-8. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Sewer Separation	Sewer Separation was not included in the preliminary estimate.	Sewer separation added as Master Plan solution.
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation	Preliminary estimates were based on 2014-dollar values	

1.10 Meeting Future Performance Targets

The proposed complete separation of the Mission district will achieve the 100 percent capture figure and no further work will be required in this district to meet the future performance target.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed as part of the CSO Master Plan and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-9.

Table 1-9. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	-	-	-	O	-	-	-
2	Existing Lift Station	-	-	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	O	-	-	-
4	Construction Disruption	-	-	-	-	R	-	-	-
5	Implementation Schedule	-	-	-	-	R	-	R	-
6	Sewer Condition	-	-	-	-	-	-	-	-
7	Sewer Conflicts	-	-	-	-	R	-	-	-
8	Program Cost	-	-	-	-	R	-	-	-
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	-	-	-	-	O	O	O	-
12	Operations and Maintenance	-	-	-	-	R / O	R	O	-
13	Volume Capture Performance	-	-	-	-	-	O	O	-
14	Treatment	-	-	-	-	O	O	O	-

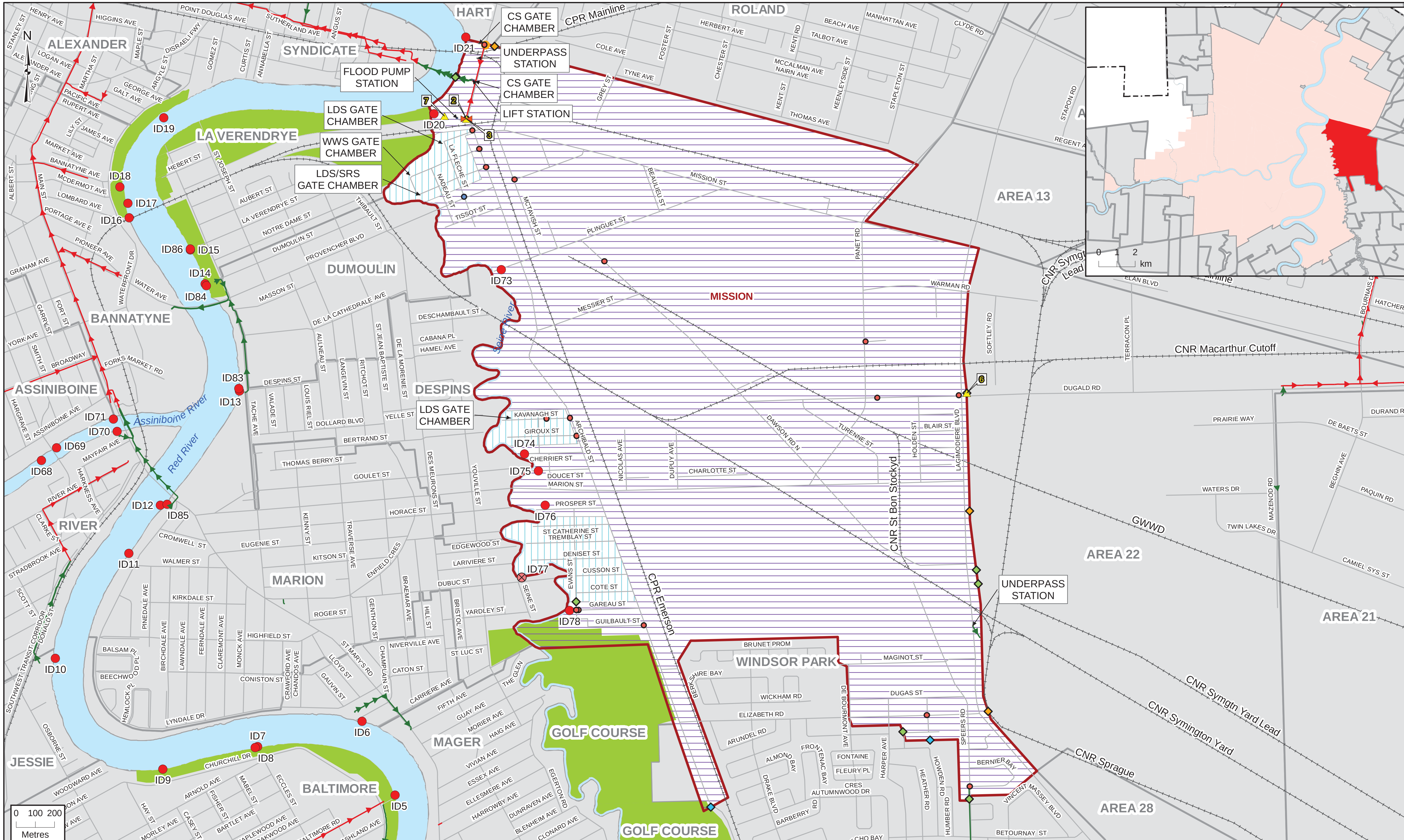
Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

AECOM. 2014. *Mission Combined Sewer District Sewer Relief Pollution Abatement Works and North East Interceptor Study*. August.

City of Winnipeg. 2017. *Marion Dugald Transportation Improvement Study Engagement Planning Summary Report*. September. Accessed August 15, 2018. https://www.winnipeg.ca/publicworks/construction/projects/MarionDugald.stm.

City of Winnipeg. 2018. *Eastern Corridor Study*. Accessed August 15, 2018. http://winnipegtransit.com/en/major-projects/rapid-transit/eastern-corridor-study/.



LEGEND

- Primary Weir
- Critical Elevation
- Decommissioned Outfall
- CSO Outfall
- Low CS Manhole

Inter-System Connection
- CS - WWS
- SRS - CS

District Boundary Crossing
- CS
- LDS
- WWS

- Interceptor Sewer
- Force Main
- Street
- Railway

- District Boundary
- Watercourse
- Greenspace

CSO MASTER PLAN PROPOSED SOLUTIONS
- Sewer Separation - Planning
- Sewer Separation - Complete

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 27
District Overview Map
Sewer District: Mission
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Moorgate District Plan

August 2019

City of Winnipeg

CSO Master Plan

Project No:	470010CH
Document Title:	Moorgate District Plan
Revision:	03
Date:	August 15, 2019
Client Name:	City of Winnipeg
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0	08/2018	DRAFT for City Comment	SG	ES	
1	12/2018	DRAFT 2 for City Review	JT	SG / MF	
2	06/2019	Final Draft Submission	JT	MF	SG
3	08/15/2019	Final Submission For CSO Master Plan	MF	MF	MF

Contents

Table(s)

Figure(s)

1. Moorgate District

1.1 District Description

Moorgate district is located near the western border of the combined sewer (CS) area and is bounded by Strathmillan district to the west, Ferry Road and Douglas Park districts to the east, and the Winnipeg Airport lands to the north. Ness Avenue and Silver Avenue make up the northern border, Davidson Street forms the western border, and Linwood Street forms the eastern border. The Assiniboine River is located along the southern border. Figure 28 provides an overview of the sewer district and the location of the proposed Combined Sewer Overflow (CSO) Master Plan control options.

Portage Avenue is a major transportation route that passes through Moorgate district along the south border and parallel to the Assiniboine River. Ness Avenue is also a highly travelled route that connects to Portage Avenue via numerous north-south streets.

Land use in Moorgate is mostly single-family residential. Portage Avenue corridor includes a mix of apartments and commercial businesses. The Assiniboine Golf Club is located along the northern edge and the Deer Lodge Centre is located just north of Portage Avenue. Approximately 34 ha of the district is classified as greenspace which includes multiple parcels spread throughout the district. Development in the eastern portion of the district occurred prior to 1925 with other developments added towards the west boundary up to the 1950s. Canadian Forces Base Winnipeg is located to the north of the district.

1.2 Development Potential

A portion of Portage Avenue is located within the Moorgate District. Portage Avenue is identified as Regional Mixed Use Corridor as part of the OurWinnipeg future development plans. As such, focused intensification along Portage Avenue is to be promoted in the future.

1.3 Existing Sewer System

Moorgate district has a drainage area of approximately 190 hectares (ha)[1] based on the district boundary. The system consists of a CS system and a land drainage sewer (LDS) system. Approximately 29 percent (56 ha) is separated and 2 percent (3 ha) identifiable as separation ready. Storm relief sewers (SRSs) are installed on Lodge Avenue, Ness Avenue, Conway Street, and Sharp Boulevard. Two LDS outfalls are located south of Portage Avenue and discharge to the Assiniboine River. The LDS system also connects into the CS outfall close to the western border, off Portage Avenue.

The CS system includes a diversion structure, lift station and one CS outfall. The CS system drains towards the Moorgate outfall and diversion chamber, located at the southern end of Conway Street at the Assiniboine River. At the outfall, flow is either diverted to the Conway CS lift station (LS) where it is pumped to the St James Interceptor or overflows the diversion weir into the Assiniboine River.

A 1900 mm by 2475 mm egg-shaped trunk sewer running along Moorgate Street collects flow from throughout the district. It connects to a 1900 mm by 2475 mm egg-shaped trunk sewer at the corner of Moorgate Street and Portage Avenue which flows into the outfall.

There is a separate LDS system in the southeast part of district along Portage Avenue and Mandeville Street. This LDS system collects flow and directs it to three LDS outfalls along the Assiniboine River. The areas along Lodge Avenue and Mount Royal Road contain a separate LDS system. The Lodge Avenue

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

LDS collects runoff from the road and conveys it to the adjacent Strathmillan district and ultimately to the Strathmillan CS outfall, which is a combined CS/LDS outfall.

During dry weather flow (DWF), the existing weir diverts flow through a 525 mm off-take to the Conway CS LS, where it is pumped through the 250-mm force main to the 375 mm St. James interceptor that takes the wastewater to the West End Sewage Treatment Plant (WEWPCC) for treatment. The Conway CS LS also receives wastewater from the Assiniboine Park Zoo. During wet weather flow (WWF) the weir may be overtopped, and WWF can bypass to the CS outfall into the Assiniboine River.

The CS outfall to the Assiniboine River is as follows:

- ID43 (S-MA70016333) – Moorgate CS Outfall

1.3.1 District-to-District Interconnections

There are five district-to-district interconnections between Moorgate and Strathmillan to the west. Each interconnection is shown in Figure 28 and shows locations of gravity and pumped flow from one district to another. The known district-to-district interconnections are identified as follows:

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

Strathmillan

- The 375 mm interceptor pipe conveys flow from the Conway CS LS along Portage Avenue through Strathmillan district, and then to WEWPCC:
  - Portage Avenue and Conway Street invert at Strathmillan district boundary – 232.98 m

1.3.1.2 District Interconnections

Strathmillan

<u>LDS to LDS</u>

- A 750 mm LDS trunk conveys flow to connect into the LDS system in Strathmillan on the eastern end of Lodge Avenue before Strathmillan Street that flows into the Strathmillan CS Outfall:
  - Lodge Avenue and Davidson Street invert at Strathmillan district boundary – 231.53 m
- A 450 mm LDS trunk conveys flow to connect into the LDS system in Strathmillan on the eastern end of Bruce Avenue before Strathmillan Street that flows into the Strathmillan CS Outfall:
  - Bruce Avenue invert at Strathmillan district boundary – 232.55 m
- A 450 mm LDS trunk conveys flow into Moorgate District on Mount Royal Road, this then flows into the Strathmillan CS Outfall:
  - Mount Royal Road and Traill Avenue invert at Strathmillan district boundary – 233.16 m

Assiniboine Park

<u>Wastewater Sewer (WWS) to CS</u>

- A 250 mm WWS pipe uses gravity to convey flow from Assiniboine Park zoo to Moorgate district to Conway gate chamber then out the outfall
  - To Conway Street from Assiniboine Park invert at district boundary – 223.96 m

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing system.

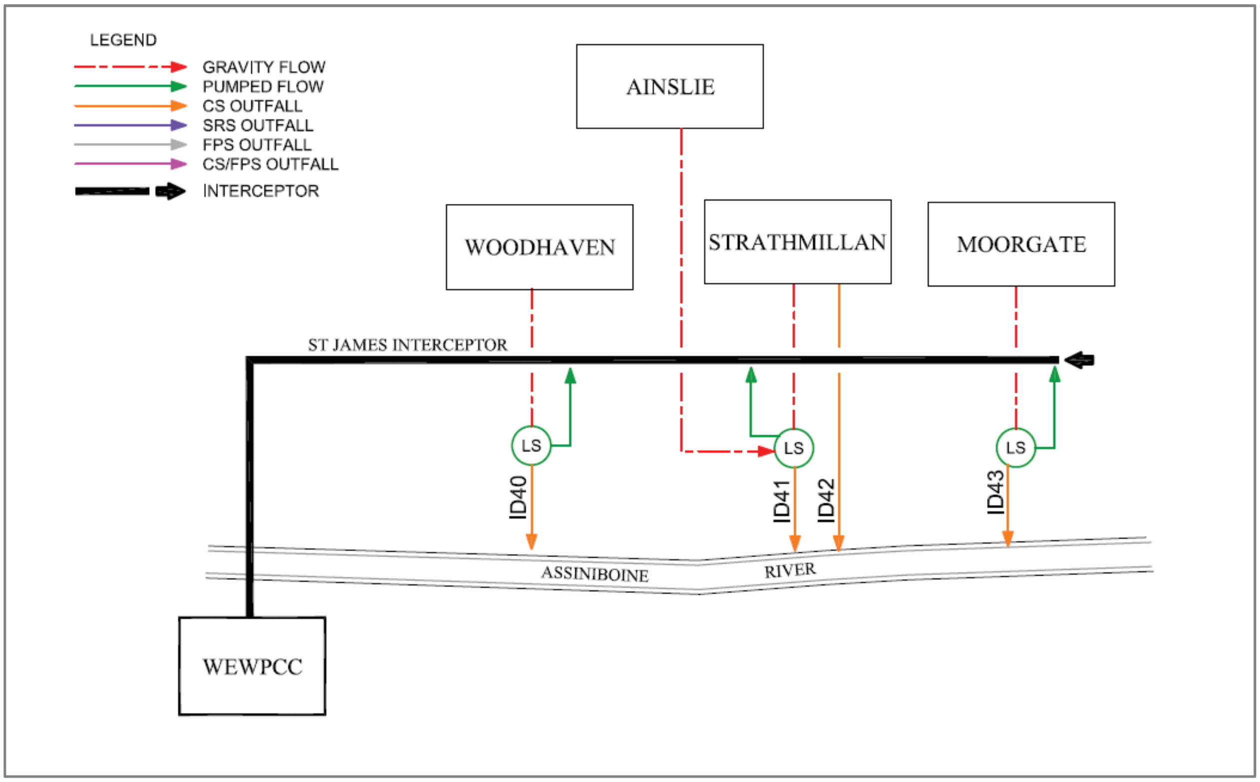

Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 28 and are listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID43)	S-RE70015578.1	S-MA70016333	1830 mm	Invert: 226 m
Flood Pumping Outfall (ID87)	N/A	N/A	N/A	
Other Overflows	N/A	N/A	N/A	
Main Sewer Trunk	S-MH20004697.1	S-MA70019493	1930 x 2515 mm	Egg-shaped Invert: 226.71 m
Storm Relief Sewer Outfalls	N/A	N/A	N/A	
Storm Relief Sewer Interconnections	N/A	S-MH20004697 S-MH70019502 S-MH70021238 S-MH70022308 S-TE70021263 S-TE70021285	233.25 231.37 229.48 228.63 228.06 228.86	SRS -CS SRS -CS SRS -CS SRS -CS SRS -CS SRS -CS
Main Trunk Flap Gate	Moorgate_Weir.1	S-CG00000722	1800 mm	Circular Invert: 227.41 m
Main Trunk Sluice Gate	S-CS00000677.1	S-MA70019487	1980 x 2590 mm	Invert: 227.25 m
Off-Take	S-MH20004694.2	S-MA70019465	525 mm	Circular Invert 226.71 m
Dry Well	N/A	N/A	N/A	
Lift Station Total Capacity	N/A	N/A	0.136 m^3/s	2 pumps @ 0.068 m^3/s each

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Lift Station ADWF	N/A	N/A	0.023 m^3/s	
Lift Station Force Main	S-MA70017371A.1	S-MA70017371	250 mm	Discharge Invert 226.73 m
Flood Pump Station Total Capacity	N/A	N/A	N/A	
Pass Forward Flow – First Overflow	N/A	N/A	0.141 m^3/s	

Notes:

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Moorgate – 225.24
2	Trunk Invert at Off-Take	226.71
3	Top of Weir	227.41
4	Relief Outfall Invert	N/A
5	Relief Interconnection	N/A
6	Sewer District Interconnection at Strathmillan	Invert at district boundary: 28-02 = 231.53
7	Low Basement	230.43
8	Flood Protection Level	230.98

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study was the *Sewer Relief and CSO Abatement Study* (UMA, 2005). It describes the CSO abatement alternatives and sewer relief implications for both Strathmillan and Moorgate CS districts.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Moorgate CS district was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations has a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Expected Completion
28 - Moorgate	2005 - Conceptual	Future Work	2013	Partial Separation Work Complete	N/A

Source: Sewer Relief and CSO Abatement Study, 2005

1.5 Ongoing Investment Work

There is ongoing maintenance and calibration of permanent instruments installed within the primary Moorgate outfall. This consists of monthly site visits in confined entry spaces to verify that physical readings concur with displayed transmitted readings and replacing desiccants when necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Moorgate sewer district are listed in Table 1-4. The proposed CSO control projects will include sewer separation, in-line storage with screening, and floatable management. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage	Storage / Transport Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	-	-	-	✓	✓	-	-	-	✓	✓	✓

Notes:- = not included
✓ = included

The existing CS system is suitable for use as in-line storage. This option would take advantage of the existing pipe networks for additional storage volume. Existing DWF from the collection system will remain the same, and overall district operations will remain the same. A review of the existing separation extent and potential remaining district separation requirement indicated a significant capital cost to reach district separation and this option was not taken forward to achieve the system wide 85 percent capture target.

All primary overflow locations are to be screened under the current CSO control plan. Installation of a control gate will be required for the screen operation, and it will provide the mechanism for capture of the in-line storage.

Floatable control will be necessary to capture floatables in the sewage. Floatables will be captured with all implemented control options to some extent, but screening may be added as required to reach the desired level of capture.

GI and RTC will be applied within each district on a system wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design. RTC is not included in detail within each plan and is described further in Section 3 of Part 3A.

1.6.2 In-Line Storage

In-line storage has been proposed as a CSO control for Moorgate district. The in-line storage will require the installation of a control gate at the CS outfall. The gate will increase the storage level in the existing CS to provide an overall higher volume capture and provide additional hydraulic head for screening operations.

A standard design was assumed for the control gate, as described in Part 3C. A standard approach was used for conceptual gate sizing by assuming it to be the lesser of the height of half of the site-specific trunk diameter or the maximum height of the gate available. The design criteria for in-line storage are listed in Table 1-5.

Table 1-5. In-Line Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	226.71 m	N/A
Trunk Diameter	1930 x 2515 mm	Egg-shaped
Gate Height	0.58 m	Gate height based on half trunk diameter assumption
Top of Gate Elevation	227.99 m	N/A
Bypass Weir Elevation	227.89 m	N/A
Maximum Storage Volume	633 m^3	N/A
Nominal Dewatering Rate	0.136 m^3/s	Based on existing CS LS capacity
RTC Operational Rate	TBD	Future RTC / dewatering review on performance

The proposed control gate will cause combined sewage to back-up in the collection system to the extent shown on Figure 28. The extent of the in-line storage and volume is related to the top elevation of the bypass side weir. The level of the top of the bypass side weir and adjacent control gate level are determined in relation to the critical performance levels in the system for basement flooding protection: when the system level increases above the bypass weir crest and proceeds above the top of the control gate during high flow events, the gate drops out of the way. At this point, the district will only provide its original interception capacity via the primary weir for the district, and all excess CS would flow over the weir and discharge to the river. After the sewer levels in the system drops back below the bypass side weir critical performance level, the control gate moves back to its original position to capture the receding limb of the WWF event. The CS LS will continue with its current operation while the control gate is in either position, with all DWF being diverted to the CS LS and pumped. The CS LS will further dewater the in-line storage provided during a WWF event as downstream capacity becomes available.

Figure 28-01 provides an overview of the conceptual location and configuration of the control gate, bypass weir and screening chambers. The proposed control gate will be installed in a new chamber within the existing trunk sewer alignment near the existing CS LS. The dimensions of the chamber will be 6 m in length and 3.2 m in width to accommodate the gate, with an allowance for a longitudinal overflow weir. DWF will continue to be diverted to the lift station through the off-take pipe and pumped through the 250-mm force main into the 375-mm interceptor pipe. This flows through Strathmillan and eventually to the WEWPCC for treatment. Further optimization of the gate chamber size may be provided if a decision is made not to include screening.

The physical requirements for the off-take and station sizing for a modification to pumping capacity have not been considered in detail, but they may be required in the future as part of an RTC program or CS LS rehabilitation or replacement project. The proposed gate chamber (also the screening chamber) are within the existing City of Winnipeg Right-Of-Way (ROW) associated with the existing CS LS and CS outfall. The location is such that residential properties border both side of the site with Portage Avenue as the north limit of the City ROW. Construction work could potentially affect the traffic on this main route and cause disruptions. The existing sewer configuration including construction of an additional off-take may have to be completed to accommodate the new control gate chamber. This will be confirmed in future design assessments

The nominal rate for dewatering is set at the existing CS LS capacity. The dewatering rate includes both the DWF and WWF components of the district flows. This allows dewatering through the existing interceptor system within 24 hours following the runoff event, allowing it to recover in time for a subsequent event. Any future considerations, for RTC improvements, would be completed with spatial rainfall as any reduction to the existing capacity for large events will adversely affect the overflows at this district. This future RTC control will provide the ability to capture and treat more volume for localized storms by using either district in-line storage or excess interceptor capacity where the runoff volume is less. Further assessment of the impact of the RTC and future dewatering arrangement will be necessary to review the downstream impacts (i.e., on Strathmillan district).

1.6.3 Floatables Management

Floatables management will require installation of a screening system to capture floatable materials. The off-line screens will be proposed to maintain the current level of basement flooding protection.

The type and size of screens depend on the specific station configuration and the hydraulic head available for operation. A standard design was assumed for screening and is described in Part 3C. The design criteria for screening, with an in-line control gate implemented, are listed in Table 1-6.

Table 1-6. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Top of Gate	227.99 m	
Bypass Weir Crest	227.89	
Normal Summer River Level	225.24 m	
Maximum Screen Head	2.65 m	
Peak Screening Rate	0.59 m^3/s	
Screen Size	1.5 m wide x 1 m high	Modelled Screen Size

The proposed side bypass overflow weir and screening chamber will be located adjacent to the proposed control gate and existing CS trunk, as shown on Figure 28-01. The screens will operate once levels within the sewer surpass the bypass weir elevation. The side bypass weir upstream of the gate will direct initial overflow to the screens located in the new screening chamber, with screened flow discharged to the downstream side of the gate to the river. The screening chamber may include screenings pumps with a discharge returning the screened material to the CS LS for routing to the WEWPCC for removal. The provision of screening pumps is dependent on final level assessment within the existing infrastructure and the Moorgate trunk. This will be confirmed during the future assessment stage.

The dimensions for the screen chamber to accommodate influent from the side weir, the screen area, and the routing of the discharge piping downstream of the gate are 3.5 m in length and 2.5 m in width. The existing sewer configuration including the off-take and the CS LS force main may have to be modified to accommodate the new chamber.

1.6.4 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district was reviewed to identify the most applicable GI controls.

Moorgate has been classified as a high GI potential district. Land use in Moorgate is mostly single-family residential. Portage Avenue corridor includes a mix of apartments and commercial businesses. This means the district would be an ideal location for bioswales, permeable paved roadways, cisterns/rain barrels, and rain gardens. The flat roof commercial buildings along Portage Avenue make would be an ideal location for green roofs.

1.6.5 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the report.

In-line storage will impact the existing sewer and will require the addition of a new chamber and a moving gate at the outfall. In-line storage dewatering will be controlled with the existing Conway CS LS, which may require more frequent and longer duration pump run times. Lower velocities in the CS trunks may create additional debris deposition and require more frequent cleaning. Additional system monitoring and level controls will be installed, which will require regular scheduled maintenance.

Floatable control with outfall screening will require the addition of another chamber with screening equipment installed. The chamber will be installed adjacent to the control gate chamber and will operate in conjunction with it. Screening operation will occur during WWF events that surpass the in-line storage control level. WWF will be directed from the main CS trunk, over the side weir in the control gate chamber and through the screens to discharge into the river. The screens will operate intermittently during wet weather events and will likely require operations review and maintenance after each event. The screenings pumped back to the interception system via a small pump and force main may be required. Additional maintenance for the pumps will be required at regular intervals in line with typical list station maintenance and after screening event. The frequency of a screened event will correlate to the number overflows identified for the district.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. Two versions of the sewer system model were created and used to measure system performance. The 2013 Baseline model represents the sewer system baseline in the year 2013 and the 2037 Master Plan – Control Option 1 model, which includes the proposed control options in the year 2037. A summary of relevant model data is provided in Table 1-7.

Table 1-7. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	195	195	5,311	37	N/A
2037 Master Plan – Control Option 1	195	195	5,311	37	IS, SC

Notes:

IS – In-line Storage

SC – Screening

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System and in Section 1.8 performance Estimate may occur.

The performance results listed in Table 1-8 are for the hydraulic model simulations using the year-round 1992 representative year. The table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. The table also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-8. Performance Summary – Control Option 1

Control Option	Preliminary Proposal Annual Overflow Volume (m^3)	Master Plan Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [a]
Baseline (2013)	65,328	64,937	-	20	0.157 m^3/s
In-line Storage	68,104	57,419 [b]	7,515	18	0.160 m^3/s
Control Option 1	**68,104**	**57,419 [b]**	**7,515**	**18**	**0.160 m^3/s**

[a] Pass forward flows assessed on the 1-year design rainfall event

b The benefit for this district is offset due to a modelled increase of overflow volume in the downstream Strathmillan district. Therefore, the proposed control option for this district should be programmed for after the Strathmillan control option construction.

The percent capture performance measure is not included in Table 1-8, as it is applicable to the entire CS system and not for each district individually.

1.9 Cost Estimates

The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-9. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-9. District Cost Estimate – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance (Over 35-year period)
In-Line Storage	N/A[a b]	$2,590,000	$40,000	$940,000
Screens		$2,450,000 [c]	$50,000	$1,100,000
Subtotal	**N/A**	**$5,040,000**	**$90,000**	**$2,040,000**
Opportunities	N/A	$500,000	$10,000	$200,000
District Total	**N/A**	**$5,540,000**	**$100,000**	**$2,240,000**

[a] Screening and In-line not included in the Preliminary Proposal 2015 costing

[b] Solution developed as refinement to Preliminary Proposal work following submission of Preliminary Proposal costs. Costs for this item of work to be $3,050,000 in 2014 dollars.

[c] Cost for bespoke screenings return pump/force main not included in Master Plan as well depend on selection of screen and type of screening return system selected

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional costs for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014-dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019-dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-10.

Table 1-10. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Control Gate	A control gate was not included in the Preliminary Proposal estimate	
	Screening	Screening was not included in the Preliminary Proposal estimate	
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management Approach	
Cost Escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation	Preliminary Proposal estimates were based on 2014-dollar values.	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, the future performance target is 98 percent capture for the representative year measured on a system-wide basis. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-11 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified for Control Option 1.

Overall the Moorgate district would be classified as a low potential for implementation of complete sewer separation as the only feasible approach to achieve the 98 percent capture future performance target in the representative year. However, opportunistic sewer separation within a portion of the district may be completed in conjunction with other major infrastructure work to address future performance targets. In addition, green infrastructure and off-line tank or tunnel storage may be utilized in key locations to provide additional storage and increase capture volume.

Table 1-11. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Opportunistic Separation Increased use of GI • Off-line Tank / Tunnel Storage

The control options selected for the Moorgate district has been aligned for the 85 percent capture performance target based on the system wide basis, and the requirement for screening at all primary outfalls. The proposed solutions in the Moorgate district are influenced by the downstream Strathmillan district and these two districts should be assessed together. The expandability of the district to the future performance target will be restricted depending on the interaction of the system wide performance.

The cost for upgrading to meet an enhanced performance target depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-12.

Table 1-12. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	R	-	-	-	-	-	-
2	Existing Lift Station	-	R	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	-	-	-	-
4	Construction Disruption	-	-	-	-	-	-	-	-
5	Implementation Schedule	-	-	-	-	-	-	R	-

Table 1-12. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
6	Sewer Condition	-	R	-	-	-	-	-	-
7	Sewer Conflicts	-	R	-	-	-	-	-	-
8	Program Cost	-	O	-	-	-	-	-	O
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	-	-	-	-	-	O	O	-
12	Operations and Maintenance	-	R	-	-	-	R	O	R
13	Volume Capture Performance	-	O	-	-	-	O	O	-
14	Treatment	-	R	-	-	-	O	O	R

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

UMA Engineering Ltd. (UMA). 2005. *Sewer Relief and CSO Abatement Study*. Prepared for City of Winnipeg, Water and Waste Department. August

LEGEND

- Primary Weir
- Critical Elevation
- Decommissioned Outfall
- CSO Outfall
- Low CS Manhole

Inter-System Connection
- CS - LDS
- CS - WWS
- SRS - CS

District Boundary Crossing
- CS
- LDS
- WWS

- Interceptor Sewer
- Force Main
- Street
- District Boundary
- Watercourse
- Greenspace

CSO MASTER PLAN PROPOSED SOLUTIONS

- Proposed Control Gate
- Extent of In-line Storage
- Sewer Separation - Complete

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 28
District Overview Map
Sewer District: Moorgate
City of Winnipeg
Combined Sewer Overflow Master Plan

LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Manhole
- Flap Gate
- Pump Location
- Force Main
- Sewer By Type
  - CS
  - SRS
  - WWS
- Control Structure Type
  - Gate Chamber
- Pump Station Type
  - Lift Station

CSO MASTER PLAN PROPOSED SOLUTIONS

- Control Gate
- Screening

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 28-01
Control Gate and Screening
Sewer District: Moorgate
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Munroe District Plan

August 2019

City of Winnipeg

CSO Master Plan

Project No: 470010CH
Document Title: Munroe District Plan
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0	10/05/2018	Version 1 Draft	DT	SG	
1	05/2019	DRAFT 2 for City Review	JT	SG/JB/MF	
2	08/19/2019	Final Draft Submission	MF	MF	MF
3	08/20/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

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1. Munroe District

1.1 District Description

Munroe district is located in the northeastern sector of the combined sewer (CS) area east of the Red River, north of the Hart and Roland districts and south of the Munroe Annex and Linden districts. Munroe is approximately bounded by Harbison Avenue, Kent Road, and Clyde Road to the south, the Red River to the west, Concordia Avenue and Chelsea Avenue to the north, and Panet Road and Molson Street to the east. Figure 29 provides an overview of the sewer district and the location of the proposed Combined Sewer Overflow (CSO) Master Plan control options.

The majority of the Munroe district land use is residential with portions of commercial and manufacturing. The residential area is mainly single-family homes with some multi-family dwellings located east of the Canadian Pacific Railway (CPR) tracks along Molson Street. An area of light manufacturing is located between Watt Street and Raleigh Street. The few commercial parcels in the district are scattered within residential neighbourhoods.

The CPR Mainline passes through the southeast end of Munroe district. Henderson Highway and Gateway Road, both running in a north-south direction, are regional roadways in the district. Other main transportation routes include Raleigh Street, Watt Street, Roch Street, Grey Street, and London Street in a north-south direction and Munroe Avenue, Washington Avenue, Trent Avenue, and Ottawa Avenue in the east-west direction.

1.2 Development

A portion of Henderson Highway is located within the Munroe District. This street is identified as a Regional Mixed Use Corridor as part of the OurWinnipeg future development plans. As such, focused intensification along Henderson Highway is to be promoted in the future.

There are areas within the Munroe CS district which have been identified as a General Manufacturing Lands as part of OurWinnipeg. Focused intensification within these areas is to be promoted in the future, with a particular focus on mixed use development. This is to verify that adequate employment lands are available to support future population growth.

1.3 Existing Sewer System

Munroe district has an approximate area of 400 ha[1] based on the GIS district boundary information and includes a CS system, a storm relief sewer (SRS) system, and a few areas with a land drainage sewer (LDS) system. There is approximately 3 percent (11 ha) already separated and 1 percent (6 ha) identifiable as separation-ready. Approximately 31 ha of the district is classified as greenspace, which includes multiple parcels spread throughout the district.

The CS system includes a diversion structure and one CS outfall. The CS system flows towards the Munroe outfall and diversion structure, located near the intersection Munroe Avenue and Henderson Highway near the Red River. At the outfall, sewage may be passed forward by a gravity siphon across the Red River to the Polson district or overflow the diversion weir and discharge into the Red River via the CS outfall.

A single sewer trunk collects flow from most of the district and flows to the diversion chamber on Munroe Avenue. The 2150 mm by 3150 mm egg-shaped CS trunk extends east to west primarily along Munroe Avenue, from Panet Street at the east limit to Henderson Highway as the west limit. Multiple secondary

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System and in Section 1.8 Performance Estimate may occur.

sewers connect to the CS trunk along Munroe Avenue, collecting and discharging flows from the north and south to service the district.

The SRS system extends throughout the district and has multiple interconnections with the CS system. During runoff events, the SRS system provides relief to the CS system in Munroe district. Except for the Bredin Drive SRS, the majority of the SRS system provides extra capacity during high flow events such that the CS system can overflow into the SRS. When CS capacity is regained, the SRS drains back into the CS system. Most catch basins are still connected to the CS system, so partial separation has not been completed through the majority of the district. A small portion of the SRS system at Bredin Drive is connected a separate, dedicated SRS outfall which provides an overflow relief to the local CS and discharges directly to the Red River. A flap gate and sluice gate are installed on this outfall pipe to control backflow into the SRS system under high river level conditions in the Red River.

The LDS system for the district is located in small localized areas in the district along Raleigh Street and Melbourne Avenue. The Raleigh Street LDS collects runoff from the road and conveys it to the CS system in the Munroe district. The Melbourne Avenue LDS is an extension of the separation completed in the Linden district. This LDS collects runoff from the road and directs it to the Linden LDS system.

During dry weather flow (DWF), the SRS is not required; sanitary sewage flows are intercepted by the primary weir in the diversion structure to a siphon river crossing. This siphon river crossing allows the intercepted sewage to crosses the Red River under pressure, and flows into Polson district eventually tying into the Main Interceptor. From this point the intercepted sewage from the Munroe district flows by gravity to the North End Sewage Treatment Plant (NEWPCC) for treatment.

During wet weather flow (WWF), any flows that exceeds the diversion capacity overtops the primary weir is discharged by gravity to the Red River through the Munroe CS outfall. Sluice and flap gates are installed on the CS outfall to prevent back-up of the Red River into the CS system under high river level conditions. However not only does the flap gate prevent river water intrusion, but it also prevents gravity discharge from the Munroe CS outfall. There is no dedicated flood pumping station (FPS) within this outfall, and so temporary flood pumps are installed in the Munroe CS outfall based on the flood manual high river level triggers to deal with situations such as this.

The two outfalls to the Red River (one CS and one SRS) are as follows:

- ID31 (S-MA70017186) – Munroe CS Outfall
- ID29 (S-MA40005212) – Bredin SRS Outfall

1.3.1 District-to-District Interconnections

There are several sewer system interconnections between this district and the adjacent districts; see Figure 29. Interconnections include gravity and pumped flow from one district to the other. The known district-to-district interconnections are identified as follows:

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

Polson

- One 300 mm WWS siphon river pipe and one 450 mm WWS siphon river pipe carry flow west by gravity from the Munroe diversion structure, across the Red River into the Polson district:
  - 300 mm WWS sewer invert at Polson district boundary 222.5 m (S-MA70017147)
  - 450 mm WWS sewer invert at Polson district boundary 222.5 m (S-MA70017149)

1.3.1.3 District Interconnections

Roland

SRS to SRS

- A 375 mm SRS relieves a 600 mm CS sewer located off Keenleyside Street in Munroe District and flows by gravity south to Kent Road into Roland District SRS System:
  - Invert at Munroe district boundary 226.24 m (S-MA40010345)
- A 2900 mm SRS flows by gravity south along Besant Street and crosses into Roland district at Molson Street:
  - Invert at Munroe district boundary 223.31 m (S-MA40007633)
- A 375 mm SRS flows by gravity south on London Street and crosses into the Roland district:
  - Invert at Roland district boundary 224.34 m (S-MA40007675)
- A 2900 mm SRS flows by gravity south along Gateway Road into the Roland district:
  - Invert at Roland district boundary 222.76 m (S-MA40008399)
- A 525 mm SRS flows by gravity south along Grey Street from Munroe district to Roland district:
  - Invert at Munroe district boundary 224.50 m (S-MA40007593)

Linden

The CS and LDS systems between the Munroe and Linden districts interact at several locations:

CS to CS

- A 250 mm CS can overflow by gravity east on Canterbury Place into Munroe district from Linden district:
  - Invert at Linden district boundary – 230.00 m (S-MA70099421)
- High point manhole
  - 300 mm CS at Kildonan Drive – 227.18 m (S-MH40006295)

LDS to LDS

- A 450 mm LDS flows by gravity north on Brazier Street from Munroe district into Linden district:
  - Invert at Munroe district boundary – 225.93 m (S-MA40005084)
- A 2250 mm LDS truck flows by gravity west on Chelsea Avenue at Henderson Highway from Linden district into Munroe district:
  - Invert at Munroe district boundary 222.09 m (S-MA40006395)
- A 2250 mm LDS trunk flows by gravity west on Chelsea Place at Kildonan Drive from Munroe district into Linden district:
  - Invert at Linden district boundary 221.94 m (S-MA40006935)
- A 300 mm LDS flows by gravity north on Kildonan Drive from Munroe district into Linden district:
  - Invert at Linden district boundary – 224.53 m (S-MA40006870)
- A 250 mm LDS flows by gravity west on Canterbury Place from Munroe district into Linden district:
  - Invert at Linden district boundary – 224.59 m (S-MA40006869)

Munroe Annex

<u>CS to CS</u>

- A 300 mm CS pipe flows south by gravity on Gateway Road to the Munroe district:
  - Invert at Munroe district boundary 227.35 m (S-MA40004574)
- A 900 mm CS pipe flows south by gravity on Golspie Street to the CS trunk on Munroe Avenue in the Munroe district:
  - Invert at Munroe district boundary 225.11 m (S-MA40004336)
- A 1200 mm CS pipe flows south by gravity on Watt Street to the CS trunk on Munroe Avenue in the Munroe district:
  - Invert at Munroe district boundary 224.74 m (S-MA40005030)
- A 375 mm CS pipe flows south by gravity on Roch Street to the CS trunk on Munroe Avenue in the Munroe district:
  - Invert at –Munroe Annex district boundary 226.57 m (S-MA40005099)

<u>WWS to CS</u>

- A 300 mm WWS pipe flows south by gravity on Moncton Avenue to the CS system in the Munroe district:
  - Invert at Munroe district boundary 228.20 m (S-MA40007499
- A 375 mm WWS pipe flows south by gravity on Louelda Street to the CS system in the Munroe district:
  - Invert at Munroe district boundary- 227.20 m (S-MA40007458)
- A 300 mm CS pipe flows south by gravity on Besant Street to the CS trunk on Munroe Avenue in the Munroe district:
  - Invert at Munroe district boundary- 226.46 m (S-MA70051892)
- A 300 mm WWS pipe flows south by gravity on Grey Street to the CS system in the Munroe district:
  - Invert at Munroe district boundary –225.92 m (S-MA40004591)

<u>LDS to LDS</u>

- A 525 mm LDS pipe flows south from Munroe Annex district to Munroe district on Raleigh Street:
  - Invert at Munroe district boundary 228.27 m (S-MA40004522)
- A 450 mm LDS pipe flows north on Roch Street from the Munroe district to the 2250 mm LDS trunk sewer on Chelsea Avenue in the Munroe Annex district:
  - Invert at Munroe Annex district boundary 223.98 m (S-MA40005096)

Callsbeck (Area 12.2)

<u>LDS to LDS</u>

- A 1200 mm LDS pipe flows east by gravity along the CPR tracks at Panet Road from Munroe district to Callsbeck district:
  - Invert at Munroe district boundary 227.29 m (S-MA70003652)

Kildonan Place (Area 13.1)

<u>LDS to LDS</u>

- A 750 mm LDS pipe flows north by gravity from Kildonan Place district to Munroe district:
  - Invert at Kildonan Place district boundary 228.12 m (S-MA70003615)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing system.

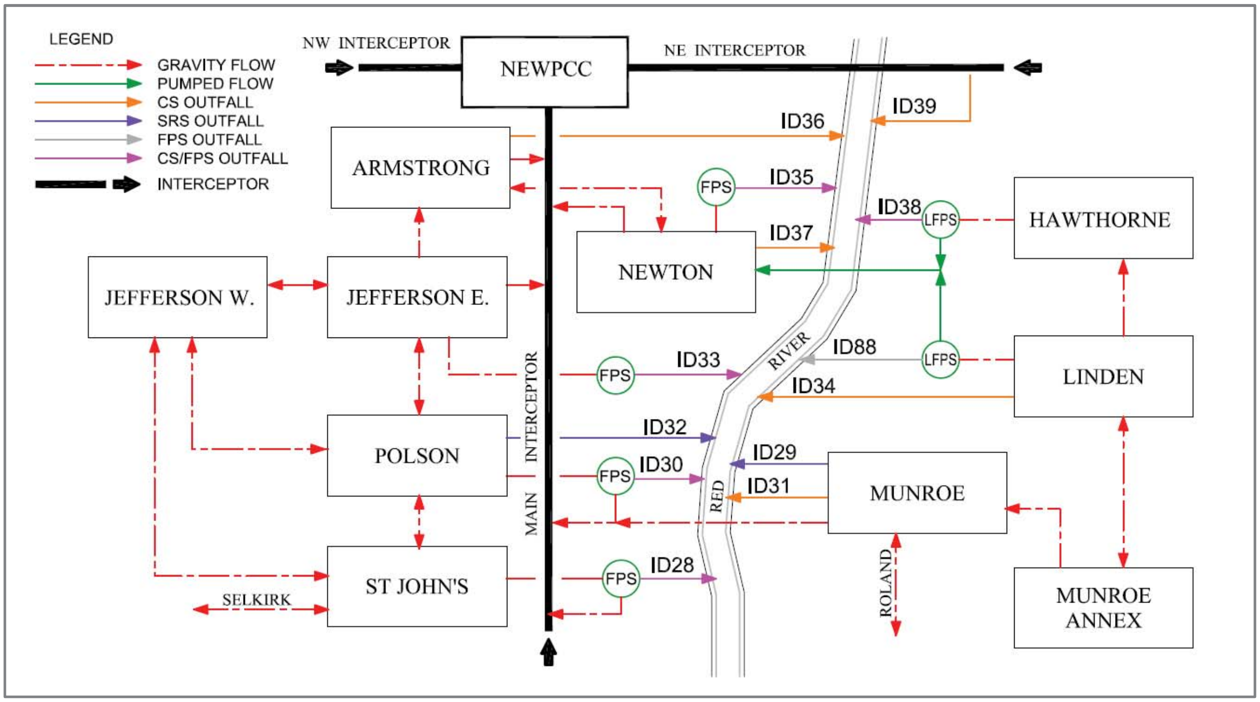

Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 29 and listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID31)	S-MH70022470.1	S-MA70017186	2150 x 3150 --> 2500	Red River Invert: 223.29 m Egg-shaped to circular
Flood Pumping Outfall	N/A	N/A	N/A	No Flood Pump Station within this district.
Other Overflows	N/A	N/A	N/A	
Main Trunk	S-TE40001634.1	S-MA400005434	2150 x 3150	Main CS that flows west on Munroe Avenue Egg-shaped Invert: 223.6 m
SRS Outfalls (ID29)	S-MH40004730.1	S-MA40005212	750 --> 900	Red River Invert: 221.71 m
SRS Interconnections				53 SRS - CS
Main Trunk Flap Gate	MUNROE_GC2.1	S-CG00001088	2,500	Invert: 224.06 m
Main Trunk Sluice Gate	MUNROE_GC1.1	S-CG00001089	2,500	Invert: 224.01 m
Off-Take	S-TE70027696.1	S-MA70017177	450 mm	Invert: 223.60 m

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Dry Well	N/A	N/A	N/A	
Lift Station Total Capacity	N/A	S-TE70027696.1 (1)	450 mm (1)	0.67 m^3/s (1)
ADWF	N/A	N/A	0.141 m^3/s	
Lift Station Force Main	N/A	N/A	N/A	
Flood Pump Station Total Capacity	N/A	N/A	N/A	
Pass Forward Flow – First Overflow	N/A	N/A	0.269 m^3/s	

Notes:

(1) Gravity pipe replacing Lift Station as Munroe is a gravity discharge district

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Bredin – 223.68 Munroe – 223.67
2	Trunk Invert at Off-Take	223.60
3	Top of Weir	224.06
4	Relief Outfall Invert at Flap Gate	224.53
5	Low Relief Interconnection (S-MH40007071)	224.85
6	Sewer District Interconnection (Roland)	221.93
7	Low Basement	225.40
8	Flood Protection Level (Munroe, Linden, Hawthorne)	229.04

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed in Roland was the *Munroe, Roland, Hart Combined Sewer Study* (Wardrop Engineering Consultants, 1985). The study's purpose was to develop sewer relief options to reduce surcharge level and relieve basement flooding. No other work has been completed on the district sewer system since that time.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Munroe Combined Sewer District was included as part of this program. Instruments installed at each of the thirty-nine primary CSO outfall locations has a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Expected Completion
29 – Munroe	1985	Future Work	2013	Study Complete	N/A

1.5 Ongoing Investment Work

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Munroe district. This consists of monthly site visits in confined entry spaces to verify that physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Munroe sewer district are listed in Table 1-4. The proposed CSO control projects will include gravity flow control, in-line storage via control gate, and floatable management via screening. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	-	-	✓	✓	✓	-	-	-	✓	✓	✓

Notes:

- = not included
✓ = included

The existing CS system in the Munroe district is suitable for use as in-line storage. These control options will take advantage of the existing CS pipe networks for additional storage volume. A gravity flow controller is also proposed on the CS system to optimize the dewatering rate from the district across the Red River to the Main Interceptor.

Floatable control will be necessary to capture any undesirable floatables in the sewage. Floatables will be captured with all implemented control options to some extent, but screening may be added as required to reach the desired level of capture. A screen will be installed on the primary outfall located at the east end of Munroe Avenue.

The SRS system in the Munroe district was found to not allow the cost effective implementation of latent storage, due to the minor overall volume reduction during the 1992 representative year analysis found during the Preliminary Proposal and CSO Master Plan modeling assessments. Latent storage has therefore not been proposed in this district.

GI and RTC will be applied within each district on a system-wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.1 In-Line Storage

In-line storage has been proposed as a CSO control for the Munroe district. In-line storage will require the installation of a control gate at the CS outfall. The gate will increase the storage level in the existing CS and provide an overall higher volume capture.

A standard design was assumed for the control gate, as described in Part 3C. A standard approach was used for conceptual gate sizing by assuming it to be the lesser of the height of half of the site-specific trunk diameter or the maximum height of the gate available. The design criteria for the in-line storage are listed in Table 1-5.

Table 1-5. In-Line Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	223.60 m	
Trunk Diameter	2150 x 3200 mm	Egg-shaped
Gate Height	1.16 m	Based on half pipe diameter assumption
Top of Gate Elevation	224.76 m	
Bypass Weir Elevation	224.71	
Maximum Storage Volume	2004 m^3	
Nominal Dewatering Rate	0.270 m^3/s	Based on minimum pass forward rate due to existing gravity sewer and river siphon crossing
RTC Operational Rate	TBD	Future RTC / dewatering review on performance

Note:
TBD = to be determined

The proposed control gate will cause combined sewage to back-up within the collection system to the extent shown on Figure 29. The extent of the in-line storage and volume is related to the elevation of the bypass weir. The level of the bypass weir is the maximum control level in the system: when the system level increases the flow overtops the bypass weir and is screened prior to discharging to the river. If the system level continues to rise, it will reach the critical level where the control gate drops out of the way. At this point, the district will only provide its original interception capacity via the primary weir for the district, and all excess CS would flow over the weir and discharge to the river. After the sewer levels in the system drops back below the bypass side weir critical performance level, the control gate moves back to its original position to capture the receding limb of the WWF event. The gravity discharge will continue with its current operation while the control gate is in either position, will all DWF being diverted to the existing siphon river crossing.

Figure 29-01 provides an overview of the conceptual location and configuration of the control gate, bypass weir and screening chambers. The proposed control gate will be installed in a new chamber within the trunk sewer alignment upstream of the diversion chamber. The dimensions of a new chamber to provide an allowance for a side weir for floatables control are 5.5 m in length and 3.5 m in width. The existing weir and off-take pipe configuration will have to be modified to allow the installation of the in-line gate and screening chambers. The outfall easement is constricted which may add difficulty to construction in this location. Additionally, residential buildings are located directly adjacent to the easement. This location is dependent on the extent of the existing underground structures and will require additional investigation to confirm the suitability of the proposed chamber locations. The relocation of the chambers to the street, Henderson Highway, also has issues with construction impacts and no dedicated overflow pipe that would require to be constructed. The implementation of the proposals may result in modifications to the existing diversion chamber and repurposing of the abandoned pump station.

The nominal rate for dewatering is per the existing downstream gravity sewer system. This accommodates dewatering through the existing interceptor system within 24 hours following the runoff event, allowing it to recover in time for a subsequent event. Any future considerations for RTC improvements would be completed with spatial rainfall as any reduction to the existing pipe capacity/operation for large events will adversely affect the overflows at this district. This future RTC control will provide the ability to capture and treat more volume for localized storms by using the excess interceptor capacity where the runoff is less.

1.6.2 Gravity Flow Control

Munroe district does not include a LS and discharges to the Main Interceptor by gravity, however a siphon river crossing is also utilized. A flow control device will be required to control the diversion rate for future RTC and dewatering. The controller will include flow measurement and a gate to control the discharge flow rate. A standard flow control device was selected as described in Part 3C.

The flow control would be installed at an optimal location on the connecting sewer between the proposed in-line control and existing diversion chamber. Figure 29-01 identifies a conceptual location for flow controller installation. A small chamber or manhole with access for cleaning and maintenance will be required. The flow controller will operate independently and require minimal operation interaction. The flow controller would operate independently during DWF and WWF and would require only minimal operational interaction.

A gravity flow controller has been included as a consideration in developing a fully optimized CS system as part of the City's long-term objective. The operation and configuration of the gravity flow controller will have to be further reviewed for additional flow and rainfall scenarios.

It should be noted that in addition to the gravity flow controller on the off-take pipe in the Munroe district, there is also a gravity flow controller proposed to be constructed in the Polson district immediately downstream of the Munroe district. As spatially varying rainfall may occur in either district this would require gravity flow controllers in both locations to allow for future RTC optimization within the combined sewer system.

1.6.3 Floatables Management

Floatables management will require installation of a screening system to capture floatable materials. The off-line screens would be proposed while still maintaining the current level of basement flooding protection.

The type and size of screens depend on the diversion chamber configuration, the siphon operation and the hydraulic head available. A generic design was assumed for screening and is described in Part 3C. The design criteria for screening with gate control implemented are listed in Table 1-6.

Table 1-6. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Top of Gate	224.76 m	
Bypass Weir Crest	224.71 m	
NSWL	223.67 m	
Maximum Screen Head	1.04 m	
Peak Screening Rate	1.16 m^3/s	
Screen Size	1.5 m wide x 1 m high	Modelled Screen Size

The proposed side bypass overflow weir and screening chamber will be located adjacent to the existing combined trunk sewer, as shown on Figure 29-01. The screen will operate with the control gate in its raised position. The side bypass weir upstream of the gate will direct the overflow to the screens located in the new screening chamber, with screened flow discharged to the downstream side of the gate to the river. The screening chamber will include screenings pumps with a discharge returning the screened material back to the interceptor and on to the NEWPCC for removal.

The dimensions for the screen chamber to accommodate influent from the side weir, the screen area, and the routing of discharge downstream of the gate are 5 m in length and 3.5 m in width. The outfall easement is constricted which may add difficulty to construction in this location. Additionally, residential buildings are located directly adjacent to the easement. This location is dependent on the extent of the existing underground structures and will require additional investigation to confirm the suitability of the proposed chamber locations. The relocation of the chambers to the street, Henderson Highway, also has issues with construction impacts and no dedicated overflow pipe that would require to be constructed. The implementation of the proposals may result in modifications to the existing diversion chamber and repurposing of the abandoned pump station.

1.6.4 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography, and soil classification for the district will be reviewed to identify applicable GI controls.

Munroe has been classified as a medium GI potential district. Land use in Munroe is mostly single-family residential, with the remaining consisting of commercial land use. This means the district would be an ideal location for bioswales, permeable paved roadways, cisterns/rain barrels. The flat roof commercial buildings make for an ideal location for green roofs.

1.6.5 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 Systems Operations and Maintenance

Systems operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

In-line storage will impact the existing sewer and will require the addition of a new chamber and a moving gate at the outfall. In-line storage dewatering will be controlled with the existing Clifton CS LS, which will require more frequent and longer duration pump run times. Lower velocities will occur in the CS trunk in the vicinity of the control gate due to lower pass forward flows, and may create additional debris deposition requiring cleaning. Additional system monitoring, and level controls will be installed, which will require regular scheduled maintenance.

Floatable control with outfall screening will require the addition of another chamber with screening equipment installed. The chamber will be installed adjacent to the control gate chamber and will operate in conjunction with it. Screening operation will occur during WWF events that surpass the in-line storage control level. WWF would be directed from the main outfall trunk, over the side weir in the control gate chamber and through the screens to discharge into the river. The screens will operate intermittently during wet weather events and will likely require operations review and maintenance after each event. Additional O&M will also be required to check the screenings pump return and envisaged to be completed in conjunction with the screen review. The frequency of a screened event would correlate to the number overflows identified for the district. Having the screenings pumped back to the interceptor system via a small LS and force main will be required. Additional maintenance for the pumps will be required at regular intervals in line with typical lift station maintenance and after significant screening events.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. An individual model was created to represent the sewer system baseline as represented in the year 2013 and a second model was created for the CSO Master Plan evaluation purposes, with all the control options recommended for the district to meet Control Option 1 implemented in the year 2037. A summary of relevant model data is provided in Table 1-7.

Table 1-7. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	402	402	14,354	70	N/A
2037 Master Plan – Control Option 1	402	402	14,354	70	IS, SC

Notes:

IS = In-line Storage

SC = Screening

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City Of Winnipeg GIS Records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-8 are for the hydraulic model simulations using the year-round 1992 representative year. This table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options, Table 1-8 also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-8. Performance Summary – Control Option 1

	Preliminary Proposal	Master Plan			
Control Option	Annual Overflow Volume (m^3)	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [a]
Baseline (2013)	431,121	432,465	-	23	0.208 m^3/s
In-Line Storage	430,508	370,430	62,035	22	0.262 m^3/s
Control Option 1	**430,508**	**370,430**	**62,035**	**11**	**0.262 m^3/s**

[a] Pass forward flows assessed on the 1-year design rainfall event

The percent capture performance measure is not included in Table 1-9, as it is applicable to the entire CS system and not for each district individually. The performance of this district is influenced by levels in the downstream interceptor system as this district has a gravity discharge.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-9. The cost estimates are a Class 5 planning level estimate with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-9. Cost Estimates – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period)
In-line Storage	N/A [a]	$2,670,000 [c]	$46,000	$990,000
Screening		$3,340,000 d	$57,000	$1,230,000
Gravity Flow Control	N/A [b]	$1,280,000	$34,000	$740,000
Subtotal	**N/A**	**$7,290,000**	**$138,000**	**$2,960,000**
Opportunities	N/A	$730,000	$14,000	$300,000
District Total	**N/A**	**$8,020,000**	**$151,000**	**$3,260,000**

[a] Solution developed as refinement to Preliminary Proposal work following submission of Preliminary Proposal costs. Costs for this item of work found to be $6,570,000

[b] Gravity Flow Control was not included in the Preliminary Proposal 2015 costing

[c] Cost associated with potential modifications to off-take to existing Munroe diversion chamber or potential modification to existing chamber location not included in in-line storage cost estimate.

[d] Cost for bespoke screenings return pump/force main not included in Master Plan as will depend on selection of screen and type of screening return system selected

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate include the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional cost for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014 dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019 dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019. Each of these values include equipment replacement and O&M costs.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-10.

Table 1-10. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	In-Line Storage	A Control Gate was not included in the Preliminary Proposal estimate	Added for the Master Plan to further reduce overflows
	Screening	Screening was not included in the Preliminary Proposal estimate	Added in conjunction with the Control Gate
	Gravity Flow Control	Gravity Flow Control was not included in the Preliminary Proposal estimate	Added in conjunction with the Control Gate
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years.	City of Winnipeg Asset Management Approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation.	Preliminary estimates were based on 2014-dollar values.	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, the future performance target is 98 percent capture for the representative year measured on a system-wide basis. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-11 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified for Control Option 1.

Overall the Munroe district would be classified as a low potential for implementation of complete sewer separation as the only feasible approach to achieve the 98 percent capture in the representative year future performance target. Opportunistic separation of portions of the district may be achieved with synergies with other major infrastructure work to address future performance targets. In addition, off-line storage elements such as an underground tank or storage tunnel with associated dewatering pump infrastructure be utilized to provide additional volume capture. Finally for focused use of green infrastructure, and reliance on said green infrastructure to provide volume capture benefits could be utilized to meet future performance targets.

Table 1-11. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Opportunistic Separation • Off-line Storage (Tunnel/Tank) • Increased use of GI

The control options for the Munroe district has been aligned to meet the 85 percent capture performance target based on the system wide basis. The expandability of this district to meet 98 percent capture target would be based both on the system wide basis analysis and the achievement of the construction of the in-line storage and screenings chambers. This may lead to the requirement for the alternative floatables management approach to be adopted in the future for this district.

The cost for upgrading to meet an enhanced performance target depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, CSO Master Plan update due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-12.

Table 1-12. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection		R	-	O	-	-	-	-
2	Existing Lift Station	-	-	-	-	-	-	-	-
3	Flood Pumping Station	-	-	-		-	-	-	-
4	Construction Disruption	-	-	-	-	-	-	-	-
5	Implementation Schedule	-	-	-	-	-	-	R	-
6	Sewer Condition	-	R	-	-	-	-	-	-
7	Sewer Conflicts		R	-		-	-	-	-
8	Program Cost		O	-		-	-	-	O
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-		-	R	-	-
11	Technology Assumptions		-	-	-	-	O	O	-
12	Operations and Maintenance	-	R	-		-	R	O	R
13	Volume Capture Performance		O	-	-	-	O	O	-
14	Treatment		R	-		-	O	O	R

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

Wardrop Engineering Consultants. 1985. *Munroe, Roland, Hart Combined Sewer Relief Study.* Prepared for the City of Winnipeg, Waterworks, Waster and Disposal Department. June.

LEGEND

	Inter-System Connection	District Boundary Crossing		
Primary Weir	CS - LDS	CS	Interceptor Sewer	District Boundary
Critical Elevation	CS - WWS	LDS	Force Main	Watercourse
CSO Outfall	SRS - CS	SRS	Street	Greenspace
Low CS Manhole	SRS - WWS	WWS	Railway	City Owned Land
Low SRS Connection				

CSO MASTER PLAN PROPOSED SOLUTIONS

- Proposed Control Gate
- Extent of In-line Storage
- Sewer Separation - Complete
- Sewer Separation - Ready

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 29
District Overview Map
Sewer District: Munroe
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Manhole
- Flap Gate
- Sluice Gate
- Force Main

Sewer By Type
- CS
- WWS

Control Structure Type
- Gate Chamber

Pump Station Type
- Diversion Chamber

CSO MASTER PLAN PROPOSED SOLUTIONS
- Control Gate
- Screening
- Flow Controller

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 29-01
Control Gate and Screening
Sewer District: Munroe
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Munroe Annex District Plan

August 2019

City of Winnipeg

JACOBS

CSO Master Plan

Project No:	470010CH
Document Title:	Munroe Annex District Plan
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Client Name:	City of Winnipeg
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0	10/05/2018	DRAFT for City Comment	DT	SG	
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2	08/19/2019	Final Draft Submission	DT	MF	MF
3	08/20/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

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Figure

1. Munroe Annex District

1.1 District Description

Munroe Annex district is located in the northeastern limit of the City's combined sewer network, and is immediately east of the Linden district. Munroe Annex is approximately bounded by Concordia Avenue and Chelsea Avenue to the south, Rock Street to the west, Roberta Avenue, Norilyn Bay, Sawchuk Bay, and Menno Bat to the north, and Molson Street to the east. Figure 30 provides an overview of the sewer district and the location of the proposed Combined Sewer Overflow (CSO) Master Plan control options.

Gateway Road bisects the Munroe Annex district into east and west; this is the only regional roadway in the district. Other major transportation routes include Raleigh Street, Watt Street, Golspie Street, Roch Street, and Louelda Street in a north-south direction and Kimberly Avenue, Linden Avenue, Chelsea Avenue, Dunrobin Avenue, and Helmsdale Avenue in the east-west direction.

Munroe Annex is primarily residential but includes a few commercial and industrial locations. Of the residential units, the majority are single-family residential, with a few multi-family and two-family units located mostly east of Gateway Road. There are a few scattered commercial and industrial land-use designations within the district. There are also six greenspace areas within the Munroe Annex district; two of these are Civic Park, a large greenspace area bordering the northwestern boundary of the district, and East Kildonan Centennial Park. Concordia Hospital is located at the eastern end of the district near Lagimodiere Boulevard.

1.2 Development

There is limited land area available for new development within Munroe Annex district. No significant developments that would impact the Combined Sewer Overflow (CSO) Master Plan are planned or expected.

1.3 Existing Sewer System

Munroe Annex district encompasses an area of 188 ha[1] based on the existing GIS district boundary information. In general, the area east of Gateway Road consists of separate LDS and WWS systems, while the area west of Gateway Road consists of a CS and SRS system. Both the east and the west sides of the district are separate systems that connect into the Munroe and Linden CS systems. There is approximately83 percent by area (156 ha) of LDS separated area and 3 percent by area (5 ha) identifiable as separation ready. The greenspace area in the district accounts for the remaining 14 percent by area, and totals approximately 27 ha.

There are no diversion structures, flow control structures, outfalls, pumping stations or lift stations (LSs) within the district. A 975 mm and a 750 mm trunk within the CS system carry flow south by gravity towards the CS system in the Munroe district. Multiple secondary sewers extend from the CS trunks along Munroe Avenue to the east and west to service the entire area. The WWS system is mainly on the east side of the district, with northern WWS sewers diverting flows to the Valley Gardens (Area 4NE) WWS system, and southern WWS sewers diverting flows to the CS system in the Munroe district.

Although the majority of the catch basins are connected to the SRS piped network, some catch basins remain connected to the CS system. CBs currently connect to specific sections of the CS system within Munroe Annex. Future plans to separate the remaining CBs from the existing CS system into the LDS system should be considered to allow for this district to be completely separation. The majority of the SRS flows in the district are diverted to an 1800 mm LDS sewer on Greene Avenue, which carries the flows

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

west towards the Linden district LDS system. Flows from the southwest portion of the Munroe Annex district is directed towards the 2100 mm LDS sewer on Chelsea Avenue, which carries flows west towards Linden district.

Secondary LDS sewers direct flow via gravity to a 1200 mm to 2100 mm LDS pipe that carries flow to the Linden district. There is also two secondary overflow points from the CS system in the Munroe Annex district to the 2100 mm LDS pipe on Chelsea Avenue at the intersections of Golspie Street and Chelsea Avenue, and Watt Street and Chelsea Avenue (S-TE40001450 and S-MH70022447). These cross-connection pipes have been reviewed as previous overflow locations and can now be utilized as emergency secondary overflows. Each overflow consists of a reduction in the CS collector pipe diameter to allow it to pass within the Chelsea LDS trunk sewer, and a side overflow weir interconnection into the LDS trunk sewer. A positive gate is installed at the overflow point to control when these overflows are allowed to connect into the LDS system to reduce basement flooding risks. At this time the positive gate for both of these CS-LDS interconnections are closed and are to remain closed until further evaluations have been completed.

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Munroe Annex and the surrounding districts. Each interconnection is shown on Figure 30 and shows locations where gravity flow can cross from one district to another. Each interconnection is listed as follows:

1.3.1.1 District Interconnections

Munroe

<u>CS to CS</u>

- A 1200 mm CS pipe flows south by gravity on Watt Street to the CS trunk on Munroe Avenue in the Munroe district:
  - Invert at Munroe district boundary 224.74 m (S-MA40005030)
- A 900 mm CS pipe flows south by gravity on Golspie Street to the CS trunk on Munroe Avenue in the Munroe district:
  - Invert at Munroe district boundary 225.11 m (S-MA40004336)
- A 300 mm CS pipe flows south by gravity on Gateway Road to the Munroe district:
  - Invert at Munroe district boundary 227.35 m (S-MA40004574)
- A 375 mm CS pipe flows south by gravity on Roch Street to the CS trunk on Munroe Avenue in the Munroe district:
  - Invert at Munroe Annex district boundary 226.57 m (S-MA40005099)

<u>LDS to CS</u>

- A 525 mm LDS pipe flows south from Munroe Annex district to Munroe district on Raleigh Street:
  - Invert at Munroe district boundary 228.27 m (S-MA40004522)

<u>WWS to CS</u>

- A 375 mm WWS pipe flows south by gravity on Louelda Street to the CS system in the Munroe district:
  - Invert at Munroe district boundary 227.20 m (S-MA40007458)
- A 300 mm WWS pipe flows south by gravity on Moncton Avenue to the CS system in the Munroe district:
  - Invert at Munroe district boundary 228.20 m (S-MA40007499)

- A 300 mm CS pipe flows south by gravity on Besant Street to the CS trunk on Munroe Avenue in the Munroe district:
  - Invert at Munroe district boundary 226.46 m (S-MA70051892)
- A 300 mm WWS pipe flows south by gravity on Grey Street to the CS system in the Munroe district:
  - Invert at Munroe district boundary 225.92 m (S-MA40005491)

LDS to LDS

- A 450 mm LDS pipe flows north on Roch Street from the Munroe district to the 2250 mm LDS trunk sewer on Chelsea Avenue in the Munroe Annex district:
  - Invert at Munroe Annex district boundary 223.98 m (S-MA40005096)

Linden

The CS and LDS systems between Munroe Annex and Linden interact at several locations.

CS to CS

- High point manholes
  - 300 mm CS at Roch Street and Roberta Avenue – 228.16 m References Munroe Annex District, 227.56 m References Linden District (S-MH40006178)
  - 375 mm CS at Roch Street and Linden Avenue – 225.78 m References Munroe Annex District, 226.66 m References Linden District (S-MH40006068)
  - 300 mm CS at Roch Street and Oakview Avenue – 227.42 m References Munroe Annex District, 227.26 m References Linden District (S-MH40006027)
  - 300 mm CS at Roch Street and Helmsdale Avenue – 227.42 m References Munroe Annex District, 227.30 m References Linden District (S-MH40005973)
- A 300 mm CS flows by gravity west at the intersection of Roch Street and Bronx Avenue from Munroe Annex district into Linden district:
  - Invert at Munroe Annex district boundary 227.76 m (S-MA40005134)

LDS to LDS

- A 2250 mm LDS trunk flows by gravity west at the intersection of Roch Street and Chelsea Avenue from Munroe Annex district into Linden district:
  - Invert at Munroe Annex district boundary 222.72 m (S-MA40005093)
- A 2100 mm LDS trunk flows by gravity west at the intersection of Roch Street and Greene Avenue from Munroe Annex district into Linden district:
  - Invert at Munroe Annex district boundary 22.84 m (S-MA40006725)
- A 750 mm LDS trunk flows by gravity north at the intersection of Roch Street and Dunrobin Avenue from Linden district into Munroe Annex district:
  - Invert at Linden district boundary 224.29 m (S-MA40006602)
- A 600 mm LDS trunk flows by gravity south at the intersection of Roch Street and Roberta Avenue from Linden district into Munroe Annex district:
  - Invert at Linden district boundary 224.15 m (S-MA40006722)
- A 450 mm LDS flows by gravity west at the intersection of Roch Street and Dunrobin Avenue from Munroe Annex district into Linden district:
  - Invert at Munroe Annex district boundary 224.56 m (S-MA40006595)

- A 375 mm LDS flows by gravity north at the intersection of Roch Street and Helmsdale Avenue from Munroe Annex district into Linden district:
  - Invert at Linden district boundary 224.83 m (S-MA40006509)
- A 300 mm LDS flows by gravity west at the intersection of Roch Street and Leighton Avenue from Munroe Annex district into Linden district:
  - Invert at Linden district boundary 224.54 m (S-MA40006148)
- A 300 mm LDS flows by gravity west at the intersection of Roch Street and Roberta Avenue from Munroe Annex district into Linden district:
  - Invert at Linden district boundary 224.39 m (S-MA40006749)
- A 300 mm LDS flows by gravity west at the intersection of Roch Street and Helmsdale Avenue from Munroe Annex district into Linden district:
  - Invert at Linden district boundary 224.91 m (S-MA40006501)
- A 250 mm LDS flows by gravity east at the intersection of Roch Street and Linden Avenue from Linden district into Munroe Annex district:
  - Invert at Munroe Annex district boundary 224.40 m (S-MA40006701)
- A 250 mm LDS flows by gravity east at the intersection of Roch Street and Oakview Avenue from Linden district into Munroe Annex district:
  - Invert at Munroe Annex district boundary 224.59 m (S-MA40006599)
- A 250 mm LDS flows by gravity east at the intersection of Roch Street and Kimberly Avenue from Linden district into Munroe Annex district:
  - Invert at Munroe Annex district boundary 225.28 m (S-MA40006513)

Valley Gardens (Area 4NE)

WWS to CS

- High point manhole
  - 250 mm WWS on Dowhan Crescent at Blantyre Avenue – 228.00 m References Munroe Annex District, 228.01 m References Valley Gardens District (S-MH40004250)

LDS to LDS

- A 1650 mm LDS pipe flows south by gravity on London Street from Valley Gardens district to the LDS system in Munroe Annex district:
  - Invert at Munroe Annex district boundary 226.53 m (S-MA40004119)
- A 1375 mm LDS pipe flows south by gravity on Louelda Street from Valley Gardens district to the LDS trunk in Munroe Annex district:
  - Invert at Munroe Annex district boundary 227.26 m (S-MA40004083)
- A 525 mm LDS pipe flows south by gravity on Tregar Bay from Valley Gardens district to the LDS system in Munroe Annex district:
  - Invert at Valley Gardens district boundary 228.21 m (S-MA40004065)
- A 300 mm LDS pipe flows south on Nathan Lane from Valley Gardens district into Munroe Annex district:
  - Invert at Munroe Annex district boundary 228.26 m (S-MA40004642)

- A 300 mm LDS pipe flows south on Dowhan Crescent at Blantyre Avenue from Valley Gardens district into Munroe Annex district:
  - Invert at Munroe Annex district boundary 228.11 m (S-MA40003990)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing system.

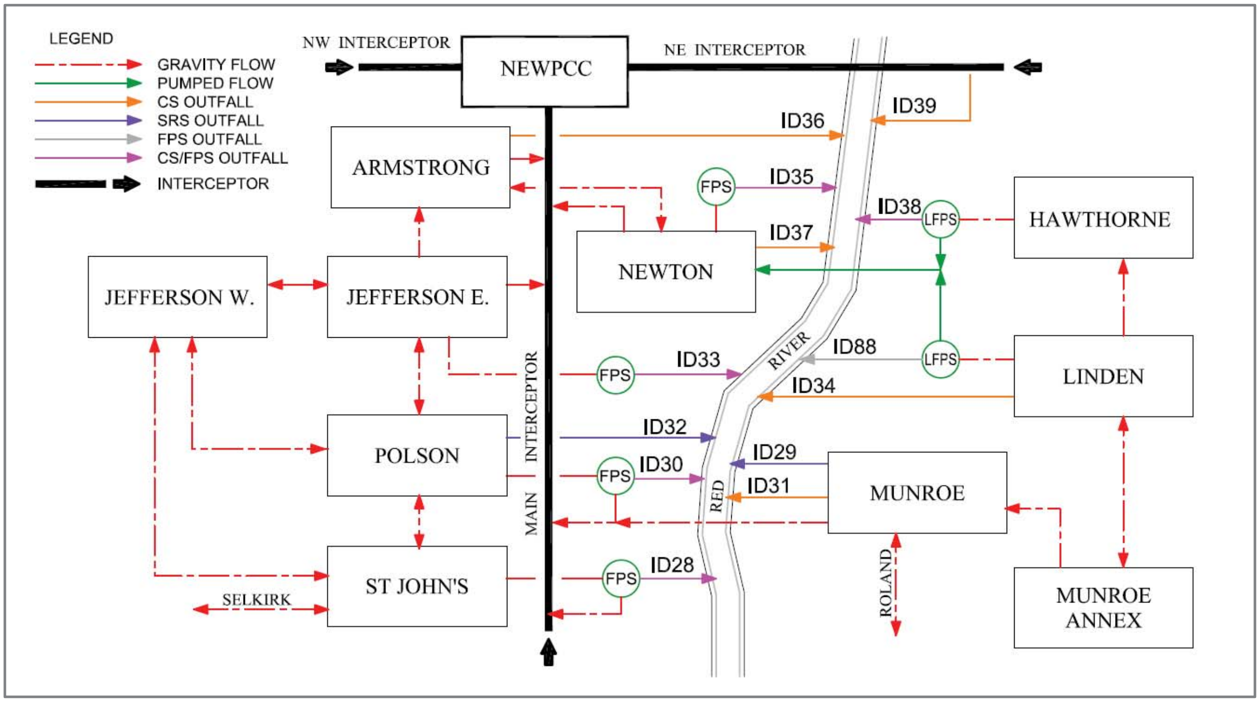

Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 30 and listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID23)	N/A	N/A	N/A	No CS outfall within the district.
Flood Pumping Outfall (ID23)	N/A	N/A	N/A	No Flood Pumping Station within the district.
Other Overflows (ID24 & ID26))	N/A	N/A	N/A	
Main Trunk	N/A	N/A	N/A	There is not a single CS trunk within the district.
SRS Outfalls (ID25)	N/A	N/A	N/A	There is no dedicated SRS outfall in the district.
SRS Interconnections	S-TE40001450.2 S-MH70022447.2	S-TE40001450 S-MH70022447	Weir width: 3000 mm Weir Crest: 225.66	This is a cross-connection between a CS and LDS system

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
			Weir Width: 900 mm Weir Crest: 225.59	This is a cross-connection between a CS and LDS system
Main Trunk Flap Gate	N/A	N/A	N/A	No CS outfall within the district.
Main Trunk Sluice Gate	N/A	N/A	N/A	No CS outfall within the district.
Off-Take	N/A	N/A	N/A	No CS outfall within the district.
Dry Well	N/A	N/A	N/A	
Lift Station Total Capacity	N/A	N/A	N/A	
ADWF	N/A	N/A	0.141 m^3/s	
Lift Station Force Main	N/A	N/A	N/A	No lift station within the district.
Flood Pump Station Total Capacity	N/A	N/A	N/A	No Flood Pumping Station within the district
Pass Forward Flow – First Overflow	N/A	N/A	N/A	

Notes:

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	N/A
2	Trunk Invert at Off-Take	N/A
3	Top of Weir	N/A
4	Relief Outfall Invert at Flap Gate	N/A
5	Low Relief Interconnection (S-MH70022447)	225.59
6	Sewer District Interconnection (Munroe - 1200 mm CS)	225.07
7	Low Basement	225.40
8	Flood Protection Level (Munroe, Linden, Hawthorne)	229.04

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed in Munroe Annex was the *Munroe, Roland, Hart Combined Sewer Study* (Wardrop Engineering Consultants, 1985). The study's purpose was to develop sewer relief options to reduce surcharge level and relieve basement flooding. No further study work has been completed on the district sewer system since that time. As a result of this study several measures to implement separation of the Munroe Annex district was completed. The Munroe Annex district was in fact part of the Munroe district originally but was separated to distinguish the portion of the district where the majority of the separation work recommended as part of this study was completed.

The district is deemed to be close to complete separation at this time as a result of previous investment work. Two individual systems are present to capture and route surface runoff, with the eastern section of the district draining to the Chelsea LDS system and the west section draining to the SRS system that flows from Munroe Annex to the adjacent Linden district and ultimately to the Red River.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Planned Completion
30 – Munroe Annex	1985	Future Work After Complete Separation	2013	Study Complete Separation Work Ongoing	N/A

Source: Report on *Munroe, Roland, Hart Combined Sewer Study*, 1985

1.5 Ongoing Investment Work

There is not any current or proposed CSO or sewer relief investment work occurring in Munroe Annex district.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The Munroe Annex district is an almost completely separate system and primarily has the remaining work required to allow for complete separation of the district proposed to meet CSO Control Option 1. Table 1-4 provides an overview of the control options included in the 85 percent capture in a representative year option. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	In-Line Storage	In-line Control Gate	Gravity Flow Control	Off-line Storage	Storage / Transport Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year *	-	-	-	-	-	-	-	✓	✓	✓	-

Notes:- = not included
✓ = included

* = Cross connection work not covered in the above table.

GI and RTC will be applied within each district on a system-wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Sewer Separation

The redirection of the existing CBs to the adjacent SRS in Chelsea Avenue and extension of the minor SRS systems in the Kimberly Avenue and Rayleigh Avenue locations would allow the system to be completely separated. It is recommended that an investigation into the system be completed to ensure that no additional WWS/CS connections to the existing SRS network are present.

Also, as part of the remaining sewer separation work, it is recommended that the interconnection between the CS and LDS systems at Golspie Street and Chelsea Avenue be modified. Each of the two CS-LDS interconnections were assessed as part of the CSO Master Plan and indicated two overflows at the Golspie Street cross connection for the representative year assessment. The reduction in pipe diameter through the cross connection is taken as a limiting factor and the weir level was taken to be too low for the WWF flows within the system. It is proposed to raise the weir and increase the pipe diameter to ensure that the cross connection does not operate for the representative year event. Optimizing the weir level/pipe diameter would require additional flow monitoring, and this is recommended that this be undertaken prior to any construction work. Further investigation and monitoring also would be needed to allow this cross connection to be abandoned. It should be noted that this work has not been included in the sewer separation capital cost estimates for the Munroe Annex district.

Upon completion of removing the WWS connections to the existing SRS connections at the Watt and Golpsie locations, the SRS systems that extend through the northern portion of the district can be classified as LDS systems.

It is proposed that future monitoring of the district is completed to verify that the sewer separation is fully compliant with the conditions modelled under the 1992 representative year conditions.

1.6.3 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography, and soil classification for the district will be reviewed to identify applicable GI controls.

Munroe Annex has been classified as a high GI potential district. Land use in Munroe Annex is primarily residential but includes a few commercial and industrial locations. This means the district would be an ideal location for bioswales, permeable paved roadways, cisterns/rain barrels. The flat roof commercial buildings make for an ideal location for green roofs. There are also higher areas of greenspace which could be used for bioretention garden projects.

1.6.4 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

Major changes to the existing system operations and maintenance (O&M) requirements for the Munroe Annex district will be minimal. The sewer separation work outstanding will include the installation of additional sewers that will require inspection, cleaning and rehabilitation.

It is recommended to continue to maintain and operate the flow monitoring instrumentation and assess the results after district separation work has been completed. This will allow the full understanding of the non-separated storm elements (foundation drain connections to the CS system) extent within the Munroe Annex district.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. An individual model was created to represent the sewer system baseline as represented in the year 2013 and a second model was created for the CSO Master Plan evaluation purposes, with all the control options recommended for the district to meet Control Option 1 implemented in the year 2037. A summary of relevant model data is provided in Table 1-5.

Table 1-5. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Added To Model
2013 Baseline	177	177	5,585	7	N/A
2037 Master Plan – Control Option 1	177	177	5,585	7	SW/Pipe

Notes:

SW/Pipe – Static Weir Increase and pipe diameter increase

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district. While this district is to be separated and as a result Clause 8 of Licence No. 3042 will not be in effect, the wet weather response of the district overall will still need to be assessed.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance of this district (from outfall perspective) is provided in the Munroe District Engineering Plan as Munroe Annex does not have a CS outfall. The overflow volume of 201m^3 is noted for the existing conditions and 0 m^3 for implementation the Control Option 1 conditions have been included in the Munroe performance estimate.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-6. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 to plus 100 percent.

Table 1-6. Cost Estimate – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period)
Sewer Separation Minor Work Outstanding	N/A	$ - [b]	N/A	N/A
Static Weir / Pipe Diameter Increase	N/A [a]	$15,000 [c]	N/A	N/A
Subtotal	**N/A**	**$15,000**	**N/A**	**N/A**
Opportunities	N/A	$0	N/A	N/A

Table 1-6. Cost Estimate – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period)
District Total	N/A	$15,000 [b c]	N/A	N/A

[a] Static Weir / pipe diameter increase not included in the Preliminary Proposal costs

[b] Separation proposal costs developed as refinement to CO1MP work following submission of CSO Master Plan Control Option 1 costs. Costs for this item of work found to be $480,000 in 2019 dollars.

[c] No costs have been included for any monitoring needed to determine the optimum weir level

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional cost for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014-dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019-dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimate additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-7.

Table 1-7. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Static Weir / Pipe Diameter Increase	Static Weir / Pipe Diameter Increase was not included in the preliminary estimate	Recent cross connection added to the Master Plan model and option
Opportunities	A fixed allowance of 10 percent has been included for program opportunities.	Preliminary Proposal estimate did not include a cost for GI opportunities.	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management approach.	

Table 1-7. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation.	Preliminary Proposal estimates were based on 2014-dollar values.	

1.10 Meeting Future Performance Targets

The remaining catch basin disconnections and proposed static weir/pipe diameter increase work recommended for the Munroe Annex district will achieve the 100 percent capture figure and no further work will be required to meet the future performance target.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-8.

Table 1-8. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	-	-	-	O	-	-	-
2	Existing Lift Station	-	-	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	O	-	-	-
4	Construction Disruption	-	-	-	-	R	-	-	-
5	Implementation Schedule	-	-	-	-	R	-	R	-
6	Sewer Condition	-	-	-	-	-	-	-	-
7	Sewer Conflicts	-	-	-	-	R	-	-	-
8	Program Cost	-	-	-	-	R	-	-	-
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	-	-	-	-	O	O	O	-

Table 1-8. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
12	Operations and Maintenance	-	-	-	-	R / O	R	O	-
13	Volume Capture Performance	-	-	-	-	-	O	O	-
14	Treatment	-	-	-	-	O	O	O	-

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

Wardrop Engineering Consultants. 1985. *Munroe, Roland, Hart Combined Sewer Relief Study.* Prepared for the City of Winnipeg, Waterworks, Waster and Disposal Department. June.

LEGEND

- Critical Elevation
- Low CS Manhole
- Low SRS Connection

Inter-System Connection
- CS - WWS
- SRS - CS
- SRS - LDS

District Boundary Crossing
- CS
- LDS
- WWS

- Interceptor Sewer
- Force Main
- Street
- Railway
- District Boundary
- Greenspace
- City Owned Land

CSO MASTER PLAN PROPOSED SOLUTIONS

- Sewer Separation - Complete
- Sewer Separation - Ready

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 30
District Overview Map
Sewer District: Munroe Annex
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Newton District Plan

August 2019

City of Winnipeg

JACOBS

CSO Master Plan

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2	07/2019	Final Draft Submission	DT	MF	MF
3	08/19/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

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Figure

1. Newton District

1.1 District Description

Newton district is located in the northern section of the combined sewer (CS) area to the west of the Red River. This district is approximately bounded by Margaret Avenue to the north, Main Street to the west, Kilbride Avenue to the south, and the Red River to the east.

Newton district primarily includes residential, parks and recreation land use areas. Kildonan Park is a large park located in the north end of the district which takes up approximately 40% of the district by area. Overall, the district includes approximately 40 ha of greenspace. Single family residential is located south of Kildonan Park between Main Street and the Red River. Commercial land use is located along Main Street and Partridge Avenue

Main Street, Partridge Avenue and Leila Avenue are the regional transportation routes in the district. Main Street runs north-south through the district. Partridge and Leila Avenue are one-way segments that run east-west and join up to Main Street.

1.2 Development

A portion of Main Street is located within the Newton District. Main Street is identified as Regional Mixed-Use Corridor as part of the OurWinnipeg future development plans. As such, focused intensification along Main Street is to be promoted in the future.

1.3 Existing Sewer System

Newton district encompasses an area of 102 ha[1] based on the district GIS boundary information and primarily includes a CS system. This district does not include any areas identified as LDS separated or separation ready.

The CS system includes a flood pumping station (FPS), diversion structure and outfall gate chamber. The system flows towards the Newton outfall located at the east end of Newton Avenue at the intersection of Newton Avenue and Scotia Street, where it is intercepted and diverted into the Main Interceptor. The diversion structure includes a weir and a 525 mm off-take pipe which reduces to 450 mm and then connects to a 1350 mm secondary interceptor that flows by gravity west along Newton Avenue to tie back into the Main Interceptor. The intercepted CS from the Linden and Hawthorne districts is conveyed across the Red River via two river crossing pipe and both also tie into this 1350 mm secondary interceptor sewer.

There are two main routes for CS to flow to the diversion structure. An 1800 mm CS trunk flows east on Newton Avenue, servicing the district area west of Main Street; a 900 mm CS trunk on Scotia Street south of the outfall services the district area south of Leila Avenue. An interconnection with the Armstrong district is present near the Armstrong diversion structure near the intersection of Armstrong Avenue and Main Street, which allows flow from Armstrong to flow into Newton. This provides the ability to utilize the Newton FPS to dewater the Armstrong CS system during wet weather flow (WWF) and high river level conditions.

During dry weather flow (DWF), sanitary sewage from the Newton district flows into the diversion chamber located at the intersection of Newton Avenue and Scotia Street upstream of the CS outfall. The sanitary sewage is then diverted by the weir to a 450 mm off-take pipe and flows by gravity back to the Main Interceptor to be treated at the North End Sewage Treatment Plant (NEWPCC).

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

During WWF, flows that exceed the diversion capacity overtop the primary weir and is discharged into the river via the CS primary outfall located near the intersection of Newton Avenue and Scotia Street. Sluice and flap gates are installed on this CS outfall to prevent river water from backing up into the CS system when the Red River levels are particularly high. However not only does the flap gate prevent river water intrusion, but it also prevents gravity discharge from the Newton CS outfall. Under these conditions the excess flow is pumped by the Newton FPS to a point in the Newton CS Outfall downstream of the flap gate, where it can be discharged to the river by gravity once more.

A CS relief outfall acts an emergency overflow for the Rainbow Stage lift station (LS), which services the Rainbow Stage and other properties located in Kildonan Park east of Riverview Drive. This includes a sewage control structure with a LS and 150 mm force main that pumps sewage from some of the park facilities into a 375 mm CS pipe which then flows by gravity back towards the Newton diversion structure.

The two outfalls to the Red River (CS):

- ID35 (S-MA00017645) – Newton CS Outfall
- ID37 (S-MA70069313) – Kildonan Park CS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Newton and the surrounding districts. Each interconnection is shown on Figure 31 and shows locations where gravity flow can cross from one district to another. Each interconnection is listed as follows:

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

Armstrong

- The 2250 mm Main Interceptor pipe flows north by gravity on Main Street out of the Newton district into the Armstrong district:
  - Invert at Newton district boundary 215.85 m (S-MA00000900)

1.3.1.2 Interceptor Connections – Upstream of Primary Weir

Jefferson East

- The 2250 mm Main Interceptor pipe flows north by gravity on Main Street into the Newton district out of the Jefferson East district:
  - Invert at Jefferson East district boundary 217.61 m (S-MA00017587)

1.3.1.3 District Interconnections

Jefferson East

<u>CS to CS</u>

- The 375 mm CS pipe flows south on Main Street out of the Newton district:
  - Invert at Newton district boundary 226.90 m (S-MA00017220)
- The 250 mm CS pipe flows east by gravity on Kingsbury Avenue out of the Newton district:
  - Invert at Newton district boundary 226.59 m (S-MA00017588)
- The 225 mm CS pipe flows west by gravity on Burrin Avenue into the Jefferson East district:
  - Invert at Newton district boundary 228.68 m (S-MA00001001)

Armstrong

CS to CS

- The 2700 mm CS main sewer trunk flows east on Armstrong Avenue out of the Armstrong district towards the Armstrong CS outfall located at the far end of Armstrong Avenue:
  - Invert at Armstrong district boundary 223.58 m (S-MA00000802)
- The 1350 mm CS pipe diverts south onto Main Street into the Newton district and connects to the Newton CS network:
  - Invert at Armstrong district boundary 225.03 m (S-MA00000789)
- The 600 mm CS pipe flows south by gravity on Main Street out of the Newton district:
  - Invert at Armstrong district boundary 224.64 m (S-MA00000784)
- The 450 mm CS pipe flows south by gravity on Main Street into the Newton district:
  - Invert at Armstrong district boundary 225.55 m (S-MA00000930)
- The 450 mm CS pipe flows south by gravity on Main Street out of the Newton district:
  - Invert at Armstrong district boundary 225.55 m (S-MA00000779)
- The 600 mm CS pipe flows east by gravity though Beeston Drive onto Main Street into the Newton district:
  - Invert at Newton district boundary 225.67 m (S-MA00000869)

Hawthorne

WWS to WWS

- The 350 mm WWS pipe flows north by pump into the Newton district:
  - Newton Avenue – 225.66 m (S-MA70021128)
- The 350 mm WWS pipe flows north by pump into the Newton district:
  - Newton Avenue – 222.63 m (S-MA00017639)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, flow controls, pumping systems, and discharge points for the existing system.

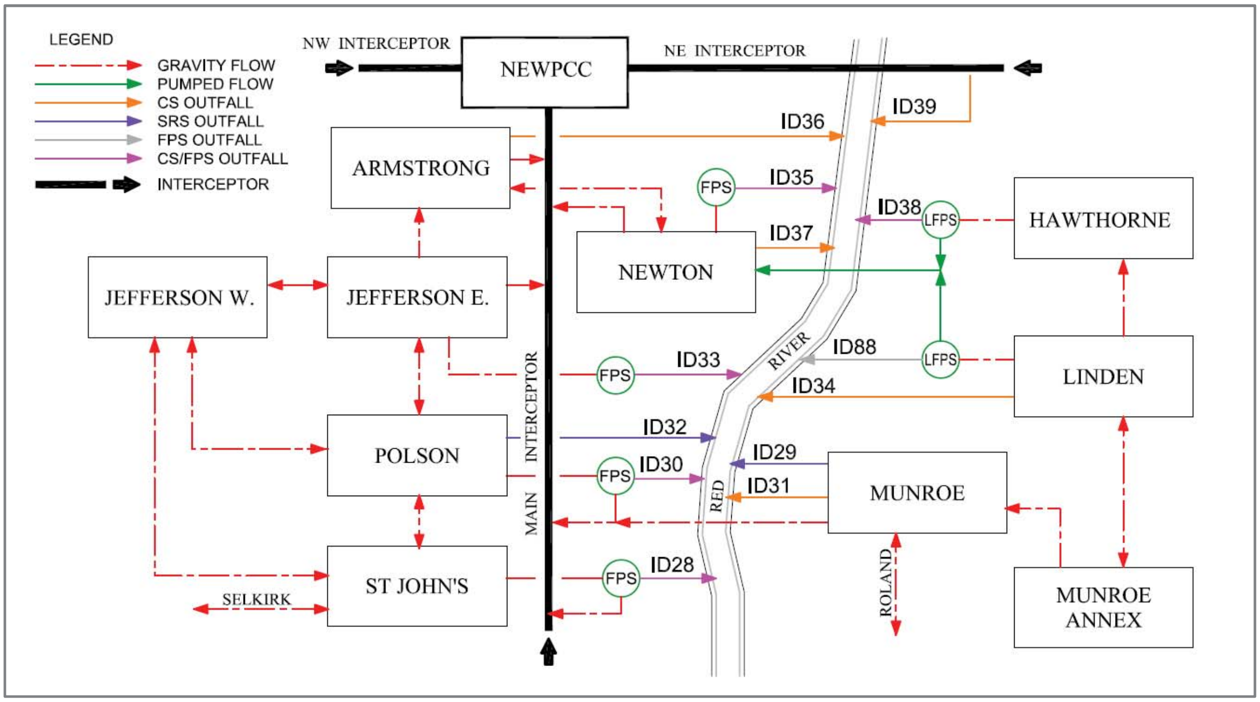

Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 31 and listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID35)	S-CO70003176.1.1	S-MA00017645	1850 mm	Red River Invert: 223.55 m
Flood Pumping Outfall (ID35)	S-CO70003176.1.1	S-MA00017645	1850 mm	Red River Invert: 223.55 m
Other Overflows (ID37)		S-MA70069313	250 mm	Invert: 223.05 m
Main Trunk	S-TE70000766.1	S-MA00001804	1800 mm	Invert: 223.59 m
SRS Outfalls	N/A	N/A	N/A	No SRS system within the district.
SRS Interconnections	N/A	N/A	N/A	No SRS system within the district.
Main Trunk Flap Gate	S-TE70026554.1	S-CG00000773	1800 mm	Invert: 224.14 m Circular
Main Trunk Sluice Gate	NEWTON_GC1.1	S-CG00000772	1800 x 1800 mm	Invert: 224.02 m
Off-Take	S-TE70000754.2	S-MA00017635	525	Invert: 223.81 m
Dry Well	N/A	N/A	N/A	
Lift Station Total Capacity	N/A	S-MA00017635 (1)	525 mm (1)	0.35 m^3/s (1)
ADWF	N/A	N/A	0.002 m^3/s	
Lift Station Force Main	N/A	N/A	N/A	

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Flood Pump Station Total Capacity	N/A	N/A	2.17 m^3/s	1 x 1.35 m^3/s 1 x 0.82 m^3/s
Pass Forward Flow – First Overflow	N/A	N/A	0.64 m^3/s	

Notes:

(1) – Gravity pipe replacing lift station as Newton is a gravity discharge district
ADWF = average dry weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation[a] (m)
1	Normal Summer River Level	Newton – 223.65 Kildonan Park – 223.65
2	Trunk Invert at Off-Take	223.81
3	Top of Weir	223.90
4	Relief Outfall Invert at Flap Gate	N/A
5	Low Relief Interconnection	N/A
6	Sewer District Interconnection (Armstrong)	224.64
7	Low Basement	226.64
8	Flood Protection Level	228.80

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed in Newton was the *Newton Combined Sewer District Sewer Relief Study* (IDG Stanley Inc, 1994). The study's purpose was to develop sewer relief options that provide a 5-year level of protection against basement flooding and to develop alternatives for reducing and eliminating pollutants from CSOs. No other work has been completed on the district sewer system since that time.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Newton CS district was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations have a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Planned Completion
31 – Newton	1994	Planned in Next 5 Years	2013	Study Complete	N/A

Source: Report on *Newton Combined Sewer District Sewer Relief Study*, 1994

1.5 Ongoing Investment Work

District flow monitoring is planned to be undertaken within the next 5 years due to its interaction with the Armstrong district.

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Newton district. This consists of monthly site visits in confined entry spaces to verify that physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Newton sewer district are listed in Table 1-4. The proposed CSO control projects will include in-line storage via a control gate, and floatable management via screening. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	-	-	✓	✓	✓	-	-	-	✓	✓	✓

Notes:

- = not included
✓ = included

The existing CS system is suitable for use as in-line storage. These control options will take advantage of the existing CS pipe networks for additional storage volume. Existing DWF from the collection system will remain the same, and overall district operations will remain the same. A gravity flow controller is proposed on the CS system to optimize the dewatering rate from the district back into the Main Interceptor.

Floatable control will be necessary to capture any undesirable floatables in the sewage. Floatables will be captured with all implemented control options to some extent, but screening may be added as required to reach the desired level of capture. A screen will be installed on the primary outfall located at the east end of Newton Avenue.

GI and RTC will be applied within each district on a system-wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 In-Line Storage

In-line storage has been proposed as a CSO control for Newton district. In-line storage will require the installation of a control gate at the CS outfall. The gate will increase the storage level in the existing CS and provide an overall higher volume capture.

A standard design was assumed for the control gate, as described in Part 3C. A standard approach was used for conceptual gate sizing by assuming it to be the lesser of the height of half of the site-specific trunk diameter or the maximum height of the gate available. The design criteria for in-line storage are listed in Table 1-5.

Table 1-5. In-Line Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	223.59 m	N/A
Trunk Diameter	1800 mm	N/A
Gate Height	0.69 m	Gate height based on half trunk diameter assumption
Top of Gate Elevation	224.59 m	N/A
Maximum Storage Volume	330 m^3	N/A
Nominal Dewatering Rate	0.35 m^3/s	Based on existing pipe system pipe full capacity
RTC Operational Rate	TBD	Future RTC/dewatering review on performance

Note:
RTC = Real Time Control
TBD = to be determined

The proposed control gate will cause combined sewage to back-up within the collection system to the extent shown on Figure 31. The extent of the in-line storage and volume is related to the top elevation of the bypass side weir. The level of the top of the bypass side weir and adjacent control gate level are determined in relation to the critical performance levels in the system for basement flooding protection: when the system level increases above the bypass weir crest and proceeds above the top of the control gate during high flow events, the gate drop out of the way. At this point, the district will only provide its original interception capacity via the primary weir for the district, and all excess CS would flow over the weir and discharge to the river. After the sewer levels in the system drops back down below the bypass side weir critical performance level, the control gate moves back to its original position to capture the receding limb of the WWF event. The gravity discharge will continue with its current operation while the control gate is in either position, , with all DWF being diverted to the Main Interceptor.

Figure 31-01 provides an overview of the conceptual location and configuration of the control gate and screening chambers. The control gate will be installed in a new chamber within the trunk sewer alignment. The dimensions of a new chamber to provide an allowance for a side weir for floatables control are 5.5 m in length and 3.5 m in width. The existing sewer configuration including the construction of an additional off-take pipe will have to be completed to allow for CS captured by the control gate to be intercepted to the Newton diversion structure. The existing primary weir would remain in place to allow flow diversion to continue when the control gate is in its lowered position. The work proposed is located within a residential street with minor disruptions expected.

The nominal rate for dewatering is determined by the performance of the existing pipe capacity as the district is a gravity discharge district. As such the flows will vary over the duration of a rainfall event and has been nominated for a gravity flow control device. Any future consideration, for RTC improvements, would be completed with spatial rainfall as any reduction to the existing pipe capacity/operation for large events will adversely affect the overflow at this district. The control device would be set to a rate similar to the existing pipe full capacity to allow the set limit to be known. This would allow the future RTC control the ability to capture and treat more volume for localized storms in other districts by using the excess interceptor capacity made available by restricting the pass forward flows through the control device where the runoff is less.

1.6.3 Gravity Flow Control

Newton district does not include a LS and discharges to the Main Interceptor by gravity. A flow control device will be required to control the diversion rate for future RTC and dewatering. The controller will include flow measurement and a gate to control the discharge flow rate. A standard flow control device was selected as described in Part 3C.

The 1350 mm sewer connecting into the Main Interceptor also receives flow from the Hawthorne and Linden districts. The flow control would be installed at an optimal location between the diversion structure and the connection into the Main Street interceptor. Figure 31-01 identifies a conceptual location for flow controller installation. A small chamber or manhole with access for cleaning and maintenance will be required. The flow controller will operate independently and require minimal operation interaction. The flow controller would operate independently during DWF and WWF and would require only minimal operational interaction. The impact of the flow controller on the force main connections to Hawthorne and Linden districts must also be considered during preliminary design.

A gravity flow controller has been included as a consideration in developing a fully optimized CS system as part of the City's long-term objective. The operation and configuration of the gravity flow controller will have to be further reviewed for additional flow and rainfall scenarios.

1.6.4 Floatables Management

Floatables management will require installation of a screening system to capture floatable materials. The off-line screens would be designed to maintain the current level of basement flooding protection.

The type and size of screens depend on the specific station configuration and the head available for operation. A standard design was assumed for screening and is described in Part 3C. The design criteria for screening, with an in-line control gate implemented, are listed in Table 1-6.

Table 1-6. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Top of Gate	224.59	
Bypass Weir Crest	224.49	
NSWL	223.649	
Maximum Screen Head	0.84	
Peak Screening Rate	0.29 m^3/s	
Screen Size	1.5 m wide x 1 m high	Modelled Screen Size

The side overflow weir and screening chamber will be located adjacent to the existing combined trunk sewer, as shown on Figure 31-01. The screens will operate once levels within the sewer surpassed the in-line control elevation. A side weir upstream of the gate will direct the overflow to the screens located in the new screening chamber, with screened flow discharged to the downstream side of the gate to the river. The screening chamber will include screenings pumps with a discharge returning the screened material back to the interceptor.

The dimensions for the screen chamber to accommodate influent from the side weir, the screen area, and the routing of discharge downstream of the gate are 2.5 m in length and 3.5 m in width.

1.6.5 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district will be reviewed to identify the most applicable GI controls.

Newton has been classified as a high GI potential district, the land use mainly consists of greenspace and single family residential land use, meaning it would be an ideal location for bioswales, permeable paved roadways, cisterns/rain barrels, and rain gardens. There are some commercial buildings that would be suitable for green roof projects.

1.6.6 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

In-line storage will impact the existing sewer and will require the addition of a new chamber and a moving gate at the outfall. In-line storage dewatering will be controlled with the existing Clifton CS LS, which will require more frequent and longer duration pump run times. Lower velocities will occur in the CS trunk in the vicinity of the control gate due to lower pass forward flows, and may create additional debris deposition requiring cleaning. Additional system monitoring, and level controls will be installed, which will require regular scheduled maintenance.

The flow controller will require the installation of a chamber and flow control equipment. Monitoring and control instrumentation will be required. The flow controller will operate independently and require minimal operation interaction. Regular maintenance of the flow controller chamber and appurtenances will be required.

Floatable control with outfall screening will require the addition of another chamber with screening equipment installed. The chamber will be installed adjacent to the control gate chamber and will operate in conjunction with it. Screening operation will occur during WWF events that surpass the in-line storage control level. WWF will be directed from the main CS trunk, over the side weir in the control gate chamber and through the screens to discharge into the river. The screens will operate intermittently during wet weather events and will likely require operations review and maintenance after each event. The frequency of a screened event will correlate to the number overflows identified for the district. Having the screenings pumped back to the interceptor system via a small LS and force main will be required. The screenings return will require O&M inspection after each event to assess the performance of the return pump system.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. An individual model was created to represent the sewer system baseline as represented in the year 2013 and a second model was created for the CSO Master Plan evaluation purposes, with all the control options recommended for the district to meet Control Option 1 implemented in the year 2037. A summary of relevant model data is provided in Table 1-7.

Table 1-7. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Added To Model
2013 Baseline	93	93	2,539	36	N/A
2037 Master Plan – Control Option 1	93	88	2,539	35	IS, SC

Notes:

IS = In-line Storage
SC = Screening

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City Of Winnipeg GIS Records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-8 are for the hydraulic model simulations using the year-round 1992 representative year. The table lists the results for the Baseline, for each individual control option, and for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. The table also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-8. Performance Summary – Control Option 1

Control Option	Preliminary Proposal	Master Plan			
	Annual Overflow Volume (m^3)	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [a]
Baseline (2013)	7,218	8,614	-	6	0.315 m^3/s
In-line Storage	2,771	2,994	5,620	2	0.315 m^3/s
Control Option 1	**2,771**	**2,994**	**5,620**	**2**	**0.315 m^3/s**

[a] Pass forward flows assessed on the 1-year design rainfall event.

The percent capture performance measure is not included in Table 1-8, as it is applicable to the entire CS system and not for each district individually.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-9. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-9. Cost Estimates – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period)
In-line Control Gate	$7,740,000 [a]	$2,550,000 [c]	$40,000	$860,000
Screening		$1,840,000 [d]	$31,000	$660,000
Gravity Flow Controller	N/A	$1,280,000	$34,000	$740,000
Off-line Storage Tank	$6,870,000 [b]	N/A	N/A	N/A
Subtotal	**$14,610,000**	**$5,670,000**	**$105,000**	**$2,260,000**
Opportunities	N/A	$570,000	$11,000	$230,000
District Total	**$14,610,000**	**$6,240,000**	**$116,000**	**$2,490,000**

[a] Screening and In-line cost was combined in the Preliminary Proposal. Solution development as refinement to Preliminary Proposal work following submission of Preliminary Proposal costs. Costs for these items of work found to be $1,000,000 in 2014 dollars

[b] Offline storage tank part of Armstrong assessment during Preliminary Proposal (however located within the Newton district).

[c] Cost associated with new off-take construction, as require, to accommodate control gate and screening chambers in location and allow intercepted CS flow to reach existing Newton gravity discharge was not included in Master Plan cost estimates.

[d] Cost for bespoke screenings return/force main not included in Master Plan as will depend on selection of screen and type of screening return system selected

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional costs for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014-dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019-dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-10.

Table 1-10. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Control Gate	A control gate was not included in the Preliminary Proposal estimate	Added for the Master Plan to further reduce overflows
	Screening	Screening was not included in the Preliminary Proposal estimate	Added in conjunction with the Control Gate
	Removal Of Off-line Storage Tank	The Master Plan assessment found that off-line tank storage not a preferred control solution.	
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management Approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation.	Preliminary Proposal estimates were based on 2014-dollar values.	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, the future performance target is 98 percent capture for the representative year measured on a system-wide basis. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-11 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified for Control Option 1.

Overall the Newton district would be classified as a low potential for implementation of complete sewer separation as the only feasible approach to achieve the 98 percent capture future performance target in the representative year. However, opportunistic sewer separation within a portion of the district may be completed in conjunction with other major infrastructure work to address future performance targets. In addition, green infrastructure and off-line tank or tunnel storage may be utilized in key locations to provide additional storage and increase capture volume.

Table 1-11. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Opportunistic Sewer Separation • Increased use of GI • Off-line Storage (Tank/Tunnel)

The control options selected for the Newton district has been aligned for the requirement to provide screening on each of the primary outfalls and not specifically for the 85 percent capture performance target based on the system wide basis. The expandability of this district to meet the 98 percent capture would be based on a stepped approach from the system wide basis. The proposed control options at the adjacent Armstrong district provide overflow reduction to this district and would be programmed to be completed prior to any work commenced in this district.

The cost for upgrading to meet an enhanced performance target depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of

master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-12.

Table 1-12. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	R	-	-	-	-	-	-
2	Existing Lift Station	-	R	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	-	-	-	-
4	Construction Disruption	-	-	-	-	-	-	-	-
5	Implementation Schedule	-	-	-	-	-	-	R	-
6	Sewer Condition	-	R	-	-	-	-	-	-
7	Sewer Conflicts	-	R	-	-	-	-	-	-
8	Program Cost	-	O	-	-	-	-	-	O
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	-	-	-	-	-	O	O	-
12	Operations and Maintenance	-	R	-	-	-	R	O	R
13	Volume Capture Performance	-	O	-	-	-	O	O	-
14	Treatment	-	R	-	-	-	O	O	R

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

IGD Stanley Inc. 1994. *Newton Combined Sewer District Sewer Relief Study*. Prepared for the City of Winnipeg, Waterworks, Waster and Disposal Department. September.

LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Low CS Manhole
- Inter-System Connection: CS - WWS
- District Boundary Crossing: CS, LDS, WWS
- Interceptor Sewer
- Force Main
- Street
- Railway
- District Boundary
- Watercourse
- Greenspace

CSO MASTER PLAN PROPOSED SOLUTIONS

- Proposed Control Gate
- Extent of In-line Storage

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 31
District Overview Map
Sewer District: Newton
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Manhole
- Pump Location
- Force Main
- Sewer By Type
  - CS
  - WWS
- Pump Station Type
  - Diversion & Flood Combined Station

CSO MASTER PLAN PROPOSED SOLUTIONS

- Control Gate
- Screening
- Flow Controller

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 31-01
Control Gate, Screening and Flow Control
Sewer District: Newton
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Parkside District Plan

August 2019

City of Winnipeg

Winnipeg CSO Master Plan

Project No: 470010CH
Document Title: Parkside District Plan
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Client Name: City of Winnipeg
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Revision	Date	Description	By	Review	Approved
0	08/2018	Version 1 DRAFT	DT / SG	ES	
1	02/15/2019	DRAFT 2 for City Review	MF	SG	MF
2	08/12/2019	Final Draft Submission	DT	MF	MF
3	08/19/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

Tables

Figure

1. Parkside District

1.1 District Description

The Parkside sewer district is in the western section of north end sewage treatment plant (NEWPCC) catchment area of the combined sewer (CS) area and adjacent to the Assiniboine River. Parkside is bordered by Portage Avenue to the north, Bourkevale Drive to the west, and the Assiniboine River to the south and east.

Land use in Parkside is mainly single-family residential with commercial along Portage Avenue. École Assiniboine School and Jae Eadie Park are significant non-residential land use parcels present in the district. Portage Avenue is the only regional transportation route that passes through Parkside district parallel to the Assiniboine River along the north district boundary.

1.2 Development

A portion of Portage Avenue is located within the Parkside District. Portage Avenue is identified as Regional Mixed Use Corridor as part of the OurWinnipeg future development plans. As such, focused intensification along Portage Avenue is to be promoted in the future.

1.3 Existing Sewer System

Parkside encompasses a combined area of 16 hectares (ha)[1] based on the district boundary. Parkside was identified for sewer separation as part of the Ferry Road and Riverbend sewer relief work. As of December 2018, sewer separation work has been completed in the Parkside district.

This district includes both a CS and LDS system and a CS outfall. It is interconnected to the Riverbend district. The combined sewage from the western section of the district is collected from three residential blocks from Cavell Drive eastwards and flows to the 600 mm trunk sewer for the district. This trunk sewer is then intercepted by the primary weir at the CS outfall, flows north into the Riverbend CS district, via a 250 mm offtake along Parkside Drive. There is also a 450 mm CS which serves the small residential area along Riverbend Crescent east of the Parkside District in the past, this 450 mm pipe would pass directly over the Riverbend CS outfall, and continue west to the Parkside district. It was realized that by constructing an outlet pipe directly below the base of where this 450 pipe passes over the Riverbend CS outfall trunk can be used to more efficiently tie this CS into the Riverbend district directly. This was constructed in the late 1960s, along with a 1 meter high brick weir to ensure the CS collected from the Riverbend Crescent area is captured by the hole in the manhole base. This essentially diverts all CS flow from this Riverbend Crescent area from the Parkside district to the Riverbend district, under DWF conditions.

During dry weather flow (DWF) Parkside district combined sewage flows towards the 600 mm trunk sewer along Assiniboine Avenue, and enters a manhole with a flap gate located within it at the intersection of Assiniboine Ave and Parkside Drive. This manhole flap gate structure is part of the CS outfall for the Parkside district. The flap gate's invert is higher than the invert of all CS pipes entering the manhole, and the flap gate invert acts as the district's primary weir to prevent DWF from spilling to the outfall. All intercepted DWF in this manhole then flows north into a 250 mm interceptor sewer along Parkside Drive that connects to the Riverbend CS system.

During wet weather flow (WWF) events, the CS outfall provides relief to sewers along Assiniboine Avenue. The Parkside CS outfall allows overflow to the Assiniboine River during wet weather flow (WWF) events when the level rises above the flap gate invert. Any flow that exceeds the flap gate invert and

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

exerts a significant enough fluid pressure to push open the flap gate is discharged to the river. A sluice gate is installed further downstream at the end of the CS outfall for flap gate maintenance purposes. The flap gate restricts back-up from the Assiniboine River into the CS system under high river level conditions. There is also no flood station at this location; when high river levels are expected and overflow operation will be prevented by the flap gate during a WWF event, temporary flood pumping can be put in place. Under WWF conditions as well, the flow received from the 450 mm CS servicing the Riverbend Crescent area in the Riverbend CS district may spill over the 1 metre brick weir installed in the manhole directly above the Riverbend CS outfall. All flow which spills over this brick weir then continues west to be intercepted in the Parkside district, at which point it may rise above the flap gate invert and discharge to the Assiniboine River.

The single CS outfall to the Assiniboine River for the Parkside District is as follows:

- ID49 (S-MA20008800) – Parkside CS Outfall

1.3.1 District-to-District Interconnections

There are three district-to-district interconnections between Parkside and the surrounding districts. These interconnections are shown on Figure 32 for Parkside district and show the locations where gravity flow crosses from one district to another. Each interconnection is listed in the following subsections.

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

Riverbend

- Combined sewage is directed into a 300 mm interceptor pipe at the Parkside outfall gate chamber, and into the Riverbend CS district:
  - Invert at district boundary - 226.79 m (S-MH70005194)

1.3.1.2 District Interconnections

Ferry Road

<u>CS to CS</u>

- The main 750 mm interceptor pipe flows eastbound by gravity on Portage Avenue from Ferry Road into Riverbend:
  - Invert at Riverbend district boundary – 230.65 m (S-MA20008863)
- High Point Manhole (flow is directed into both districts from this manhole)
  - Assiniboine Avenue and Bourkevale Drive – 229.87 m (S-MH70016002)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing district.

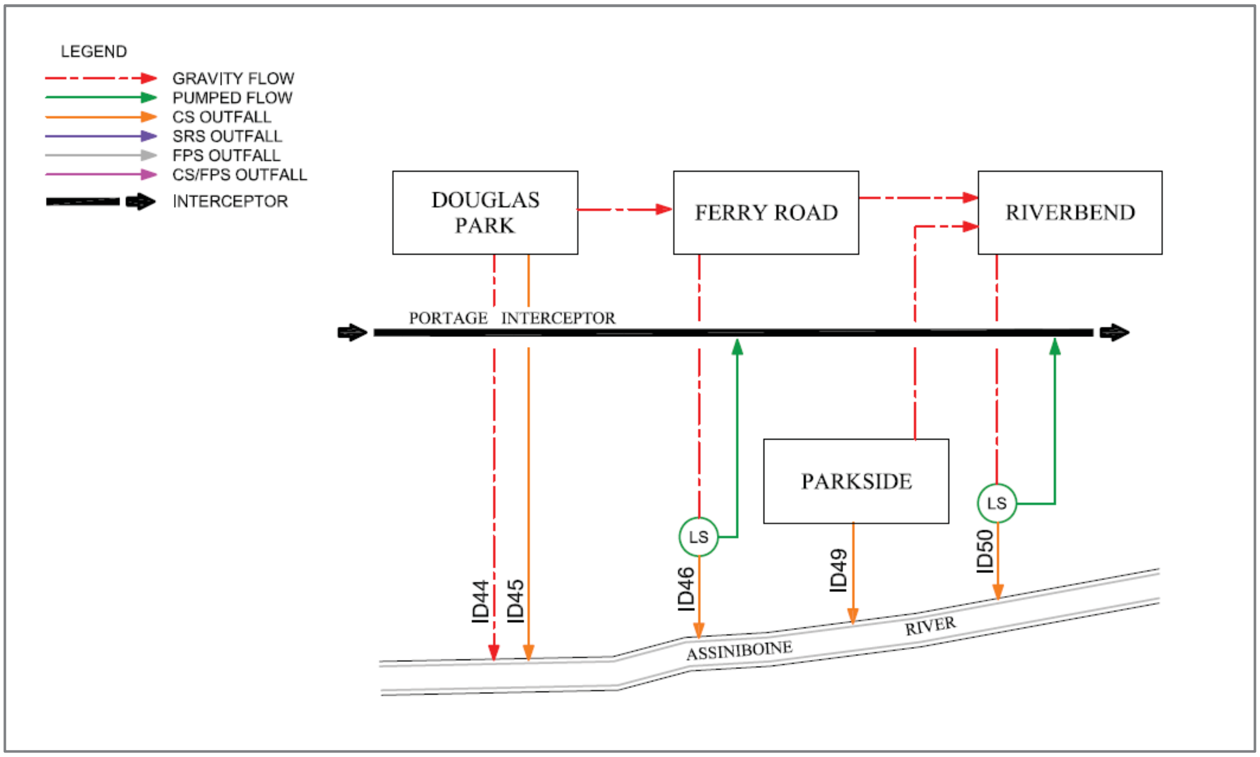

Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for Parkside are shown on Figure 32 and are listed in Table 1-1.

Table 1-1. Parkside Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID49)	S-CG00001138.1	S-MA20008800	750 mm	Circular Invert: 227.00 m
Flood Pumping Outfall	N/A	N/A	N/A	No flood pump station within the district.
Other Overflows	N/A	N/A	N/A	
Main Trunks (from Ferry Road and Riverbend)	S-AC70013535.1 S-MH70007104.1	S-MA20008803 S-MA70019339	750 mm 600 mm	Circular, Invert: 228.21 m Circular, Invert: 228.46 m
SRS Outfalls	N/A	N/A	N/A	No SRS within the district.
SRS Interconnections	N/A	N/A	N/A	No SRS within the district.
Main Trunk Flap Gate	S-MH70005190.2	S-CG00000894	750 mm	Flap Gate size Invert: 228.36 m
Main Trunk Sluice Gate	S-MH20008110.1	S-CG00001138	750 x 750 mm	Sluice Gate size Invert: 227.25 m
Off-Take	S-MH70005190.1	S-MA70013033	250 mm	Circular Invert: 228.17 m
Dry Well	N/A	N/A	N/A	No lift station within the primary CS outfall.
Lift Station Total Capacity	N/A	S-MA70013033 (1)	250 mm (1)	0.049 m^3/s (1)

Table 1-1. Parkside Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Lift Station ADWF	N/A	N/A	0.0002 m^3/s	
Lift Station Force Main	N/A	N/A	N/A	No lift station within the primary CS outfall.
Flood Pump Station Total Capacity	N/A	N/A	N/A	No flood pump station within the district.
Pass Forward Flow – First Overflow	N/A	N/A	0.011m^3/s	

Notes:

(1) – Gravity pipe replacing Lift Station as Douglas Park is a gravity discharge district
ADWF = average dry-weather flow

GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Parkside Drive – 224.40
2	Trunk Invert at Off-Take	228.17
3	Top of Weir	N/A
4	Relief Outfall Invert	N/A
5	Low Relief Interconnection	N/A
6	Sewer District Interconnection (Ferry Road)	228.93
7	Low Basement	231.49
8	Flood Protection Level	229.69

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed for Parkside was in 2006 with the *Ferry Road and Riverbend Combined Sewer Relief Works* (Wardrop, 2006). This study discussed the possible relief work available for the Ferry Road, Douglas Park, Parkside and Riverbend CS Systems to reduce the incidences of basement flooding.

The majority of Parkside has been separated as part of a large scale sewer relief project which resulted from this 2006 study. This includes the installation of a separate land drainage sewer (LDS) system to collect surface runoff. There are plans to abandon the Parkside CS outfall completely following post separation flow monitoring. All three contracts for the sewer separation portion of the works have been completed.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Planned Completion
32 - Parkside	2006 - Conceptual	Future Work	2013	Sewer Separation Complete	2018

1.5 Ongoing Investment Work

The separation work was completed between 2016 and 2018 and will be integrated into the CSO Master Plan. Post-separation flow monitoring and decommissioning of the Parkside CS outfall is to be completed as future work. There is no further study or construction proposed for the Parkside district at this time.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Parkside district are listed in Table 1-4. The proposed CSO control is complete sewer separation. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 percent Capture in a Representative Year	-	-	-		-	-	-	✓	✓	✓	-

Notes:

- = not included
✓ = included

The decision to include complete separation of Parkside as part of the CSO and BFR program has removed a large volume of existing land drainage from the CS system, thereby reducing the volume and number of CSOs for the district. The proposed outfall abandonment would eliminate CSO occurrences entirely from the district.

GI and RTC will be applied within each district on a system-wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Sewer Separation

Sewer separation has been recently completed in the Parkside district as part of the Ferry Road and Riverbend Basement Flood Relief project. Complete separation of Parkside removes a large volume of land drainage runoff from the CS system, thereby reducing the volume and number of CSOs for the district.

The work included installation of a new independent LDS system to collect road drainage. The collected stormwater runoff will be routed through the new LDS via local streets to Winston Drive, east along Parkside Drive and through Jae Eadie Park to a new dedicated LDS outfall discharging to the Assiniboine River.

The flows to be collected after separation will be as follows:

- DWF will remain the same – with it being diverted by gravity to the Riverbend CS LS via the primary weir for the district.
- WWF will consist of sanitary sewage combined with foundation drainage.

This will result in a reduction in combined sewage flow received at Riverbend CS LS after the separation project is complete. It is proposed that future flow monitoring of the district during DWF and WWF is completed to verify that the sewer separation is fully compliant with the modelled removal of all CSOs. A static weir elevation increase may be necessary at the CS diversion to eliminate all occurrences of CSO. Should the flow monitoring confirm the removal of all CSOs occurrences, work to abandon the Parkside CS outfall entirely will be evaluated.

1.6.3 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district will be reviewed to identify the most applicable GI controls.

Parkside has been classified as a medium GI potential district. Land use in Parkside is mainly single-family residential with commercial along Portage Avenue. There are also greenspace areas. This means the district would be an ideal location for bioswales, permeable paved roadways, cisterns/rain barrels, rain gardens, and green roofs. The greenspace areas in the district would be ideal for bioretention garden projects.

1.6.4 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the master plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

Systems operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

Sewer separation will include the installation of additional sewers that will require inspection, cleaning and rehabilitation. This will result in additional maintenance costs over the long term, but operational costs will be minimal. The existing larger CS pipes within the district may also receive insufficient flow with the separation work for proper scouring velocities in the sewer pipes. This could result in solids settling within the sewers, and requiring more frequent cleaning operations. The impacts of the reduced flows in larger CS pipes will be evaluated as part of the sewer separation design for the district.

It is recommended to complete a temporary flow monitoring campaign for the district, and assess the results after district separation work has been completed. This will allow the full understanding of the non-separated storm elements (foundation drain connections to the CS system) extent within the Riverbend district. Should it be confirmed that there is no further CSOs under WWF events, complete decommissioning of the Parkside CS outfall can occur. This will remove the O&M component for this outfall from the City's overall O&M program.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. An individual model was created to represent the sewer system baseline as represented in the year 2013 and a model for the CSO Master Plan with the control options implemented in the year 2037. A summary of relevant model data is summarized in Table 1-5.

Table 1-5. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	11	11	88	77	N/A
2037 Master Plan – Control Option 1	11	8	88	7	SEP

Notes:

Total area is based on the model subcatchment boundaries for the district.
SEP = Separation
% = percent

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district. While this district is to be separated and as a result Clause 8 of Licence No. 3042 will not be in effect, the wet weather response of the district overall will still need to be assessed.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City Of Winnipeg GIS Records. Therefore minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-6, are for the hydraulic model simulations using the year-round 1992 representative year applied uniformly. The table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan – Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. The table also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-6. Performance Summary – Control Option 1

Control Option	Preliminary Proposal Annual Overflow Volume (m^3)	Master Plan Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [a]
Baseline (2013)	2,983	2,979	-	16	0.011 m^3/s
Separation	0	0	2,979	0	TBD
Control Option 1	**0**	**0**	**2,979**	**0**	**TBD**

[a] Pass forward flows assessed up to 5-year design rainfall event. Possible overflow for larger design events to be confirmed.

The percent capture performance measure is not included in Table 1-6, as it is applicable to the entre CS system, and not for each district individually. However, the full capture of overflows volumes for the Parkside district would represent a 100 percent capture rate on a district level.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each relevant control option with overall program costs summarized and described in Section 3.4 of Part 3A of the CSO Master Plan. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-7. The cost estimates are a Class 5 planning level estimate with a level of accuracy range of minus 50 percent to plus 100 percent.

Table 1-7. Cost Estimates – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost [a]	2019 CSO Master Plan Capital Cost [b]	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance (Over 35-year period) [b]
Sewer Separation	$0	$0	$0	$0
Subtotal	**$0**	**$0**	**$0**	**$0**
Opportunities	N/A	$0	$0	$0
District Total	**$0**	**$0**	**$0**	**$0**

[a] Parkside separation was underway at the time of the Preliminary Proposal Cost development, however all costs for the remaining work for the district was already budgeted within the City of Winnipeg. Therefore the remaining separation costs for the district were omitted from the Preliminary Proposal future cost projections.

[b] Parkside separation has been recently completed and therefore zero costs have been included for the Master Plan capital cost and O&M costs. Actual Annual O&M costs were established as $5,200 and Total cost of $120,000 over the 35-year period.

The estimates include updated construction costs based on level of completion of work to date. The calculations for the CSO Master Plan cost estimate include the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional costs for RTC. As there are no capital costs allocated to this district as the work to align with the CSO Master Plan is complete, there has also been no capital costs in this district allocated to GI or RTC opportunities.
- The Preliminary Proposal capital cost is in 2014-dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019 dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-8.

Table 1-8. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	No costs allocated opportunities as capital costs for district removed.

Table 1-8. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Lifecycle Costs	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation	Preliminary Proposal estimates were based on 2014-dollar values	

1.10 Meeting Future Performance Targets

The complete separation of the Parkside district has achieved the 100 percent capture figure, and no further work in this district will be required to meet the future performance target. It is recommended to complete post separation flow monitoring and model calibration to confirm the performance.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk and Opportunity Control Option Matrix covering the district control options has been developed as part of the CSO Master Plan and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-9.

A specific acceptable risk for the Parkside district is connected to the complete sewer separation work already implemented within this district. As a result, no costs for GI opportunities have been allocated, since this cost is a percentage of future capital costs. However, this does not restrict any GI or RTC opportunities from occurring in this district, as in this situation the 10% allowance attributed to other districts will be utilized.

Table 1-9. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	-	-	-	O	-	-	-
2	Existing Lift Station	-	-	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	O	-	-	-
4	Construction Disruption	-	-	-	-	R	-	-	-
5	Implementation Schedule	-	-	-	-	R	-	R	-
6	Sewer Condition	-	-	-	-	-	-	-	-

Table 1-9. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
7	Sewer Conflicts	-	-	-	-	R	-	-	-
8	Program Cost	-	-	-	-	R	-	-	-
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	-	-	-	-	O	O	O	-
12	Operations and Maintenance	-	-	-	-	R / O	R	O	-
13	Volume Capture Performance	-	-	-	-	-	O	O	-
14	Treatment	-	-	-	-	O	O	O	-

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

Wardrop. 2006. *Ferry Road and Riverbend Combined Sewer Relief Works*. Prepared for the City of Winnipeg Water and Waste Department. November.

LEGEND

Critical Elevation	Inter-System Connection	District Boundary Crossing	Force Main	District Boundary
CSO Outfall	CS - WWS	CS	Street	Watercourse
Low CS Manhole		WWS		Greenspace

CSO MASTER PLAN PROPOSED SOLUTIONS

Sewer Separation - Complete

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 32
District Overview Map
Sewer District: Parkside
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Polson District Plan

August 2019

City of Winnipeg

CSO Master Plan

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2	07/2019	Final Draft Submission	DT/MF	MF	MF
3	08/20/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

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Figure

1. Polson District

1.1 District Description

Polson district is located in the northern section of the combined sewer (CS) area west of the Red River and north of St Johns district. Polson is approximately bounded by Church Avenue and Atlantic Avenue to the south, Tinniswood Street and McPhillips Street to the west, Polson Avenue, Carruthers Avenue and McAdam Avenue to the north, and the Red River to the east.

The district is mainly a residential area with a mix of single and two-family land use. The single-family homes are located in the west, east and north part of the district, while the two-family homes are located in the south-central portion around Main Street. Approximately 20 ha of greenspace is distributed throughout the district at schools and various parks and playgrounds.

The Canadian Pacific Railway (CPR) Winnipeg Beach passes through the Polson district parallel with Sinclair Street running north-south. Regional transportation routes in the district include Main Street, Salter Street, McGregor Street, Arlington Street and McPhilips Street in a north-south direction and Inkster Boulevard in the east-west direction.

1.2 Development

A portion of Main Street is located within the Polson District. Main Street is identified as Regional Mixed Use Corridor as part of the OurWinnipeg future development plans. As such, focused intensification along Main Street is to be promoted in the future.

1.3 Existing Sewer System

Polson district encompasses an approximate area of 242 ha[1] based on the district boundary and includes a CS system and a storm relief sewer (SRS) system. This district does not include any areas that may be identified as LDS separated or separation ready. The interceptor pipe from the Polson district also receives intercepted combined sewage flow from the Munroe sewage pump station (SPS) via river crossing across the Red River. The flow from Munroe SPS connects into the interceptor pipe for the Polson district, immediately upstream of the diversion off-take pipe for the Polson outfall.

The CS system includes a diversion structure, flood pump station (FPS) and outfall gate chamber. The CS system drains towards the Polson CS outfall and diversion chamber, located at the eastern end of Polson Avenue and Scotia Street adjacent to the Red River. There are three primary routes for CS to flow to the diversion chamber. A 1750 mm by 2175 mm CS trunk collects all flow from the district areas west of Main Street and runs primarily along Polson Avenue. A 750 mm CS services the northeastern areas of Polson east of Main Street which runs south along Scotia Street. Finally, a 750 mm CS services the southeastern section of Polson from Emsue Street to Scotia Street and also runs north along Scotia Street. At the outfall, combined sewage is diverted to the Polson secondary interceptor and back to the Main Street interceptor, or may be discharged by gravity/via the FPS adjacent to the CS outfall directly into the Red River. Intercepted combined sewage flow from the Munroe district enters the Polson district from across the Red River via a 450mm/300mm steel force main river crossing, and discharges into the 750 mm diameter secondary interceptor adjacent to the flood pump station, which also received the intercepted combined sewage from the Polson district as a whole. The SRS system within the Polson district includes various interconnections to the CS system and an outfall gate chamber. The SRS system is installed throughout most of the district and connects to the CS system via various interconnections which consist of overflow pipes and weirs. During runoff events, the SRS system provides relief to the CS system in the Polson district. Most catch basins are still connected into the CS system, so no partial

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

separation has been completed and the SRS system acts as an overflow conduit for the CS to prevent basement surcharge. The SRS system discharges directly to the Red River through the Inkster SRS outfall located near the intersection of Inkster Boulevard and Scotia Street. Upstream of the Inkster SRS outfall is an SRS offtake pipe which will divert all collected CS in the SRS system into the Polson secondary interceptor and back into the CS system, under DWF and minor WWF conditions. A flap gate and sluice gate is installed on the Inkster SRS outfall pipe to control backflow into the SRS system.

During dry weather flow (DWF), the SRS is not required; sanitary sewage is diverted by the weir within the Polson FPS, through a 500 offtake to the 750 mm Polson secondary interceptor pipe and back to the Main Street interceptor by gravity and on to the North End Sewage Treatment Plant (NEWPCC) for treatment.

During wet weather flow (WWF), any flow that exceeds the diversion capacity overtops the weir and is discharged through the gate chamber to the Polson CS outfall to the Red River. Sluice and flap gates are installed on the CS outfall to prevent back-up of the Red River into the CS system. When the Red River levels are particularly high the flap gate prevents gravity discharge from the Polson CS outfall. Under these conditions the excess flow is pumped by the Polson FPS to a point in the Polson CS Outfall downstream of the flap gate, where it can be discharged to the river by gravity.

The two outfalls to the Red River (one CS, and one SRS) are as follows:

- ID30 (S-MA00017967) – Polson CS Outfall
- ID32 (S-MA00017939) – Inkster SRS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Polson and the surrounding districts. Each interconnection is shown on Figure 33 and shows locations where gravity and pumped flow can cross from one district to another. Each interconnection is listed as follows:

1.3.1.1 Interceptor Connections - Downstream of Primary Weir

Jefferson E

- The 2250 mm Main Interceptor flows north by gravity on Main Street from Polson district into Jefferson East district:
  - Invert at Jefferson East district boundary 218.03 m (S-MA70008112)

St Johns

- The 750 mm Interceptor flows west by gravity on Polson Street from Polson district into St Johns district into the 2250 mm Main Interceptor on Main Street:
  - Invert at St Johns district boundary 219.54 m (S-MA00018028)

1.3.1.2 Interceptor Connections - Upstream of Primary Weir

Munroe

- Two force mains river crossings flow by gravity from the Munroe diversion chamber and cross the Red River to connect to the Polson CS diversion chamber on Polson Avenue, where it flows to the Main Interceptor:
  - 450 mm force main sewer on Polson Avenue – 222.5 m (S-MA70017149)
  - 300 mm force main sewer on Polson Avenue – 222.5 m (S-MA70017147)

1.3.1.3 District Interconnections

St Johns

CS to CS

- The main 1675 mm by 2150 mm CS trunk in Polson district flows by gravity into St Johns district at the corner of Polson Avenue and Main Street:
  - Invert at Polson district boundary 222.99 m (S-MA00009348)
- The main 1750 mm by 2175 mm CS trunk flows east by gravity back into Polson district at the corner of Polson Avenue and Main Street:
  - Invert at St Johns district boundary 223.07 m (S-MA00009318)
- A 925 mm by 1200 mm CS flows southbound on Main Street servicing sections of Polson district and crosses into St Johns district where it connects to the main CS trunk at the corner of Polson Avenue and Main Street:
  - Invert at St Johns district boundary 223.45 m (S-MA00009340)
- High point manhole:
  - Tinniswood Street – 229.48 m (S-MH00008542)
  - Radford Street – 229.45 m (S-MH00008556)
  - Monreith Street at Church Avenue – 229.24 m (S-MH00008543)
  - Robertson Street at Church Avenue – 228.90 m (S-MH00010474)
  - Kildarroch Street – 229.08 m (S-MH00010481)
  - Airlies Street at Church Avenue – 228.78 m (S-MH00010493)
  - Minnigaffe Street at Church Avenue – 229.271 m (S-MH00010536)
  - Penninghame Street at Church Avenue – 228.82 m (S-MH00010604)
  - Luxton Avenue – 228.34 m (S-MH00011069)
  - Atlantic Avenue – 227.71 m (S-MH00014025)
  - Bannerman Avenue at Emslie Street – 228.19 m (S-MH00014033)
  - Cathedral Avenue at Emslie Street – 227.68 m (S-MH00014021)
- High sewer overflow:
  - Dalton Street at Machray Avenue – 229.35 m (S-MH00010407)
  - Bannerman Avenue – 227.96 m (S-MH00006413)

SRS to CS

- A 750 mm SRS flows northbound by gravity on Salter Street and connects to the CS system in Polson district at the intersection of Salter Street and Polson Avenue:
  - Invert at Polson district boundary 224.55 m (S-MA00009212)
- A 450 mm SRS provides relief from the manhole at the intersection of Atlantic Avenue and Aikins Street in St Johns district and flows by gravity to connect to the main CS in Polson district:
  - Invert at Polson district boundary 224.21 m (S-MA00009270)
- A 450 mm SRS flows by gravity from a manhole at the intersection of Main Street and Luxton Avenue where it relieves the CS and connects to the 925 mm by 1200 mm CS in Polson district:
  - Invert at Polson district boundary 224.05 m (S-MA00009352)

SRS to SRS

- A 375 mm SRS flows southeast by gravity at Cathedral Avenue and Emslie Street from Polson district into St Johns district:

- Invert at St Johns district boundary 225.69 m (S-MA00016728)

- A 450 mm SRS flows south by gravity on Emslie Street from Polson district into St Johns district:
  - Invert at St Johns district boundary 225.43 m (S-MA00015777)
- A 750 mm SRS relieves the CS system on Machray Avenue in Polson district and flows by gravity southbound on Kildarroch Street into St Johns district where it connects to the main 2900 mm SRS on Mountain Avenue:
  - Invert at St Johns district boundary 225.20 m (S-MA00012123)

Jefferson West

<u>CS to CS</u>

- High point manhole:
  - Machray Avenue at McPhillips Street – 228.74 m (S-MH00007230)

Jefferson East

<u>CS to CS</u>

- High point manhole
  - Polson Avenue – 229.11 m (S-MH00009095)
- High sewer overflow:
  - McGregor Street at Carruthers Avenue – 228.60 m (S-MH00006709)

<u>SRS to SRS</u>

- An 2950 mm SRS flows by gravity on Inkster Boulevard from Jefferson East district into Polson district SRS system:
  - Invert at Polson district boundary 223.00 m (S-MA00008238)

<u>SRS to CS</u>

- An 1800 mm SRS relieves the main CS trunk on Polson Avenue and flows by gravity northbound on Airlies Street from Polson district to Jefferson East district. It connects with the Jefferson East CS network at the corner of Inkster Boulevard and Airlies Street before continuing onto Inkster Boulevard:
  - Invert at Jefferson East district boundary 224.01 m (S-MA00011342)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing system.

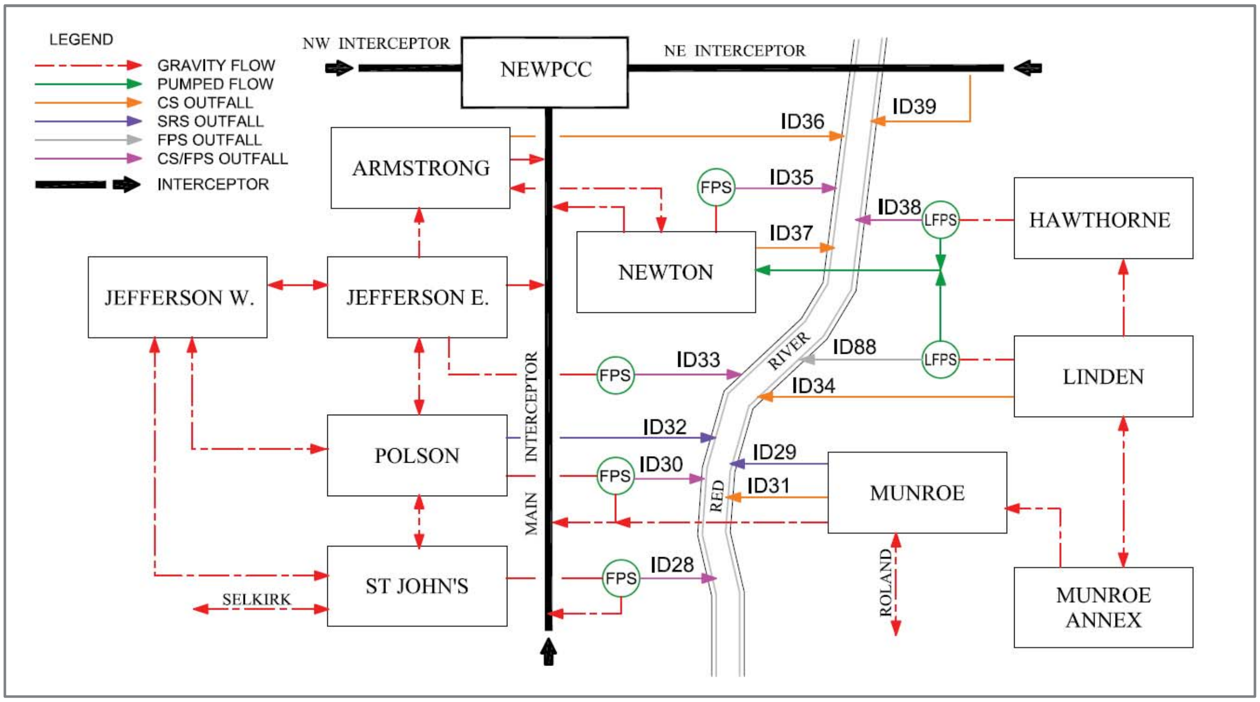


Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 33 and listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID30)	S-AC00007716.1	S-MA00017967	1750 x 2175 mm – 1800 mm	Red River Invert: 222.38 m
Flood Pumping Outfall (ID30)	S-AC00007716.1	S-MA00017967	1750 x 2175 mm – 1800 mm	Red River Invert: 222.38 m
Other Overflows	N/A	N/A	N/A	
Main Trunk	Polson Flood PS.1	S-MA70016460	1750 x 2175 mm	Egg-shaped Invert: 222.38 m
SRS Outfalls (ID32)	S-AC00007709.1	S-MA00017939	2900 mm	Red River Invert: 220.60 m
SRS Interconnections	N/A	N/A	N/A	38 SRS - CS
Main Trunk Flap Gate	S-CG00001045.1	S-CG00001045	2000 mm	Invert: 222.92 m
Main Trunk Sluice Gate	S-CG00001046.1	S-CG00001046	2000 x 2000 mm	Invert: 222.76 m
Off-Take	S-AC70007899.1	S-MA00017968	500 mm	Invert: 222.53 m
Dry Well	N/A	N/A	N/A	
Lift Station Total Capacity	N/A	S-MA00017968 (1)	500 mm (1)	1.578 m^3/s (1)
ADWF	N/A	N/A	0.170 m^3/s	
Lift Station Force Main	N/A	N/A	N/A	
Flood Pump Station Total Capacity	N/A	N/A	1.82 m^3/s	1 x 0.74 m^3/s 2 x 0.54 m^3/s
Pass Forward Flow – First Overflow	N/A	N/A	0.298 m^3/s	

Notes:

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments

[(1)] – gravity pipe replacing the Lift Station as Polson is a gravity discharge district

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Polson – 223.67 Inkster – 223.67
2	Trunk Invert at Off-Take	222.53
3	Top of Weir	223.12
4	Relief Outfall Invert at Flap Gate	221.85
5	Low Relief Interconnection (S-TE70023427)	223.98
6	Sewer District Interconnection (St Johns)	222.96
7	Low Basement	229.82
8	Flood Protection Level	229.04

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed in the Polson district was the Flood Relief Study (IDE, 1980). An SRS system was installed in the district as a result of this study. No other work has been completed on the district sewer system since that time.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Polson CS district was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations have a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Planned Completion
33 – Polson	1980 I.D. Engineering	Future Work	2013	SRS Relief Sewer Installed	N/A

Source: Report on Flood Relief Study, 1980

1.5 Ongoing Investment Work

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Polson district. This consists of monthly site visits in confined entry spaces to ensure physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Polson sewer district are listed in Table 1-4. The proposed CSO control projects will include gravity flow control and an alternative floatable management approach. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	-	-	✓	-	-	-	-	-	✓	✓	✓ [a]

Notes:

- = not included
✓ = included

[a] = proposed alternative floatables management approach

The existing SRS system is suitable for use as latent storage. An existing drain from the SRS system to the CS system already provides the necessary dewatering of the latent storage by gravity. Further improvements in the latent storage arrangements could be made with the addition of a latent flood pumping station (LFPS) but it was determined this would not be required to meet the Control Option 1 performance target.

The existing CS system was found to already provide sufficient in-line storage capture based on the outfall and CS LS elevations relative to the Red River. From modeling the sewer system in the Polson district, it was found that the NSWL at this location was well above the primary weir. The NSWL was found to be approximately 100mm above the half pipe diameter height, which would have been provided by the control gate installation. The NSWL bears against the flap gate on the CS outfall at this location, and essential behaves as a weir with this height under these conditions. Under these conditions the installation of a control gate would not provide any further improvement to the volume of in-line storage volume capture, and was therefore not recommended as a solution for the Polson district. It should be noted that if modifications to the modelling methods dictate a river level other than the NSWL be applied this should be further evaluated. If it is found through these modifications that the river level no longer impacts CS discharges from this outfall, then further evaluation of the potential to construct a control gate to provide additional in-line storage should be completed.

The Polson district discharges to the interceptor by gravity; therefore, it will also require a method of gravity flow control to optimize and control the discharge rate to the interceptor for future dewatering Real Time Controls (RTCs).

Floatable control will be necessary to capture any undesirable floatables in the sewage overflows. Floatables are typically captured via a screening facility, however, the hydraulic constraints within the Polson district do not allow sufficient positive head to be achieved and an alternative floatables management approach will be necessary.

GI and RTC will be applied within each district on a system-wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Gravity Flow Control

Polson district does not include a LS and discharges to the Main Interceptor by gravity. A flow control device will be required to control and monitor the diversion rate for future RTC and dewatering. The controller will include flow measurement and a gate to control the discharge flow rate. Due to the interaction with the upstream Munroe district, this control would also have to account for the pumped flows from the Munroe district. Any flow restriction will have to be fully assessed to minimize the risk to both districts.

A standard flow control device was selected as described in Part 3C. This has been taken as part of the City's future vision to develop a fully integrated CS system network and will be needed to review flows during spatial rainfall WWF scenarios. The CSO Master Plan assessment utilized a uniform rainfall event and no further investigative work has been completed within the CSO Master Plan.

The gravity flow controller would be installed at an optimal location on the connecting sewer between the existing diversion chamber and the Main Street interceptor. Figure 33-01 identifies a conceptual location for flow controller installation. A small chamber or manhole with access for cleaning and maintenance will be required. The flow controller will operate independently and require minimal operation interaction. The work proposed will take place within the boulevard of a minor residential collector street, with minimal disruption to the local area expected.

A gravity flow controller has been included as a consideration in developing a fully optimized CS system as part of the City's long-term objective. The operation and configuration of the gravity flow controller will have to be further reviewed for additional flow and rainfall scenarios.

1.6.3 Floatables Management

Floatables management for the Polson district, due to the existing hydraulic constraints, is proposed to be an alternative floatables management approach. This approach is to ensure that the proposed required floatable management requirements outlined within the Environment Act Licence 3042 can be maintained.

This alternative approach to floatables management will be achieved by targeting floatables source control. This will be achieved by implementing more focused efforts towards street cleaning and catch-basin cleaning, to remove floatable material from surface runoff before it enters the combined sewer system. The second broad component of this alternative approach will focus on public education in an effort to reduce the sanitary components from ever entering plumbing systems. This is expected to achieve similar or better results while eliminating the end-of-pipe screening. The proposed approach will be similar to the program currently carried out in the City of Ottawa to meet their CSO mitigation requirements.

The alternative approach will be further investigated and demonstrated during the interim period between the submission of the CSO Master Plan (August 2019) and the revised CSO Master Plan submission (April 2030), and is discussed in further detail in Part 2 of the CSO Master Plan. It is recommended that as part of this work these measures will be undertaken in the Polson district, due to screening limitations mentioned above.

1.6.4 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography, and soil classification for the district will be reviewed to identify applicable GI controls.

Polson has been classified as a medium GI potential district. The district is mainly a residential area with a mix of single and two-family land use. This means the district would be an ideal location for bioswales, permeable paved roadways, cisterns/rain barrels.

1.6.5 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

The flow controller will require the installation of a chamber and flow control equipment. Monitoring and control instrumentation will be required. The flow controller will operate independently and require minimal operation interaction. Regular maintenance of the flow controller chamber and appurtenances will be required.

The alternative floatable management control is based on implementing additional operating and maintenance measures, in an effort to match the performance of the capital construction projects to meet the floatables management requirements. As such dedicated additional operating and maintenance costs should be allocated to this district. The goal however is for this work to overall be more cost effective from a life cycle perspective, considering the upfront capital and operating and maintenance costs associated with screening facilities.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. An individual model was created to represent the sewer system baseline as represented in the year 2013 and a second model was created for the CSO Master Plan evaluation purposes, with all the control options recommended for the district to meet Control Option 1 implemented in the year 2037. A summary of relevant model data is provided in Table 1-5.

Table 1-5. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	242	242	10,500	70	N/A
2037 Master Plan – Control Option 1	242	242	10,500	70	N/A

Notes:

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-6 are for the hydraulic model simulations using the year-round 1992 representative year. This table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. Note that as a result of the CSO Master Plan Assessments, all Control Options which would provide a volume capture benefit were not recommended. As a result, there be no improvements in terms of overflow reduction. Due to issues surrounding dewatering of the district, the performance results are in fact increased above the baseline results. This is further detailed below.

Table 1-6. District Performance Summary – Control Option 1

Control Option	Preliminary Proposal Annual Overflow Volume (m^3)	Master Plan Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [b]
Baseline (2013)	436,714	455,282	-	20	0.373 m^3/s
In-line Storage	317,812 [a]	N/A [c]	N/A [c]	N/A [c]	N/A [c]
Off-line Storage		N/A [c]	N/A [c]	N/A [c]	N/A [c]
Tunnel Storage		N/A [c]	N/A [c]	N/A [c]	N/A [c]
Control Option 1	**317,812**	**455,282 [d]**	**N/A [d]**	**20**	**0.295 m^3/s**

[a] In-line, Off-line and Tunnel storage not simulated independently during the Preliminary Proposal assessments.

[b] Pass forward flows assessed on the 1-year design rainfall event

[c] This control option not recommended as part of the Master Plan assessment.

[d] Modelled increase in overflow volume found due to dewatering constraints in the Polson district, interaction with adjacent districts and high water levels within the Main Interceptor during peak rainfall events.

The district performance summary indicates the high level of interaction between the Polson district and the existing CS system, resulting in erroneous performance. This is primarily due to the additional CS contained within the Main Interceptor at the point the Polson district ties in. All of the additional volume capture from the solutions recommended throughout the CSO Master Plan result in insufficient capacity available in the Main Interceptor to accommodate the captured volume from the Polson district. As a result from the system-wide modelling assessments the volume captured would surcharge within the Polson secondary interceptor, and ultimately spill over the primary weir and result in CSOs. The issue that must be corrected to allow for the existing in-line storage arrangement to provide volume capture is to ensure the Main Interceptor has sufficient capacity to accommodate this flow. Therefore the Polson district should be prioritized to be implemented in tandem with Real Time Control (RTC), as part of the dewatering strategy. By implementing RTC with the dewatering strategy, neighboring districts dewatering can be delayed sufficiently to allow the volume capture from the Polson district to be collected within the interceptor system and sent to treatment.

The percent capture performance measure is not included in Table 1-6, as it is applicable to the entire CS system and not for each district individually.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-7. The cost estimates are AACE Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-7. Cost Estimates – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance (Over 35-year period)
In-line Control Gate	N/A [a]	N/A	N/A	N/A
Screening		N/A	N/A	N/A
Latent Storage	$1,670,000	N/A	N/A	N/A
Gravity Flow Control	N/A	$1,290,000	$34,000	$740,000
Off-line Tank Storage	$16,430,000	N/A	N/A	N/A
Off-line Tunnel Storage	$7,400,000	N/A	N/A	N/A
Floatables Management Allowance	N/A	$2,540,000 [b]	$40,000	$860,000 [b]
Subtotal	**$25,**490,000	**$3,830,000**	**$74,000**	**$1,600,000**
Opportunities	N/A	$380,000	$7,000	$160,000
District Total	**$25,490,000**	**$4,210,000**	**$81,000**	**$1,760,000**

[a] Solution developed as refinement to Preliminary Proposal work following submission of Preliminary Proposal costs. Costs for the In-Line Storage and Screening items of work found to be $2,330,000 in 2014 dollars

[b] Cost allowance to account for the alternative floatable management measures. This allowance is based on a typical district control gate cost.

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- Refinements in solutions selected from analysis during Master Plan phase.
- A fixed allowance of 10 percent has been included for GI, with no additional costs for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014-dollar values.

- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019-dollar values:
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-8.

Table 1-8. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Removal of Control Gate	The Master Plan assessment found that in-line storage was sufficiently provided by the existing outfall based on the river level in that location.	
	Removal Of Screening	Screening determined to not be feasible due to hydraulic constraints.	
	Alternative Floatables Management	Added to Master Plan cost, assumed to be comparable to typical control gate projected cost.	
	Removal Of Latent Storage	Minor latent storage arrangement currently in place by gravity, therefore no cost added to Master Plan	
	Removal Of Off-line Tunnel Storage	The Master Plan assessment found that off-line tunnel storage was not a preferred control solution for CO1.	
	Removal Of Off-line Tank Storage	The Master Plan assessment found that off-line tank storage was not a preferred control solution for CO1.	
Opportunities	A fixed allowance of 10 percent has been included for program opportunities such as Green Infrastructure.	Preliminary estimate did not include a cost for opportunities	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management Approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation.	Preliminary estimates were based on 2014-dollar values.	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, a future performance target of 98 percent capture for the representative year measured on a system-wide basis was evaluated. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-9 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified for Control Option 1.

Overall the Polson district would be classified as a low potential for implementation of complete sewer separation as the only feasible approach to achieve the 98 percent capture future performance target in the representative year. The interactions with upstream Jefferson West SRS system would result in continued CSOs at the Polson district (via the Inkster SRS outfall) and this would require assessment and quantifying prior to selection of appropriate future control options. Off-line storage was previously recommended for the district as part of the Preliminary Proposal, and could be utilized once the interactions with the Jefferson West SRS is evaluated. Focused use of green infrastructure, and reliance on said green infrastructure as well can provide volume capture benefits and could be utilized to meet future performance targets.

A future monitoring program is recommended to establish the flow linkage between Polson, Jefferson West, Jefferson East and Munroe districts as well as the Main Interceptor sewer.

Table 1-9. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Off-line Storage (Tank or Tunnel) • Increased use of GI

The control options for the Polson district have been aligned for the requirement to provide screening on each of the primary outfalls and not specifically for the 85 percent capture performance target on a system wide basis, although district hydraulic issues result an alternative floatables management approach being recommended. The gravity discharge and interaction with the upstream Munroe and Jefferson West districts, and the downstream Main Interceptor sewer system result in a negative impact at this location, once all other Control Option 1 proposals have been implemented.

The cost for upgrading to meet an enhanced performance level depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-10.

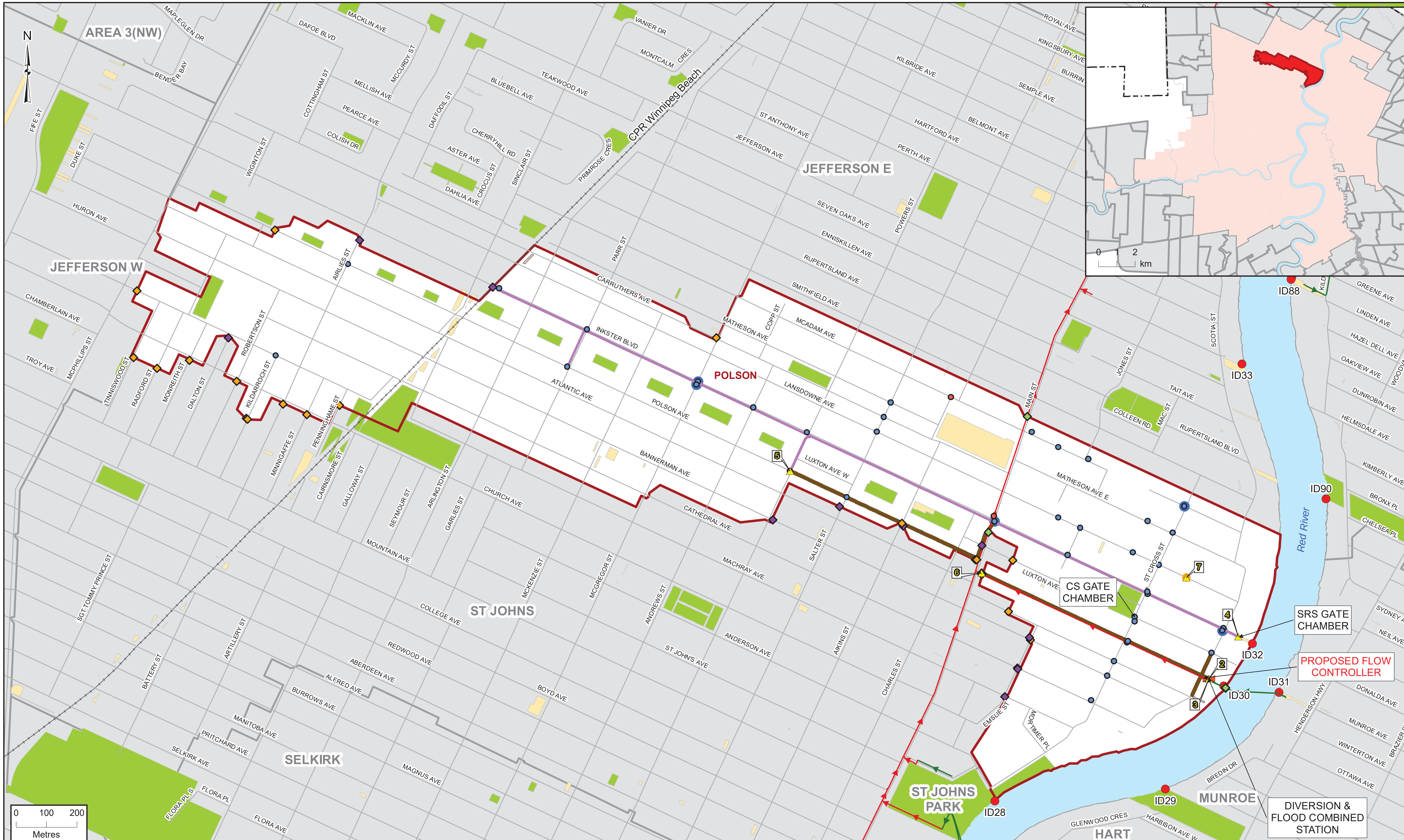
Table 1-10. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	-	-	-	-	-	-	-
2	Existing Lift Station	-	-	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	-	-	-	-
4	Construction Disruption	-	-	-	-	-	-	-	-
5	Implementation Schedule	-	-	-	-	-	-	R	-
6	Sewer Condition	-	-	-	-	-	-	-	-
7	Sewer Conflicts	-	-	-	-	-	-	-	-
8	Program Cost	-	-	-	-	-	-	-	O
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	-	-	-	-	-	O	O	R
12	Operations and Maintenance	-	-	-	-	-	R	O	R
13	Volume Capture Performance	-	-	-	-	-	O	O	-
14	Treatment	-	-	-	-	-	O	O	R

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

I.D. Engineering. 1980. Flood relief study - St. John's and Polson districts and the Sisler ward. Prepared for the City of Winnipeg.



LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Low CS Manhole
- Low SRS Connection

Inter-System Connection
- CS - WWS
- SRS - CS

District Boundary Crossing
- CS
- SRS
- WWS

- Existing Latent Storage Limit
- Extent of Existing In-line Storage
- Interceptor Sewer
- Force Main
- Street
- Railway

- District Boundary
- Watercourse
- Greenspace
- City Owned Land

CSO MASTER PLAN PROPOSED SOLUTIONS

Note: Alternative Floatables Management Approach to be tested prior to implementation.

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 33
District Overview Map
Sewer District: Polson
City of Winnipeg
Combined Sewer Overflow Master Plan

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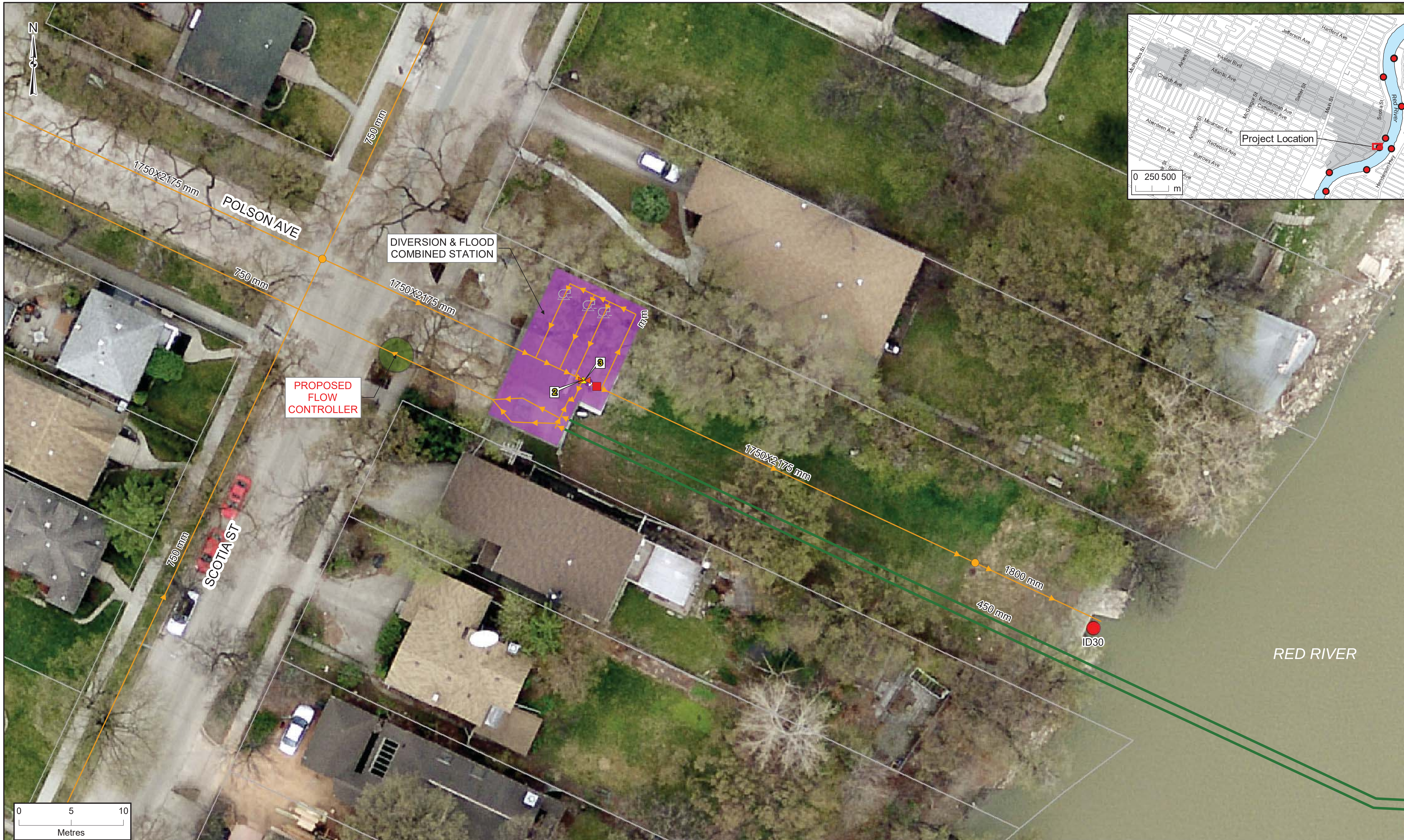

LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Manhole
- Flap Gate
- Sluice Gate
- Pump Location
- Force Main
- Sewer By Type
  - CS
  - WWS
- Pump Station Type
  - Diversion & Flood Combined Station
- Land Parcel

CSO MASTER PLAN PROPOSED SOLUTIONS

- Flow Controller

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 33-01
Flow Controller
Sewer District: Polson
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

River District Plan

August 2019

City of Winnipeg

CSO Master Plan

Project No:	470010CH
Document Title:	River District Plan
Revision:	03
Date:	August 18, 2019
Client Name:	City of Winnipeg
Project Manager:	John Berry
Author:	Jack Tinker
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Document History and Status

Revision	Date	Description	By	Review	Approved
0	07/2018	Version 1 DRAFT	SG	ES	
1	03/22/2019	Version 2 DRAFT	JT	SG	MF
2	07/2019	Final Draft Submission	DT	MF	MF
3	08/18/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

Tables

Figure

1. River District

1.1 District Description

River district is situated immediately south of the junction of the Assiniboine River and Red River, and is just south of downtown Winnipeg. The boundaries are the Assiniboine River to the north and west, the Red River to the east, and the Jessie combined sewer (CS) district to the south. Jessie Avenue and Daly Street act as the southern border for the district. River district is three-quarters residential and one-quarter commercial land use, with the commercial businesses located along Pembina Highway and Osborne Street. River district is a high traffic and densely populated area, with the presence of Osborne Village, which includes many restaurants, shops, and services.

The major transportation routes are Pembina Highway, Donald Street, and Osborne Street; each of which travel north into downtown Winnipeg or south into the Jessie district. The Canadian National Railway Mainline passes over Osborne Street and parallel with Donald Street. It travels north towards The Forks in the Bannatyne district and south into Jessie district.

The residential section of River district is a mix of single-family houses to the west and high-rise apartments predominately based along the Assiniboine River. A major non-residential feature is the Winnipeg Winter Club, which is located on the southeastern corner of River Avenue and Donald Street. The Southwest Bus Rapid Transit Corridor travels along the eastern boundary of the River District and ends at Queen Elizabeth Way.

Approximately 21 ha of the River district is made up of greenspace, which includes Gerald James Lynch Park, Fort Rouge Park, and Mayfair Park East and West, all located on River Avenue. South Point Park is located in the northern corner of the district.

1.2 Development

River district includes a significant portion of the Osborne Village area, and the potential for redevelopment and further densification in the future is high. Redevelopment within this area could impact the CS and will be investigated on a case-by-case basis for potential impacts to the combined sewer overflow (CSO) Master Plan. All developments within the CS districts are mandated to offset any peak combined sewage discharge by adding localized storage and flow restrictions, in order to comply with Clause 8 of the Environment Act License 3042.

The Southwest Bus Rapid Transit Corridor is also located along the eastern boundary of the River District. Existing land adjacent to this transit corridor will be prioritized to be developed into a higher density, mixed-use community, to align with Transit Oriented Development (TOD) principles.

A portion of Pembina Highway and Osborne Street are located within River district. These streets are identified as Regional Mixed Use Corridors as part of the Our Winnipeg future development plans. As such, focused intensification along Pembina Highway and Osborne Street is to be promoted in the future.

1.3 Existing Sewer System

The River district has an approximate area of 130 ha[1] based on the district boundary. The district is serviced by both a CS system and storm relief sewer (SRS) system. There is a small section serviced by a land drainage sewer (LDS). There is no separated or separation ready areas.

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

River district receives the sewage from the Jessie district through dual 300 mm force mains that connect into the 600 mm secondary interceptor pipe on Clarke Street. The Clarke Street secondary interceptor then connects to the CS trunk on River Avenue. As a result the intercepted combined sewage from the Jessie district is intercepted once more by the primary weir in the River district. The River district also receives pumped combined sewage flow from the Marion district through a 500 mm force main. The Marion LS force main connects into the Mayfair LFPS force main downstream of the LFPS.

The CS system includes a combined lift and flood pump station (LFPS), one combined FPS and CS outfall and one SRS outfall. All domestic wastewater and CS flows collected in River district are routed to Mayfair Avenue, where the Mayfair LFPS and outfall are located. Sewage primarily flows through the main 1000 by 1500 mm CS trunk that runs eastbound on River Avenue. All minor CSs within River district connect to the main CS trunk including flow from Jessie district. The force main from Jessie connects to this main CS at the eastern edge of River Avenue. A CS varying in size runs along Nassau Street North collecting combined sewage from the south western part of the River district. All other streets include minor CSs that flow by gravity towards the main CS trunks and Mayfair LFPS. The height of the existing primary weir in the Mayfair LFPS is high enough that it negates the need to add a control gate to utilize additional in-line storage. A level of in-line storage is provided by the existing primary weir height. This is discussed in further detail in Section 1.6.3 below.

During heavy rainfall events, the SRS system provides relief to the CS system in the River district. Most catch basins are still connected into the CS system, so the SRS acts as an overflow conduit for the CS system with the captured CS flow continuing to the Mayfair CS LS. The SRS system was completed in 1967, with a main 1650 mm trunk along Scott Street, and connects to a dedicated SRS outfall pipe at Fort Rouge Park off River Avenue. A flap gate and sluice gate installed along the outfall pipe prevents river water from backing up into the SRS system under high river level conditions. Latent storage pumps are located upstream of the flap gate. Where high river levels keep the flap gate closed, the pumps keep the SRS dewatered following wet weather events. The pumps discharge upstream of the River district primary weir, but are prevented from dewatering in the event of high levels in the River CS System. SRS sub-trunks along River Avenue, Clarke Street, Roslyn Road, and Stradbrook Avenue branch out from the main SRS trunk sewer. In addition, there are SRS which relief existing combined sewers on Wellington Crescent, Wardlaw Avenue, and Gertrude Avenue, and re-connect to the CS system on the CS trunk on Osborne Street.

A minor land drainage sewer (LDS) system within the River district services a portion of the Southwest Transit Corridor. The majority of this LDS connect directly to the River LFPS where both the overflow from the CS system and the LDS flow gravity through a combined outfall pipe to the Assiniboine River. A portion of the LDS system installed with the Southwest Transit Corridor also ties into the existing SRS system. There is also localized LDS installation work installed in the southeast corner of the River district servicing businesses surrounding the Osborne Junction. This LDS work also eventually ties into the SRS system.

During dry weather flow (DWF), intercepted sewage flows are directed by the primary weir to the Mayfair LFPS and pumped across the Assiniboine River via a 500 mm and 600 mm dual river crossing to connect to the Main interceptor in the Bannatyne district. The Main interceptor then eventually reaches the North End Sewage Treatment Plant (NEWPCC) for treatment.

During wet weather flow (WWF), any flow that exceeds the diversion capacity of the primary weir is discharged into the River CS/FPS outfall, where it flows to the Red River by gravity. Sluice and flap gates are installed on the CS outfall to prevent back-up of the Assiniboine River into the systems under high river level conditions. Under these high river level conditions and when gravity discharge through the outfall is not possible, the excess flow is pumped within the LFPS and redirected to a point in the combined outfall downstream of the flap and positive gates allowing gravity discharge to the river once more. Note that the Mayfair LFPS utilizes the same pumps for both pumping intercepted CS to the river crossing as mentioned above, and for redirecting excess CS to the CS outfall under high river level conditions. A small LDS system also discharges to the LFPS, collecting storm flows from a small area along Stradbrook Avenue, and discharges to the Mayfair LFPS downstream of the primary weir.

The two outfalls (one CS and one SRS) to the Assiniboine River are as follows:

- ID70 (S-MA70004387) – River CS/FPS Outfall
- ID67 (S-MA60020193) – Fort Rouge Park SRS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between the River district and the surrounding districts. Each interconnection is shown on Figure 34 and shows gravity and pumped flow from one district to another. Each interconnection is listed as follows:

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

Bannatyne

- Two force mains (600 mm and 500 mm diameter) convey sewage across the Assiniboine River at Queen Elizabeth Way and Main Street flow out of River district into Bannatyne district:
  - Invert at Queen Elizabeth Way in Bannatyne district, flowing from River District – 227.72 m
  - Invert at Queen Elizabeth Way in Bannatyne district, flowing from River District – 227.72 m

1.3.1.2 Interceptor Connections – Upstream of Primary Weir

Jessie

- The Jessie CS LS has two 300 mm force mains that convey flow into River district from Jessie district:
  - Southwest Transit Corridor and Jessie Avenue invert at district boundary – 230.41 m

Marion

- A 500 mm force main conveys sewage from Marion CS LS and across the Red River at Queen Elizabeth Way and St. Mary's Road flowing from Marion district into River district:
  - Invert at Queen Elizabeth Way in River district, flowing from Marion district – 225.06 m

1.3.1.3 District Interconnections

Jessie

<u>CS to SRS</u>

- A 450 mm SRS discharges into Jessie district CS system at the intersection of Jessie Avenue, between Pembina Highway and Osborne Street:
  - Southern River District SRS Tie-In – 224.35 m (S-MA70010953)
- A 350 mm SRS in the River district discharges into Jessie CS system by gravity flow at the intersection of Corydon Avenue and Daly Street:
  - Corydon Avenue SRS Tie-In – 228.353 m (S-MH60008961)
- A 250 mm SRS in the River district CS discharges into Jessie CS system by gravity flow at the intersection of McMillan Avenue and Daly Street:
  - McMillan Avenue SRS Tie-In – 228.32 m (S-MH70016737)
- High Sewer Overflow (SRS overflow pipe connects River's CS to Jessie's CS system).
  - Wellington Crescent & Gertrude - 229.06 m (S-MH60017449)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing district.

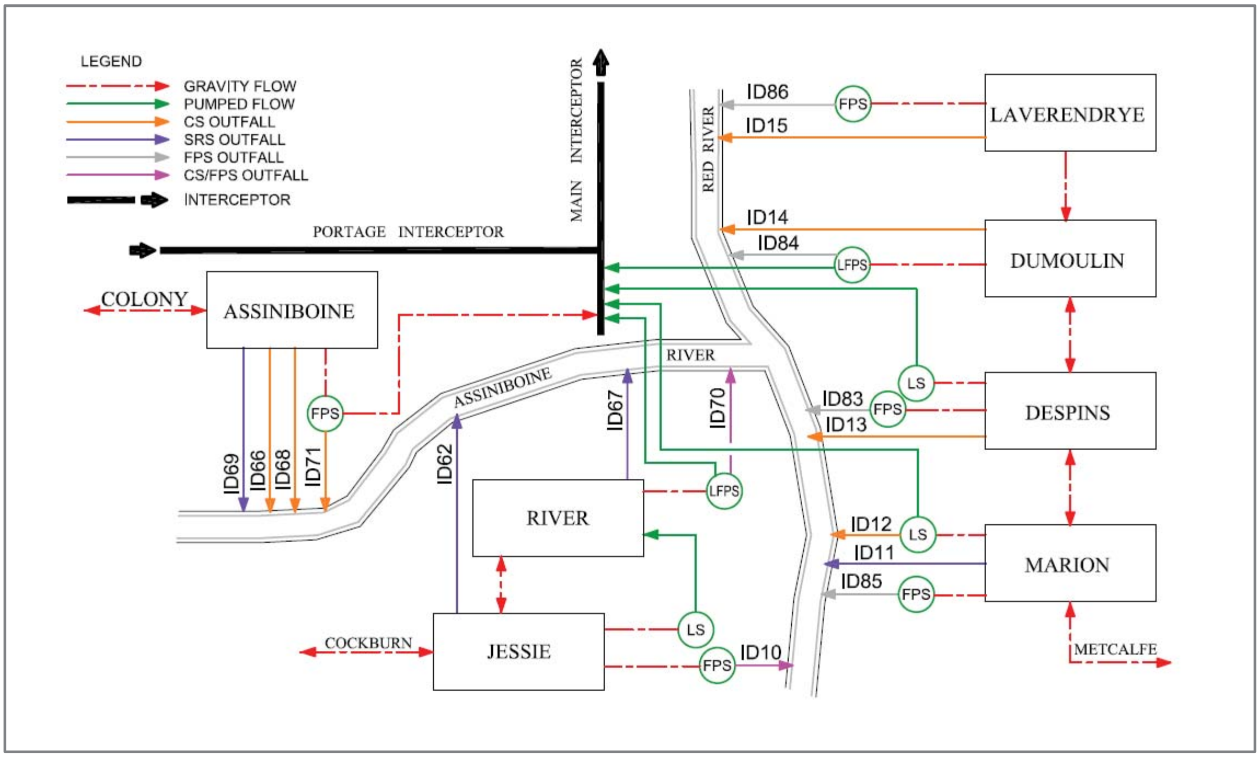

Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 34 and are listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID70)	S-TE70001756.1	S-MA70004375	1600 mm	Invert: 221.71 m
Flood Pumping Outfall (ID70)	S-MH70010676.1	S-MA70029012	1600 mm	Invert: 221.71 m
Other Overflows	N/A	N/A	N/A	
Main Sewer Trunk	S-MH60006079.3	S-MA70029065	1350 mm	Invert: 222.94 m
Storm Relief Sewer Outfall (ID67)	S-CO60007999.1	S-MA60020193	2400 mm	Invert: 221.61 m
Storm Relief Sewer Interconnections	N/A	N/A	N/A	
Main Trunk Flap Gate	RIVER_GC1.1	S-CG00001081	1600 mm	Invert: 222.50 m
Main Trunk Sluice Gate	RIVER_GC2.1	S-CG00001082	1600 mm	Invert: 222.33 m
Off-Take	N/A	N/A	N/A	CS trunk flows directly into wet well and is either intercepted or discharged.
Dry Well	N/A	N/A	N/A	
Lift Station Total Capacity	N/A	N/A	0.49 m^3/s	1 x 0.275 m^3/s 1 x 0.215 m^3/s
Lift Station ADWF	N/A	N/A	0.119 m^3/s	

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Lift Station Force Main	S-BE70001773.1	S-MA70012102	600 mm	Discharge Invert 224.77 m
Flood Pump Station Total Capacity	N/A	N/A	0.95 m^3/s	LFPS combined, single pump
Pass Forward Flow – First Overflow	N/A	N/A	0.55 m^3/s	

Notes:

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	River/Mayfair – 223.83 Fort Rouge Park – 223.83
2	Trunk Invert at Off-Take	N/A
3	Top of Weir	224.00
4	Relief Outfall Invert (Upstream of Fort Rouge Gate Chamber)	221.72
5	Low Relief Interconnection (S-MH60017478)	224.62
6	Sewer District Interconnection (S-MA70010953)	Invert at district boundary: 34-02 = 224.35
7	Low Basement	230.28
8	Flood Protection Level	229.91

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed in River was the 1986 Basement Flooding Relief Program Review (Girling & Sharp, 1986). No other work has been completed on the district since that time.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the River Combined Sewer District was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations has a combination of inflow and overflow level meters and flap gate inclinometers if available.

A latent pump and gate chamber have been constructed on the Fort Rouge Park SRS pipe. This work was completed in 2017 and upgraded the existing SRS gate chamber with a new dual chamber attached to the existing chamber that provided new sluice and flap gates on the SRS pipe. The existing chamber was re-designed as a latent pump chamber with a new submersible pump and a new force main connecting back to the CS system on River Avenue.

From 2009 – 2012 the Southwest Rapid Transit Corridor for the City of Winnipeg was constructed. A portion of this major development was constructed in the River district. As part of this work a local LDS system was installed to capture all surface runoff from the corridor itself. This LDS system ultimately ties back into the River district at various points.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Planned Completion
34 - River	1986	Ongoing	2013	Complete	N/A

1.5 Ongoing Investment Work

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall of the River district. This consists of monthly site visits in confined entry spaces to verify physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

Specific to the Fort Rouge SRS, an ongoing annual flow monitoring program will be completed to assess the performance of the Fort Rouge latent storage facility previously constructed.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the River sewer district are listed in Table 1-4. The proposed CSO control projects will include screening installation primarily. In-line storage and latent storage facilities are either already provided by existing infrastructure, or have already been recently implemented within this district and are described in the sub-sections below. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage	Storage / Transport Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year		-	-	-		-	-	-	✓	✓	✓

Notes:

- = not included
✓ = included

The River district has an existing primary weir elevation of 224 m just upstream of the River CS outfall and located inside the LFPS. The height of the existing weir is high enough that it negates the need to add a control gate to utilize additional in-line storage. The weir height is already above the sewer obvert. The existing height of the weir provides an existing in-line storage of 508 m^3 when evaluated against the 1992 representative year, and will continue to operate in this fashion.

The City has also previously completed the SRS latent storage arrangements utilizing the Fort Rouge Park SRS outfall. This project is discussed in further detail in Section 1.6.2 below.

Floatable control will be necessary to capture floatables in the sewage. Floatables will be captured with all implemented control options to some extent, but screening may be added as required to reach the desired level of capture. The screening arrangement for River will be located on the CS trunk and upstream from the Mayfair LFPS.

GI and RTC will be applied within each district on a system wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design. RTC is not included in detail within each plan and is described further in Section 3 of Part 3A.

1.6.2 Latent Storage

Latent storage is a suitable control option for the River district for the utilizing the Fort Rouge SRS system. Latent storage has been recently installed in the district at the Fort Rouge SRS outfall and has been included as part of the CSO Master Plan performance evaluation. The latent storage level in the system is controlled by the river level, and the resulting backpressure of the river level on the SRS outfall flap gate, as explained in Part 3C. The latent storage design criteria which was utilized in the 2017 design is identified in Table 1-5. The storage volumes indicated in Table 1-5 are based on the NSWL river level conditions over the course of the 1992 representative year.

Table 1-5. Latent Storage Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	221.95 m	
NSWL	223.83 m	
Trunk Diameter	2400 / 1200 mm	Two different pipes upstream from gate chamber
Design Depth in Trunk	1880 mm	
Maximum Storage Volume	1284 m^3	
Force Main	150 mm	
Flap Gate Control	N/A	
Lift Station	N/A	In-line pump
Nominal Dewatering Rate	0.07 m^3/s	Based on existing pump capacity
RTC Operational Rate	TBD	Future RTC/dewatering review on assessment

Note:

NSWL = normal summer water level

The existing latent pumping system is located within the SRS outfall gate chamber located along River Avenue between Cauchon Street and Scott Street. Figure 34-02 provides an overview of the gate chamber and connections to the CS system constructed as part of this recent work. A dual chamber was constructed adjacent to the existing gate chamber and provided new sluice and flap gates on the SRS outfall pipe. The existing chamber was then re-designed as a latent pump chamber with a new submersible pump and a new force main. The force main pumps into the nearby 900 mm x 1350 mm CS pipe into the manhole (S-MH60017500) on River Avenue. The operational intent is for the existing latent pump to dewater the SRS system in preparation for the next runoff event. This would align with the requirement for the system to be ready for the next event within a 24-hour period after completion of the previous event.

Figure 34 identifies the extent of the SRS system within the River district that is being used now to provide latent storage. The maximum storage level as part of the CSO Master Plan performance evaluation is directly related to the NSWL and the size and depth of the SRS system. Once the level in the SRS exceeds the river level, the flap gate opens to allow discharge to the Assiniboine River.

The lowest interconnection between the combined sewer and SRS systems is higher than the proposed latent and in-line storage control levels, meaning that the two systems would function independently.

As part of the evaluation of the latent storage volume was completed using the continuous NSWL river conditions, This NSWL was found to utilize 90 percent of the SRS pipe height with the existing latent storage arrangements and, therefore, additional flap gate control was not recommended as a further measure to provide the required latent storage as part of the CSO Master Plan.

In situations where non modelled assessments are to be completed, the actual river levels will be both lower and higher than the NSWL level at various points throughout an annual year. Where the level is below the NSWL, the latent volume will be less than predicted during the MP assessment, while conversely when the level is above the NSWL, the latent volume will be more than predicted. The continuous assessment is seen as a conservative approach since the majority of the representative year rainfall events occur when the river levels are higher than the NSWL.

1.6.3 In-Line Storage

Any potential additional in-line storage within the River district via control gate construction has already been maximized based on the height of the existing primary weir in this district. The primary outfall consists of a combined lift and FPS with the primary weir located inside. The existing in-line storage will not require a control gate due to the existing height of the weir, but will still utilize the existing combined sewers for in-line storage. The obvert of the main trunk rests at 224.25 m, and the top of primary weir elevation rests close to this obvert elevation at 224 m. Therefore no further work associated with in-line storage is proposed for the River district.

The nominal rate for dewatering is set at the existing LS capacity. This allows dewatering through the existing interceptor system within 24 hours following the runoff event, allowing it to recover in time for a subsequent event. Future RTC / dewatering assessment will be necessary to define additional rates. This would provide some flexibility in the ability to increase the dewatering rate for spatial rainfall events. This would dewater the district more quickly, to capture and treat more volume for these localized storms by using the excess interceptor capacity where the runoff is less.

1.6.4 Floatables Management

Floatables management will require installation of a screening system to capture floatable materials that bypass the LS. There are limitations in the application of an off-line screening arrangement at this location due to the primary weir being located within the LFPS structure. As well, a separate LDS connection is also located within the LFPS. Therefore, in order to accommodate screening of this outfall, an arrangement is proposed to bypass the existing primary weir via a new pipe to transfer excess CS collected to the screened chamber. All screened flow would then tie back into the LFPS chamber downstream of the primary weir, where it can be discharged to the Assiniboine River. This would occur for the first flush flow as per normal screening operation noted in other district screening operations.

The type and size of screens depend on the specific station configuration and the head available for operation. A standard design was assumed for screening and is described in Part 3C. The design criteria for screening are listed in Table 1-6.

Table 1-6. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Top of Gate	224.00 m	
Bypass Weir Crest	N/A	Existing high level weir

Table 1-6. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Normal Summer River Level	223.83 m	
Maximum Screen Head	0.17 m	
Peak Screening Rate	0.96 m^3/s	
Screen Size	1.5 m wide x 1 m high	Modelled Screen Size

The proposed screening chamber will be located in-line on the existing 1350 mm CS trunk and upstream of the existing primary weir, as shown on Figure 34-01. Within the new screening chamber, it is proposed that the flow in the CS trunk would overtop the bypass side weir, situated within the 1350mm trunk pipe wall, and this will flow through the screens. also located in the new screening chamber. The screened flow will be discharged to the existing LFPS downstream of the primary weir via new pipework and then overflow as per existing conditions via gravity/pumped and discharge to the river. The screening chamber will include screenings pumps with a discharge returning the screened material to the CS LS for routing to the NEWPCC for removal. High flows would be still be directed to the primary weir as per existing conditions.

1.6.5 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district was reviewed to identify the most applicable GI controls.

River has been classified as a medium GI potential district. Land use in River is mostly single-family residential, with the remaining consisting of commercial land use. This means the district would be an ideal location for bioswales, permeable paved roadways, cisterns/rain barrels. The flat roof commercial buildings make for an ideal location for green roofs.

1.6.6 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

The latent storage facilities constructed will take advantage of the SRS infrastructure already in place; therefore, minimal additional maintenance will be required for the sewers. The latent LS and dewatering pumps will require regular maintenance that would depend on the frequency of operation. Additional system monitoring, and level controls will be installed which will require regular scheduled maintenance.

Floatable control with outfall screening will require another chamber with screening equipment installed. The chamber will be upstream of the existing weir due to the weir being located within the LFPS structure. Screening operation will occur during WWF events that surpass the existing in-line storage control level. WWF will flow over the bypass weir and through the screens directed to discharge into the river via a new transfer pipe and the existing outfall pipe. The screens will operate intermittently during wet weather events and will likely require operations review and maintenance after each event. The frequency of a screened event would correlate to the number overflows identified for the district. The screenings return will require a small LS and force main to pump this back to the CS trunk. Additional maintenance for the pump will be required at regular intervals in line with typical lift station maintenance after screening events.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. Two versions of the sewer system model were created and used to measure system performance. The 2013 Baseline model represents the sewer system baseline in the year 2013 and the 2037 Master Plan – Control Option 1 model, which includes the proposed control options in the year 2037. A summary of relevant model data is provided in Table 1-7.

Table 1-7. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	121	121	10,214	38	N/A
2037 Master Plan – Control Option 1	121	121	10,214	38	LS, SC

Notes:

Total area is based on the model subcatchment boundaries for the district.
LS = Latent Storage (Latent Storage was constructed by the City in 2017)

SC = Screening
No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-8 are for the hydraulic model simulations using the year-round 1992 representative year. This table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. Table 1-8 also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-8. District Performance Summary – Control Option 1

	Preliminary Proposal	Master Plan			
Control Option	Annual Overflow Volume (m^3)	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [a]
Baseline (2013)	11,331	15,904	-	11	0.490 m^3/s
Latent Storage	8,452	15,904	0	11	0.490 m^3/s
Control Option 1	**8,452**	**15,904** [b]	**0**	**11**	**0.490 m^3/s**

[a] Pass forward flows assessed on the 1-year design rainfall event

[b] Model influenced by other districts performance

A slight increase to the overflow volume was found when modeling the system with the control options implemented. This is believed to be due to the influence from other districts discharging to the interceptor sewer upstream of the connection point for the River district. This will require further modelling to establish suitable option to reduce flows and assess the performance of the existing SRS system.

The percent capture performance measure is not included in Table 1-8, as it is applicable to the entire CS system and not for each district individually.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-9. The cost estimates are Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-9. Cost Estimates – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period)
Latent	$1,740,000	N/A	N/A	N/A
Screening	N/A [a]	$2,950,000 [b c]	$44,000	$950,000
Subtotal	**$1,740,000**	**$2,950,000**	**$44,000**	**$950,000**
Opportunities	N/A	$300,000	$4,500	$100,000
District Total	**$1,740,000**	**$3,250,000**	**$48,500**	**$1,050,000**

[a] Solution developed as refinement to Preliminary Proposal work following submission of Preliminary Proposal costs. Costs for the screening item of work found to be $590,000 in 2014 dollars

[b] Costs associated with new pipework including offtake construction, as required, to accommodate screening chamber in the location proposed and allow intercepted CS flow to reach existing River CS LS was not included in the Master Plan cost assessment.

[c] Cost for bespoke screenings return/force main not included in Master Plan as will depend on selection of screen and type of screening return system selected

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional cost for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014-dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019-dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-10.

Table 1-10. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Latent	Latent storage is already installed in the River district	Not included in Master Plan cost estimate.
	Screening	Unit cost for this control option updated for the Master Plan	
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation.	Preliminary Proposal estimates were based on 2014 dollar values.	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, the future performance target is 98 percent capture for the representative year measured on a system-wide basis. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-11 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified for Control Option 1.

Overall the River district would be classified as a low potential for implementation of complete sewer separation as the only feasible approach to achieve the 98 percent capture future performance target in the representative year. However, opportunistic sewer separation within a portion of the district may be completed in conjunction with other major infrastructure work to address future performance targets. In addition, green infrastructure and off-line tank or tunnel storage may be utilized in key locations to provide additional storage and increase capture volume

Table 1-11. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Opportunistic Separation • Increased use of GI • Off-Line Storage (Tank/Tunnel)

The control options selected for the River district have been aligned for the 85 percent capture performance target based on the results from the system wide basis. The expandability of this district to meet the 98 percent capture is to be determined on system wide basis. Additional separation in this district may be difficult due to the heavy traffic and development density.

The cost for upgrading to meet an enhanced performance target depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of

master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-12.

Table 1-12. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	R	-	-	-	-	-	-	-
2	Existing Lift Station	-	-	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	-	-	-	-
4	Construction Disruption	-	-	-	-	-	-	-	-
5	Implementation Schedule	-	-	-	-	-	-	R	-
6	Sewer Condition	R	-	-	-	-	-	-	-
7	Sewer Conflicts	R	-	-	-	-	-	-	-
8	Program Cost	O	-	-	-	-	-	-	O
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	R	-	-	-	-	O	O	-
12	Operations and Maintenance	R	-	-	-	-	R	O	R
13	Volume Capture Performance	O	-	-	-	-	O	O	-
14	Treatment	R	-	-	-	-	O	O	R

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

Girling, R.M. and E.J. Sharp. 1986. *Basement Flooding Relief Program Review - 1986*. Month of publication if available.

LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Low CS Manhole
- Low SRS Connection

Inter-System Connection
- CS - LDS
- CS - WWS
- SRS - CS

District Boundary Crossing
- SRS
- WWS

- Existing Latent Storage Limit
- Extent of Existing In-line Storage
- Interceptor Sewer
- Force Main
- Street
- Railway

- District Boundary
- Watercourse
- Greenspace
- City Owned Land

CSO MASTER PLAN PROPOSED SOLUTIONS

- Screening

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 34
District Overview Map
Sewer District: River
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- Primary Weir
- CSO Outfall
- Manhole
- Flap Gate
- Sluice Gate
- Pump Location
- Force Main
- Sewer By Type
  - CS
  - LDS
  - WWS
- Control Structure Type
  - Gate Chamber
- Pump Station Type
  - Lift & Flood Combined Station

CSO MASTER PLAN
PROPOSED SOLUTIONS

Screening

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 34-01
Screening
Sewer District: River
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- Critical Elevation
- CSO Outfall
- Manhole
- Sluice Gate
- Pump Location

Sewer By Type
- CS
- SRS
- WWS

Control Structure Type
- Weir Structure

Pump Station Type
- Flood Pump Station

CSO MASTER PLAN
PROPOSED SOLUTIONS

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

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WATER AND WASTE DEPARTMENT

FIGURE 34-02
Latent SRS Control
Sewer District: River
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Riverbend District Plan

August 2019

City of Winnipeg

CSO Master Plan

Project No: 470010CH
Document Title: Riverbend District Plan
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Project Manager: John Berry
Author: Stephen Godon
File Name: Riverbend_Plan_Final_CO1MP_08162019

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0	08/2018	Version 1 DRAFT	SG	ES	
1	02/15/2019	DRAFT 2 for City Review	MF	SG	MF
2	08/12/2019	Final Draft Submission	DT	MF	MF
3	08/16/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

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Figure

1. Riverbend District

1.1 District Description

The Riverbend district is located towards the western section of the North End Sewage Treatment Plant (NEWPCC) catchment area within the combined sewer (CS) area on the north side of the Assiniboine River. Riverbend is approximately bordered by Saskatchewan Avenue to the north, St. James Street to the east, Marjorie and Century Streets to the west, and the Assiniboine River to the south. The district is also bounded to the north by the Riverbend Separate district.

Riverbend land use includes areas of residential, commercial, and industrial. Commercial land use is located along St. James Street, Century Street, and King Edward Street; industrial manufacturing facilities are located in the north between Ellice Avenue and Saskatchewan Avenue.

Century Street, King Edward Street, and St. James Street are regional roadways that run north-south through the district. Portage Avenue, Silver Avenue, St Matthews Avenue, Ellice Avenue, Sargent Avenue, and Wellington Avenue are regional roadways that run east-west through the district. The area is a major shopping district and is a main link between Downtown and the airport.

1.2 Development

A portion of Portage Avenue is located within the Riverbend District. Portage Avenue is identified as Regional Mixed Use Corridor as part of the OurWinnipeg future development plans. As such, focused intensification along Portage Avenue is to be promoted in the future.

1.3 Existing Sewer System

Riverbend encompasses a combined area of 227 hectares (ha)[1] based on the district boundary and includes CS and land drainage sewer (LDS) system. There is approximately 3 percent (8 ha) separated.

Riverbend is planned to have separation work that primary includes the installation of additional LDS and use of the existing CS system for wastewater primarily. As of December 2018, no additional areas of district have been separated, but as part of the work ongoing the district is anticipated to be completely separated in the future.

The CS system includes a CS lift station (LS) and one CS outfall. The CS outfall is located immediately west of Riverbend Crescent. The district is served by a 1500 mm main trunk flowing southbound on King Edward/Century Street; this becomes a 1950 mm CS south of Ellice Avenue, a 2100 mm from St. Matthews to Century Street, and a 2250 mm main trunk that runs south on Century Street. This trunk sewer on Century Street veers southwest at the Century near the Portage Underpass and flows to the Riverbend CS LS located in a back lane west of Riverbend Crescent and South of Portage Avenue. A 450 mm CS serves the small residential area along Riverbend Crescent, south of Portage Avenue and connects into the 2250 mm outfall trunk via a hole and outlet pipe in the base of the manhole in the 450 mm CS. In the past, this 450mm pipe would pass directly over the 2250 mm outfall, and continue west to the Parkside district. It was realized this hole in the pipe where the 450 mm pipe passes directly over the outfall trunk can be used to more efficiently tie this CS into the Riverbend district directly. A 1 meter brick weir is also installed in this manhole along the 450mm pipe, to ensure the CS collected from the Riverbend Crescent area is captured by the hole in the manhole base.

During dry weather flow (DWF), sewage is intercepted by the primary weir for the district, located immediately upstream of the outfall gate chamber. Sewage from the 450 mm Riverbend Crescent CS is

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[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

also intercepted by the 1 metre brick weir, and flows the Riverbend outfall to also be intercepted by the primary weir. The intercepted sewage backs up in the 2250 mm trunk sewer from the CS outfall and is diverted through a 600 mm off-take pipe to the Riverbend LS, located near the intersection of Portage Avenue and Riverbend Crescent. From here it is pumped to the 900 mm interceptor pipe on Portage Avenue and on to the NEWPCC for treatment.

During wet weather flow (WWF) the level of flow may exceed the primary weir height, at this point it spills over this weir and is discharged by gravity to the Assiniboine River via the Riverbend outfall. A sluice gate and flap gate are installed at the CS outfall, with the flap gate preventing back-up of the Assiniboine River into the CS system during high river levels. There is no flood station provided to relieve the CS which has spilled over the primary weir under these high river level conditions. Temporary flood pumps are installed in Riverbend based on the flood manual high river level triggers to deal with situations such as this. Under WWF conditions as well, the flow received from the 450mm CS servicing the Riverbend Crescent area may spill over the 1 metre brick weir installed in the manhole directly over the CS outfall. All flow which spills over this brick weir then continues west to the Parkside district.

A 1500 mm LDS runs north to south through the entire length of the district, called the Brookland-Rosser Industrial Trunk LDS. The Brookland-Rosser Industrial Trunk LDS serves two separate sewer districts north of Riverbend, the Riverbend Separate and Brooklands districts. This LDS trunk sewer includes an outfall to the Assiniboine River at Century near the St. James Bridge. This outfall has positive gate protection to protect against high Assiniboine River levels backflowing into the LDS system.

An underpass pumping station for the St. James Underpass is also located in this district. This underpass pumping station discharges to a 900 mm LDS outfall to the Assiniboine River, located beneath the St. James Bridge. This outfall has both flap and positive gates to protect against high Assiniboine River levels backflowing into the LDS system.

The areas already considered LDS separated within the Riverbend district cover the Madison Square shopping mall and the section of Route 90 approximately between Portage Avenue and St James Street.

The CS outfall to the Assiniboine River is as follows:

- ID50 (S-MA20008967) – Riverbend CS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Riverbend and the surrounding districts. These interconnections are shown on Figure 35 for Riverbend district and show the locations where gravity flow crosses from one district to another. Each interconnection is listed in the following subsections.

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

Tylehurst

- A 900mm interceptor carrying intercepted CS flows by gravity from the Riverbend district into the Tylehurst district and on to the North End Sewage Treatment Plant (NEWPCC) for treatment.
    - Portage Avenue interceptor invert – 230.01 m (S-MH20010370)

1.3.1.2 Interceptor Connections – Upstream of Primary Weir

Ferry Road

- A 900mm interceptor carrying intercepted CS flows by gravity from the Ferry Road district into the Riverbend district and on to the North End Sewage Treatment Plant (NEWPCC) for treatment.

- Portage Avenue interceptor invert – 230.65 m (S-MH20008213)

Parkside

- A 300 mm interceptor pipe carrying CS intercepted from the Parkside district enters the Riverbend district and ties into the Riverbend CS outfall upstream of the primary weir.
  - Invert at Riverbend district boundary – 226.79 m (S-MH70005194)

1.3.1.3 District Interconnections

Ferry Road

CS to CS

- A 300 mm CS sewer acts as an overflow pipe from the Ferry Road CS system into the Riverbend CS system:
  - St. Matthews Avenue and Marjorie Street – 230.65 m (S-MH20007039) – (GIS suspected to be incorrect and interconnection as high point manhole at 230.85 m (S-MH20007046), further investigation required)
- High Point Manhole (flow is directed into both districts from this manhole):
  - Silver Avenue and Madison Street – 231.52 m (S-MH20009635)

Riverbend Separate

CS to CS

- High Point Manhole (flow is directed into both districts from this manhole):
  - Sherwin Road and Saskatchewan Avenue – 231.48 m (S-MH20006484)
  - Border Street and Saskatchewan Avenue – 230.30 m (S-MH70058515)

WWS to CS

- A 600 mm WWS from Riverbend Separate flows by gravity into the Riverbend CS system in the manhole at the intersection of Saskatchewan Avenue and King Edward Street:
  - King Edward Street – 229.45 m (S-MH20006458)

LDS to LDS

- A 1500 mm LDS flows by gravity southbound on King Edward Street from Riverbend Separate into Riverbend. It flows through Riverbend to discharge into the Assiniboine River:
  - Invert at Riverbend district boundary –224.43 m (S-MH20006451)

A district interconnection schematic is included as Figure 1-1**Error! Not a valid bookmark self-reference.**. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing district.

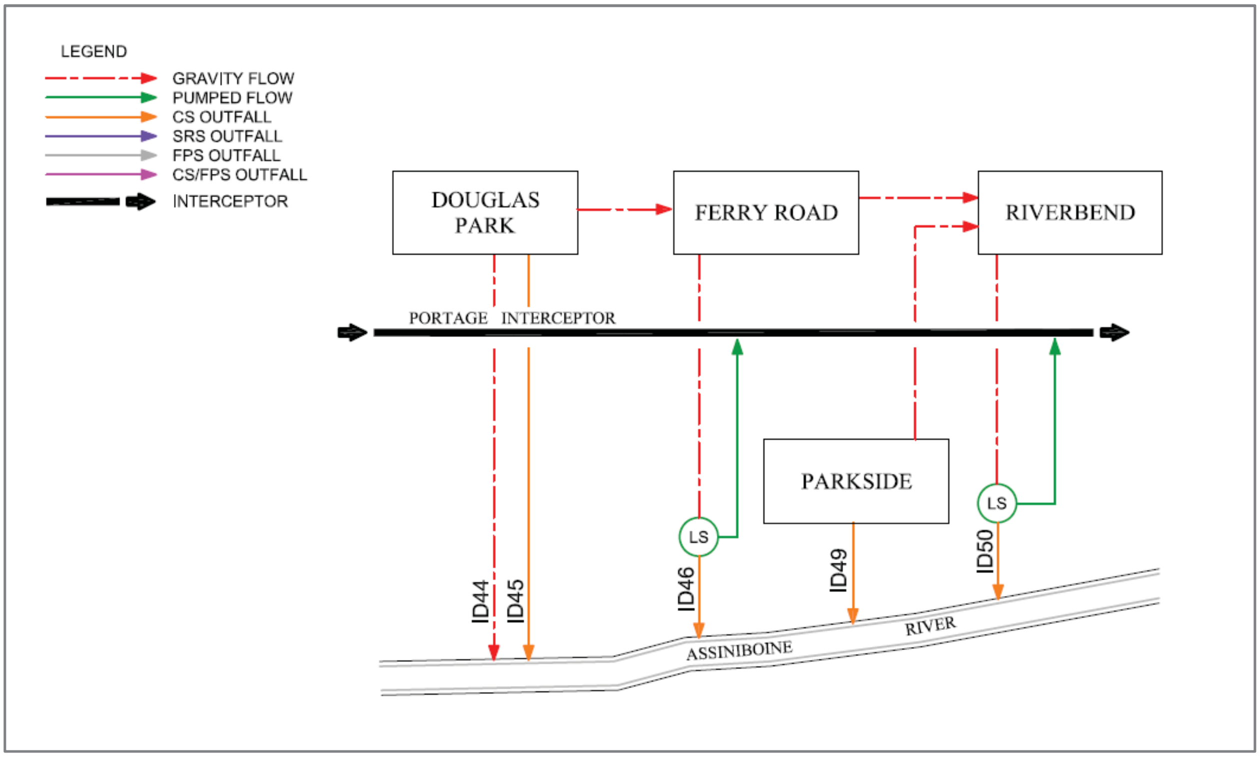


Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for Riverbend are shown on Figure 35 and are listed in Table 1-1.

Table 1-1. Riverbend Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID50)	S-CG00001136 DS.1	S-MA20008967	2340 mm	Circular Invert: 224.00 m
Flood Pumping Outfall	N/A	N/A	N/A	No flood pump station within the district.
Other Overflows	N/A	N/A	N/A	
Main Sewer Trunk	S-TE20002146.1	S-MA70040303	2280 mm	Circular Invert: 225.07 m
SRS Outfalls	N/A	N/A	N/A	No SRS within the district.
SRS Interconnections	N/A	N/A	N/A	No SRS within the district.
Main Trunk Flap Gate	S-CG00001136.1	S-CG00001137	1800	Flap Gate size Invert: 225.56 m
Main Trunk Sluice Gate	S-MH20008302.1	S-CG00001136	2250 x 2250 mm	Sluice Gate size Invert: 225.56 m
Off-Take	S-TE20002181.1	S-MA20008912	600 mm	Circular Invert: 225.20 m
Dry Well	N/A	N/A	N/A	
Lift Station Total Capacity	N/A	N/A	0.302 m^3/s	

Table 1-1. Riverbend Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Lift Station ADWF	N/A	N/A	0.0268 m^3/s	
Lift Station Force Main	S-TE70026794.1	S-MA20008911	300 mm	Circular Invert: 224.00 m
Flood Pump Station Total Capacity	N/A	N/A	N/A	No flood pump station within the district.
Pass Forward Flow – First Overflow	N/A	N/A	0.040 m^3/s	

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	224.26
2	Trunk Invert at Off-Take	225.20
3	Top of Weir	226.09
4	Relief Outfall Invert at Flap Gate	N/A
5	Low Relief Interconnection	N/A
6	Sewer District Interconnection (Tylehurst)	230.01
7	Low Basement	231.74
8	Flood Protection Level	230.41

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed in Riverbend was in 2006 with the *Ferry Road and Riverbend Combined Sewer Relief Works* (Wardrop, 2006). This study discussed the possible relief work available for Ferry Road and Riverbend CS Systems to reduce the incidence of basement flooding. The southern portion of the district has been separated with the installation of a separate LDS sewer.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Riverbend Combined Sewer District was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations have a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Planned Completion
35 - Riverbend	2006 - Conceptual	Future Work Following Complete Separation	2013	Separation Ongoing	TBD

Note:
TBD = to be determined

1.5 Ongoing Investment Work

The Riverbend basement flooding relief (BFR) work began in 2013 with ongoing separation work being completed within the district. Once complete, it will provide complete road drainage separation of the Riverbend district. Once completed, it will provide complete road drainage separation of the Ferry Road, Douglas Park, Parkside and Riverbend districts. Separation work will be integrated into the CSO Master Plan along with other control options.

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Riverbend district. This consists of monthly site visits in confined entry spaces to verify that physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Riverbend district are listed in Table 1-4. The proposed CSO control solution is complete sewer separation. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	-	-	-		-	-	-	✓	✓	✓	-

Notes:
- = not included
✓ = included

The decision to include complete sewer separation of Riverbend under the BFR work will remove a large volume of land drainage from the CS system, thereby reducing the volume and number of CSOs for the district. The intent of complete separation would be to eliminate all CSOs from the district under the 1992 representative year rainfall conditions. This will require post separation monitoring to confirm the elimination of CSOs and remaining wet weather response in the district from existing building foundation drainage connections to the CS system.

GI and RTC will be applied within each district on a system-wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Sewer Separation

Sewer separation is proposed for the Riverbend district as part of the CSO Master Plan and is underway as part of the Ferry Road and Riverbend BFR work. Complete separation of Riverbend will remove a large volume of land drainage runoff from the CS system, thereby reducing the volume and number of CSOs for the district.

The work would include the installation of an independent LDS system to collect road drainage. Collected stormwater would be routed down the local streets to new LDS pipes on Portage Avenue and diverted south down Winston Drive to connect to the new separate LDS outfall in Jae Eadie Park (as part of the Parkside district separation project). This Jae Eadie Park outfall will then discharge to the Assiniboine River. The extent of the proposed LDS system upstream of this point is still under development as part of the BFR work, and the location of the LDS system should be assessed further at the preliminary design stage. The flows to be collected after separation will be as follows:

- DWF will remain the same – collected flow pumped from Riverbend CS LS to the interceptor.
- WWF will consist of sanitary sewage combined with foundation drainage.

This will result in a reduction in combined sewage flow received at Riverbend CS LS after the separation project is complete. It is proposed that future monitoring of the district is completed to verify that the sewer separation is fully compliant with the modelled simulated elimination of all CSO overflows under the 1992 representative year. A static weir elevation increase may be necessary at the CS diversion to eliminate the occurrence of all CSOs. Any weir elevation raise will also be evaluated in terms of existing basement flood protection to ensure the existing level of basement flood protection remains.

1.6.3 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district will be reviewed to identify the most applicable GI controls.

Riverbend has been classified as a medium GI potential district. Riverbend land use includes areas of residential, commercial, and industrial. Commercial land use is located along St. James Street, Century Street, and King Edward Street; industrial manufacturing facilities are located in the north between Ellice Avenue and Saskatchewan Avenue. This means the district would be an ideal location for bioswales, permeable paved roadways, cisterns/rain barrels, rain gardens, and green roofs.

1.6.4 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the master plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

Sewer separation will include the installation of additional sewers that will require inspection, cleaning and rehabilitation. This will result in additional maintenance costs over the long term, but operational costs will be minimal. The existing larger CS pipes within the district may also receive insufficient flow with the separation work for proper scouring velocities in the sewer pipes. This could result in solids settling within the sewers, and requiring more frequent cleaning operations. The impacts of the reduced flows in larger CS pipes will be evaluated as part of the sewer separation design for the district.

It is recommended to continue to maintain and operate the flow monitoring instrumentation and assess the results after district separation work has been completed. This will allow the full understanding of the non-separated storm elements (foundation drain connections to the CS system) extent within the Riverbend district.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. An individual model was created to represent the sewer system baseline as represented in the year 2013 and a model for the CSO Master Plan with the control options implemented in the year 2037. A summary of relevant model data is summarized in Table 1-5.

Table 1-5. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	169	169	1,213	59	N/A
2037 Master Plan – Control Option 1	169	25	1,213	1	SEP

Notes:

Total area is based on the model subcatchment boundaries for the district.
SEP = Separation
% = percent

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district. While this district is to be separated and as a result Clause 8 of Licence No. 3042 will not be in effect, the wet weather response of the district overall will still need to be assessed.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City Of Winnipeg GIS Records. Therefore minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance estimates for Control Option 1 as shown in Table 1-6 are based on the hydraulic model simulation using the 1992 representative year applied uniformly. The control option performance is compared to the baseline performance to determine the overflow reduction. The baseline performance was determined for the existing conditions represented in the hydraulic model based on 2013 system conditions.

Table 1-6. Performance Summary – Control Option 1

Control Option	Preliminary Proposal Annual Overflow Volume (m^3)	Master Plan Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [a]
Baseline (2013)	87,370	87,057	-	20	0.040 m^3/s
Separation	0	0	87,057	0	TBD
Control Option 1	**0**	**0**	**87,057**	**0**	**TBD**

[a] Pass forward flows assessed up to 5-year design rainfall event. Possible overflow for larger design events to be confirmed.

The percent capture performance measure is not included in Table 1-6, as it is applicable to the entre CS system, and not for each district individually. However, the full capture of overflows volumes for the Riverbend district would represent a 100 percent capture rate on a district level.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each relevant control option with overall program costs summarized and described in Section 3.4 of Part 3A of the CSO Master Plan are identified in Table 1-7. The cost estimates are a Class 5 planning level estimate with a level of accuracy range of minus 50 percent to plus 100 percent.

Table 1-7. Cost Estimates – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period)
Sewer Separation	$76,800,000	$76,590,000	$45,000	$980,000
In-line Control Gate	$7,700,000 [a]	N/A	N/A	N/A
Screening		N/A	N/A	N/A
Subtotal	**$84,500,000**	**$76,590,000**	**$45,000**	**$980,000**
Opportunities	N/A	$7,660,000	$5,000	$100,000
District Total	**$84,500,000**	**$84,250,000**	**$50,000**	**$1,080,000**

[a] Screening and In-line costs were combined in the Preliminary Proposal.

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional costs for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014-dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019-dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-8.

Table 1-8. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Sewer Separation	Unit Costs were updated	
	Control Gate	Removed from Master Plan	No longer required with complete separation work.
	Screening	Removed from Master Plan	No longer required with complete separation work.
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation	Preliminary Proposal estimates were based on 2014-dollar values	

1.10 Meeting Future Performance Targets

The complete separation of the Riverbend district will achieve the 100 percent capture figure, and no other further work will be required to meet the future performance target. It is recommended to complete post separation modelling to confirm the target is fully achieved.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed as part of the CSO Master Plan and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-9.

Table 1-9. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	-	-	-	O	-	-	-
2	Existing Lift Station	-	-	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	O	-	-	-
4	Construction Disruption	-	-	-	-	R	-	-	-

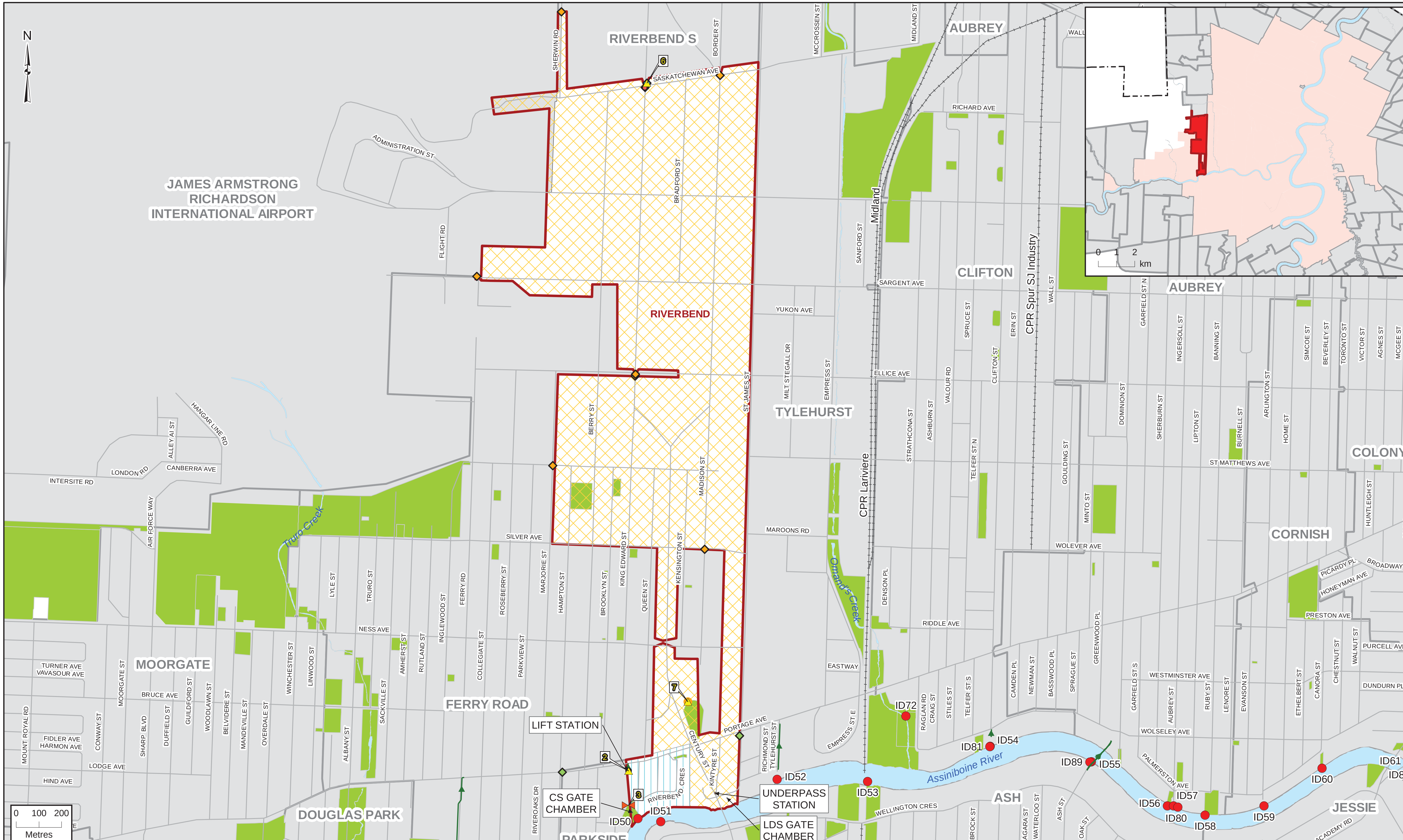
Table 1-9. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
5	Implementation Schedule	-	-	-	-	R	-	R	-
6	Sewer Condition	-	-	-	-	-	-	-	-
7	Sewer Conflicts	-	-	-	-	R	-	-	-
8	Program Cost	-	-	-	-	R	-	-	-
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	-	-	-	-	O	O	O	-
12	Operations and Maintenance	-	-	-	-	R / O	R	O	-
13	Volume Capture Performance	-	-	-	-	-	O	O	-
14	Treatment	-	-	-	-	O	O	O	-

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

Wardrop. 2006. *Ferry Road and Riverbend Combined Sewer Relief Works*. Prepared for the City of Winnipeg Water and Waste Department. November.



LEGEND

Primary Weir
Critical Elevation
CSO Outfall
Low CS Manhole

Inter-System Connection
CS - WWS

District Boundary Crossing
CS
LDS
WWS

Force Main
Street
Railway

District Boundary
Watercourse
Greenspace

CSO MASTER PLAN PROPOSED SOLUTIONS

Sewer Separation - Underway
Sewer Separation - Complete

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 35
District Overview Map
Sewer District: Riverbend
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Roland District Plan

August 2019

City of Winnipeg

CSO Master Plan

Project No:	470010CH
Document Title:	Roland District Plan
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1	02/15/2019	DRAFT 2 for City Review	SB	MF	MF
2	07/2019	Final Draft Submission	JT	MF	MF
3	08/19/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

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Figure

1. Roland District

1.1 District Description

Roland district is located in the northeastern sector of the combined sewer (CS) area along the eastern edge of the Red River and north of the Mission district. The district is bounded by Munroe district to the north, Area 13 and Kildonan Place district (Area 13.1) to the east, the Mission district to the south, and the Hart district to the west. Roland is bounded by Thomas Avenue to the south, Gateway Road to the west, Kent Road and Harbison Avenue East to the north, and Panet Road to the east.

Roland district is located in close proximity to downtown and has many major transportation routes run through the district. The Canadian Pacific Railway Mainline passes through this district. Nairn Avenue is the only regional road in the district.

Roland district is a mix of residential, commercial and manufacturing land use. The residential area is primarily single-family and two-family. The commercial area is located along Nairn Avenue and Panet Road and a manufacturing area is located along Thomas Avenue. The greenspace areas include Montcalm Playground, Chalmers Park, King Edward Park, Hap Hopkinson Memorial Park, and various school parks, playgrounds, and community areas throughout the district. The Canadian National Railways East Yards border the southern district boundary at Thomas Avenue.

1.2 Development

A portion of Nairn Avenue is located within the Roland District. This street is identified as a Regional Mixed Use Corridor as part of the OurWinnipeg future development plans. As such, focused intensification along Nairn Avenue is to be promoted in the future.

Nairn Avenue, Thomas Avenue, and a portion of Foster Street within the Roland District have been identified as part of the potential routes for the Eastern Corridor of Winnipeg's Bus Rapid Transit. The work along these streets could result in additional development in the area, which could also present an opportunity to coordinate sewer separation works alongside the transit corridor development, providing further sewer separation within the Roland District. This would reduce the extent of the Control Options listed in this plan required.

1.3 Existing Sewer System

Roland district encompasses an area of 204 ha[1] and includes a CS system and a storm relief sewer (SRS) system. There is approximately 3.5 ha (1.7 percent) identified as land drainage sewer (LDS) separated. There are no identifiable separation-ready areas. Approximately 12 ha of the district is classified as greenspace.

The Roland sewer system includes a diversion structure, flood pump station (FPS), CS outfall, and SRS outfall gate chambers. The CS systems drain towards the Roland diversion structure and primary CS outfall, located in the Hart district at the northern end of Archibald Street at the Red River. Approximately 120 m upstream of the Roland outfall, sewage is diverted to the Montcalm sewage Lift Station (LS) located in Mission district, at which point it is pumped into a river crossing pipe and enters the Syndicate district. A single sewer trunk collects flow from most of the district and directs flow to the diversion structure near Archibald Street. The 1625 mm by 2060 mm CS trunk extends from the diversion structure to Gateway Road. Multiple secondary sewers extend form the CS trunk along Gateway Road to the north and Talbot Avenue to the east to service the district.

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The SRS system includes various interconnections to the CS system. The Roland SRS system also receives the excess CS diverted from the majority of the Munroe SRS system to the north. The Roland SRS connects into a dedicated SRS gate chamber, but utilizes the same Roland primary CS outfall for the SRS system discharge. The gate chamber on the SRS system includes sluice and flap gates to prevent river water from backing up into the SRS system when the Red River levels are particularly high. During runoff events, the SRS system provides relief to the CS system in Roland district and in turn the Munroe district. The SRS system extends throughout the district and has multiple interconnections with the CS system. Catch basins are connected to the CS system, so the SRS provide additional capacity to the CS to main basement flooding protection.

During dry weather flow (DWF), the SRS is not required; sanitary sewage flows to the diversion structure and is diverted by the primary weir to a 600 mm interceptor pipe, where it flows by gravity southbound along Archibald Street approximately 225 m to the gate/junction chamber to the Montcalm sewage LS in Mission district to be pumped across the Red River to the Syndicate district, which ties into the Main Street Interceptor, and eventually and on to the North End Sewage Treatment Plant (NEWPCC) for treatment.

During wet weather flow (WWF), any flow that exceeds the diversion capacity overtops the weir and is discharged to the river. When the river level is high and gravity discharge is not possible, excess flow is pumped by the Roland FPS to the river. Sluice and flap gates are installed within the FPS to prevent back-up of the Red River into the CS system. However not only does the flap gate prevent river water intrusion, but it also prevents gravity discharge from the Roland CS outfall. Under these conditions the excess flow is pumped by the Roland FPS to a point in the Roland CS Outfall downstream of the flap gate and downstream of the SRS gate chamber, where it can be discharged to the river by gravity once more.

There is one (shared CS and SRS) outfall to the Red River as follows:

- ID21 (S-MA40011011) – Roland CS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Roland and the surrounding districts. Each interconnection is shown on Figure 36 and shows locations where gravity flow can cross from one district to another. Each interconnection is listed as follows:

1.3.1.1 Interceptor Connections - Downstream of Primary Weir

Mission

- CS flows through a 600 mm CS off-take secondary interceptor pipe south by gravity on Archibald Street from Hart district into Mission district. This is CS intercepted from the Roland district. This CS then flows into the Montcalm CS LS and is pumped via force main river crossing into the Syndicate district.
  - Archibald Street and Mission district boundary invert – 223.56 m (S-MA50018054)

1.3.1.2 District Interconnections

Hart

<u>SRS to SRS</u>

- A 2900 mm SRS flows southwest by gravity crossing Elmwood Road from Roland district into Hart district. This trunk connects into the same gate chamber and outfall as the Watt Street SRS; there is no interaction with the Hart system upstream of the gate chamber.
  - Invert at Hart district boundary – 222.27 m (S-MA40011025)

<u>CS to CS</u>

- A 1625 x 2060 mm CS flows west by gravity on Elmwood Road at Watt Street from Roland district into Hart district:
  - Invert at Hart district boundary – 223.52 m (S-MA40011002)

Munroe

<u>SRS to SRS</u>

- A 375 mm SRS relieves a 600 mm CS sewer off of Keenleyside Street in Munroe district and flows by gravity south along Keenleyside Street into Roland SRS System:
  - Invert at Munroe district boundary – 226.24 m (S-MA40010345)
- A 2900 mm SRS flows from Munroe district by gravity south along Besant Street and crosses into Roland district SRS system at Molson Street:
  - Invert at Munroe district boundary – 223.31 m (S-MA40007633)
- A 375 mm SRS flows from Munroe district by gravity eastbound on London Street and crosses into the Roland district SRS system:
  - Invert at Roland district boundary – 224.34 m (S-MA40007675)
- A 2900 mm SRS flows from Munroe by gravity south along Gateway Road into the Roland district SRS system:
  - Invert at Roland district boundary – 222.76 m (S-MA40008399)
- A 525 mm SRS flows from Munroe by gravity south along Grey Street to Roland district SRS system:
  - Invert at Munroe district boundary – 224.50 m (S-MA40007593)

Kildonan Place (Area 13.1)

<u>CS to CS</u>

- A 450 mm CS flows from Kildonan Place district by gravity west on Talbot Avenue at Panet Road into Roland district:
  - Invert at Roland district boundary – 226.65 m (S-MA40011663)
- A 1050 mm CS flows from Kildonan Place district by gravity west on Regent Avenue West into Roland district:
  - Invert at Roland district boundary – 226.31 m (S-MA70040189)

A district interconnection schematic for this district is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing system.

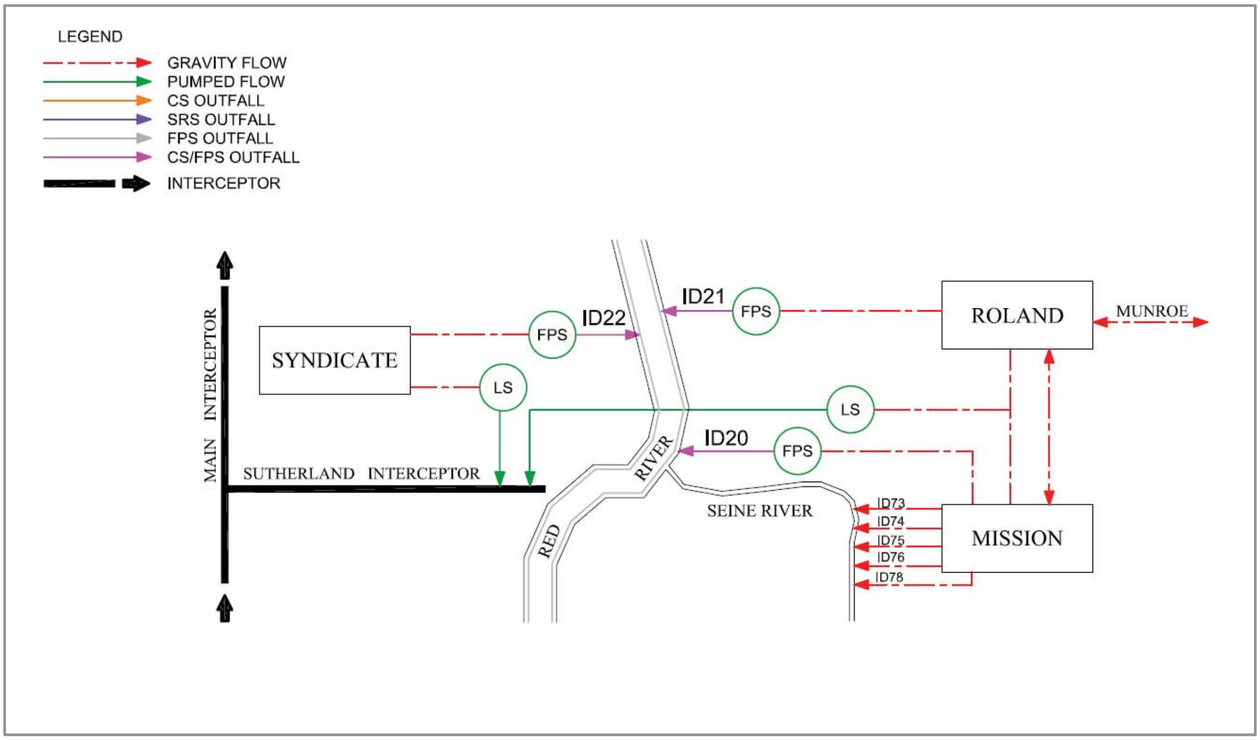


Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 36 and listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID21)	ROLAND_SRS_GC_03.1	S-MA40011011	3700 mm	Red River Invert: 221.39 m
Flood Pumping Outfall (ID21)	ROLAND_SRS_GC_03.1	S-MA40011011	3700 mm	Red River Invert: 221.39 m
Main Trunk	S-MH40009951.1	S-MA40011217	1625 x 2050 mm	Main CS that flows west across Archibald Street Invert: 223.48 m
SRS Outfalls (ID21)	ROLAND_SRS_GC_03.1	S-MA40011011	3700 mm	Red River Invert: 221.39 m
SRS Interconnections	N/A	N/A	N/A	43 SRS - CS
Main Trunk Flap Gate	S-TE70026812.2	S-CG00000732	1500 x 2100 mm	Invert: 223.71 m
Main Trunk Sluice Gate	S-CG00000733.1	S-CG00000733	1500 x 2100 mm	Invert: 223.61 m
Off-Take	S-MH70032213.2	S-MA50018054	600	Invert: 223.56
Dry Well	N/A	N/A	N/A	
Lift Station Total Capacity	N/A	N/A	0.84 m^3/s + one more pump	3 x 0.28 m^3/s, 1 x N/A
ADWF	N/A	N/A	0.016 m^3/s	
Lift Station Force Main	N/A	S-MA70046417	600 mm	2 x 600 mm

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
		S-MA70046432		
Flood Pump Station Total Capacity	N/A	N/A	1.70 m^3/s	2 x 0.85 m^3/s
Pass Forward Flow – First Overflow	N/A	N/A	0.473 m^3/s	

Notes:

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Roland – 223.70
2	Trunk Invert at Off-Take	223.56
3	Top of Weir	223.98
4	Relief Outfall Invert at Flap Gate (S-MA40011231)	222.11
5	Low Relief Interconnection (S-MA70024476)	224.50
6	Sewer District Interconnection (Hart)	222.42
7	Low Basement	229.06
8	Flood Protection Level	229.34

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed in Roland was the *Munroe, Roland, Hart Combined Sewer Study* (Wardrop Engineering Consultants, 1985). The study's purpose was to develop sewer relief options to reduce surcharge level and relieve basement flooding. No other work has been completed on the district sewer system since that time.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Roland Combined Sewer District was included as part of this program. Instruments installed at each of the thirty nine primary CSO outfall locations has a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Expected Completion
36 – Roland	1985	Future Work	2013	Study Complete	N/A

Source: Report *Munroe, Roland, Hart Combined Sewer Study*, 1985

1.5 Ongoing Investment Work

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Roland district. This consists of monthly site visits in confined entry spaces to verify physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Roland sewer district are listed in Table 1-4. The proposed CSO control projects will include latent storage, in-line storage via control gate, and floatable management via screening. Program opportunitiess including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage	Storage / Transport Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	✓	-	-	✓	✓	-	-	-	✓	✓	✓

Notes:

- = not included
✓ = included

The existing CS and SRS systems are suitable for use as in-line and latent storage. These control options will take advantage of the existing CS and SRS pipe networks for additional storage volume.

Floatable control will be necessary to capture any undesirable floatables in the sewage. Floatables will be captured with all implemented control options to some extent, but screening may be added as required to reach the desired level of capture. A screen will be installed on the Roland primary CS outfall.

GI and RTC will be applied within each district on a system wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.1 Latent Storage

Latent storage is proposed as a control option for the Roland district. There is one SRS system that shares the outfall with the main Roland CS outfall. The SRS system connects to the CS outfall pipe upstream of the SRS gate chamber with flap gate protection, and will provide additional storage. The latent storage level in the system is controlled by the river level, and the resulting backpressure of the river level on the SRS gate chamber flap gate, as explained in Part 3C. The SRS for the Roland district receives all the diverted CS flow from Roland as well as most of the SRS flow from Munroe to the north. The latent storage design criteria are identified in Table 1-5. The storage volumes indicated in Table 1-5 are based on the continuous NSWL river level conditions over the course of the 1992 representative year.

Table 1-5. Latent Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	Watt – 222.11 m	Flap Gate invert
NSWL	223.07 m	
Trunk Diameter	2900 mm	
Design Depth in Trunk	1600 mm	
Maximum Storage Volume	5200 m^3	
Force Main	225 mm	
Flap Gate Control	N/A	
Lift Station	Yes	
Nominal Dewatering Rate	0.075 m^3/s	Based on 24-hour emptying requirement
RTC Operational Rate	TBD	Future RTC/dewatering assessment required

Notes:

NSWL = normal summer water level
RTC = real time control

The addition of a pump and force main that connects back to the CS system will be required for the latent storage arrangement. A conceptual layout for the pump station and force main is shown on Figure 36-01. The pump station will be located north of the existing FPS in the adjacent parking lot near Archibald Street to avoid disruption to existing sewers or neighboring roads. The latent force main will pump east to the nearby 1625 by 2060 mm trunk sewer on Archibald Street and into the manhole (S-MH40009951) on the east curb on Archibald Street. The pump station will operate to dewater the SRS system in preparation for the next runoff event, the requirement for the system to be ready for the next event within a 24-hour period after completion of the previous event.

Figure 36 identifies the extent of the SRS system within Roland district that would be used for latent storage. The maximum storage level is directly related to the NSWL and the size and depth of the SRS system. Once the level in the SRS exceeds the river level, the flap gate opens, and the combined sewage is discharged to the river.

The river level will keep the SRS flap gate closed and system level maintained at the NSWL. This level utilizes 55 percent of the SRS pipe height. As part of the evaluation, the latent storage volume was completed using the continuous NSWL river conditions. It was found that additional flap gate control will not be required to meet the Control Option 1 85% capture target. In situations where non modelled assessments are to be completed, the actual river levels will be both lower and higher than the NSWL level at various points throughout an annual year. Where the level is below NSWL, the latent volume will be less than predicted during the MP assessment, while conversely when the level is above the NSWL, the latent volume will be more than predicted. The continuous assessment is seen as a conservative approach since the majority of the representative year rainfall events occur when the river levels are higher than the NSWL.

As described in the standard details in Part 3C wet well sizing for the latent storage pump station will be determined based on the final pump selection, operation and dewatering capacity required. The interconnecting piping between the new gate chamber and the pump station would be sized to provide sufficient flow to the pumps while all pumps are operating.

1.6.2 In-Line Storage

In-line storage has been proposed as a CSO control for Roland district. The in-line storage will require the installation of a control gate at the CS outfall. The gate will increase the storage level in the existing CS and provide an overall higher volume capture and provide additional hydraulic head for screening operations. The existing Montcalm sewage LS will provide the dewatering for the in-line storage.

A standard design was assumed for the control gate, as described in Part 3C. A standard approach was used for conceptual gate sizing by assuming it to be the lesser of the height of half of the site-specific trunk diameter or the maximum height of the gate available. The design criteria for the in-line storage is listed in Table 1-6.

Table 1-6. In-Line Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	223.48 m	Downstream invert of lowest pipe at diversion chamber
Trunk Diameter	1625 x 2060 mm	
Gate Height	0.65 m	Gate height based on half trunk diameter assumption (flood assessment included)
Top of Gate Elevation	224.63 m	
Bypass Weir Height	224.53 m	
Maximum Storage Volume	1,151 m^3	
Nominal Dewatering Rate	0.443 m^3/s	Based on minimum pass forward rate for gravity discharge district (Montcalm LSPS located downstream)
RTC Operational Rate	TBC	Future RTC / dewatering

Note:
TBC = to be confirmed
RTC – Real Time Control

The proposed control gate will cause combined sewage to back-up within the collection system to the extent shown on Figure 36. . The extent of the in-line storage and volume is related to the top elevation of the bypass side weir. The level of the top of the bypass side weir and adjacent control gate level are determined in relation to the critical performance levels in the system for basement flooding protection: when the system level increases the flow overtops the bypass weir and is screened prior to discharging to the river. If the system level continues to rise, it will reach the critical level where the control gate drops out of the way. At this point, the district will only provide its original interception capacity via the primary weir for the district, and all excess CS would flow over the weir and discharge to the river. After the sewer levels in the system drops back below the bypass side weir critical performance level, the control gate moves back to its original position to capture the receding limb of the WWF event. The gravity discharge will continue with its current operation while the control gate is in either position, will all DWF being diverted to the Montcalm Pumping Station.

Figure 36-01 provides an overview of the conceptual location and configuration of the control gate and screening chambers. The proposed control gate will be installed in a new chamber within the existing trunk sewer alignment near the FPS. The dimensions of a new chamber to provide an allowance for a side weir for floatables control are 5.0 m in length and 3.0 m in width to accommodate the gate, with an allowance for a longitudinal overflow weir. The chamber will be located immediately east of the FPS, within the local street and minor disruptions to the Archibald Street traffic would be noted during the potential construction period. The existing sewer configuration may have to be modified to allow the installation of the in-line gate and screening chambers. The physical requirements for the off-take and station sizing for a modification to pumping capacity have not been considered in detail, but they will be required in the future as part of an RTC program or FPS rehabilitation or replacement project.

The nominal rate for dewatering is already set as the existing pipe capacity as the district is a gravity discharge district, although impacted by the downstream Montcalm sewage LS. Any future considerations, for RTC improvements, would be completed with spatial rainfall and the interactions of the Montcalm sewage LS and the Mission district, which also drains to the Montcalm sewage LS.

1.6.3 Floatables Management

Floatables management will require installation of a screening system to capture floatable materials. The off-line screens would be proposed while still maintaining the current level of basement flooding protection.

The type and size of screens depend on the LS and the hydraulic head available for operation. A standard design was assumed for screening and is described in Part 3C. The design criteria for screening with gate control implemented, are listed in Table 1-7.

Table 1-7. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Top of Gate	224.63 m	
Bypass Weir Crest	224.53 m	
NSWL	223.70 m	
Maximum Screen Head	0.93 m	
Peak Screening Rate	0.35 m^3/s	
Screen Size	1.5 m x 1.0 m	Modelled Screen Dimensions

The proposed side overflow bypass weir and screening chamber will be located adjacent to the proposed control gate and existing CS trunk sewer, as shown on Figure 36-01. The screens will operate with the control gate in its raised position. A side bypass weir upstream of the gate will direct the overflow to the screens located in the new screening chamber, with screened flow discharged to the downstream side of the gate to the river. The screening chamber will include screenings pumps with a discharge returning the screened material back to the interceptor and on to the NEWPCC for removal.

The dimensions for the screen chamber to accommodate influent from the side weir, the screen area, and the routing of discharge downstream of the gate are 3.0 m in length and 2.3 m in width. The existing sewer configuration may have to be modified to accommodate the new chamber. The chamber will be located immediately east of the FPS, within the local street and minor disruptions to the Archibald Street traffic would be noted during the potential construction period.

1.6.4 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district will be reviewed to identify applicable GI controls.

Roland has been classified as a medium GI potential district. Roland district is a mix of residential, commercial and industrial. This district would be an ideal location for cisterns/rain barrels, and rain garden bioretention within the residential areas. Commercial areas are suitable to green roofs and parking lot areas are ideal for paved porous pavement. Bioswales may be suitable to the industrial areas.

1.6.5 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

The latent storage would take advantage of the SRS infrastructure already in place, therefore, minimal additional maintenance will need to be anticipated. The proposed latent LSPS will require regular maintenance that would depend on the frequency of operation. The flap control gate will require maintenance inspection for continued assurance that the flap gate would open during WWF events.

In-line storage will impact the existing sewer and will require the addition of a new chamber and a moving gate at the outfall. In-line storage dewatering will be controlled with the existing Clifton CS LS, which will require more frequent and longer duration pump run times. Lower velocities will occur in the CS trunk in the vicinity of the control gate due to lower pass forward flows, and may create additional debris deposition requiring cleaning. Additional system monitoring, and level controls will be installed, which will require regular scheduled maintenance.

Floatable control with outfall screening will require the addition of another chamber with screening equipment installed. The chamber will be installed adjacent to the control gate chamber and will operate in conjunction with it. Screening operation will occur during WWF events that surpass the in-line storage control level. WWF will be directed from the main CS trunk, over the side weir in the control gate chamber and through the screens to discharge into the river. The screens will operate intermittently during wet weather events and will likely require operations review and maintenance after each event. The frequency of a screened event will correlate to the number overflows identified for the district. Having the screenings pumped back to the interceptor system via a small LS and force main will be required. The screenings return will require O&M inspection after each event to assess the performance of the return pump system.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. Two versions of the sewer system model were created and used to measure system performance. The 2013 Baseline model represents the sewer system baseline in the year 2013 and the 2037 Master Plan – Control Option 1 model, which includes the proposed control options in the year 2037. A summary of relevant model data is provided in Table 1-8.

Table 1-8. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	287	287	5,318	48	N/A
2037 Master Plan – Control Option 1	287	287	5,318	48	IS, Lat St, SC

Notes:

Lat St = Latent Storage
IS = In-line Storage
SC = Screening

Table 1-8. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur

The performance results listed in Table 1-9 are for the hydraulic model simulations using the year-round 1992 representative year. This table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. Table 1-9 also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-9. District Performance Summary – Control Option 1

Control Option	Preliminary Proposal	Master Plan			
	Annual Overflow Volume (m^3)	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [b]
Baseline (2013)	301,845	299,396	-	20	0.401 m^3/s
In-Line Storage	301,103	290,998	8,398	18	0.479 m^3/s
In-Line & Latent Storage	N/A [a]	181,108	109,890	14	0.479 m^3/s
Control Option 1	**301,103**	**181,108**	**118,288**	**14**	**0.479 m^3/s**

[a] Latent storage was not simulated during the Preliminary Proposal assessment

[b] Pass forward flows assessed on the 1-year design rainfall event

The percent capture performance measure is not included in Table 1-9, as it is applicable to the entire CS system and not for each district individually.

1.9 Cost Estimates

The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in **Error! Reference source not found.**. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-10. District Cost Estimate – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period)
Latent Storage	N/A [a]	$2,790,000	$82,000	$1,780,000

In-Line Storage	N/A [b]	$2,540,000 [c]	$40,000	$850,000
Screening		$1,990,000 [d]	$31,000	$660,000
Subtotal	**N/A**	**$7,320,000**	**$153,000**	**$3,290,000**
Opportunities	N/A	$730,000	$15,000	$330,000
District Total	**N/A [b]**	**$8,050,000**	**$168,000**	**$3,620,000**

[a] Latent Storage not included in the Preliminary Proposal

[b] Solution development as refinement to Preliminary Proposal costs. Revised costs for these items of work found to be $7,410,000 in 2014 dollars.

[c] Costs associated with any revision to existing off-take, as required, to accommodate the control gate location and allow the intercepted CS flow to reach the existing gravity interceptor are not included

[d] Cost for bespoke screening return/force main not included in Master Plan as will depend on selection of screen and type of screening return system selected

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional cost for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014 dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019 dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-11.

Table 1-11. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	In-line Storage Control Gate	A control gate was not included in the initial preliminary estimate	Added to Master Plan
	Screening	Screening was not included in the initial Preliminary Proposal	Added for the Master Plan.
	Latent Storage	Latent Storage was not included in the Preliminary Proposal	Added for the MP to further reduce overflows.

Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation	Preliminary estimates were based on 2014-dollar values	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, the future performance target is 98 percent capture for the representative year measured on a system-wide basis. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-12 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified for Control Option 1.

Overall the Roland district would be classified as a high potential for implementation of complete sewer separation as the only feasible approach to achieve the 98 percent capture future performance target in the representative year. The non-separation measures recommended as part of this district engineering plan to meet Control Option 1, specifically in-line storage and floatables management via off-line screening, are therefore at risk of becoming redundant and unnecessary when the measures to achieve future performance targets are pursued. As a result, these measures should not be pursued until the requirements to meet future performance targets are more defined. Should it be confirmed that complete separation is the recommended solution to meet future performance targets, then complete separation will likely be pursued to address Control Option 1 instead of implementing the non-separation measures. This will be with the understanding that while initial complete separation is less cost-effective to meet Control Option 1, it is the most cost effective solution to meet the future performance target and removes the capital costs on short term temporary solutions. Focused use of green infrastructure, and reliance on said green infrastructure as well can provide volume capture benefits and could be utilized to meet future performance targets.

Table 1-12. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Sewer Separation • Increased use of GI

The control options selected for the Roland district have been aligned for the 85 percent capture performance target based on the system wide basis. The expandability of this district to meet the 98 percent capture would not align with the proposed options for the 85 percent capture target. The future higher level of percent capture indicates that complete sewer separation would be applicable in this district.

The cost for upgrading to meet an enhanced performance target depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-13.

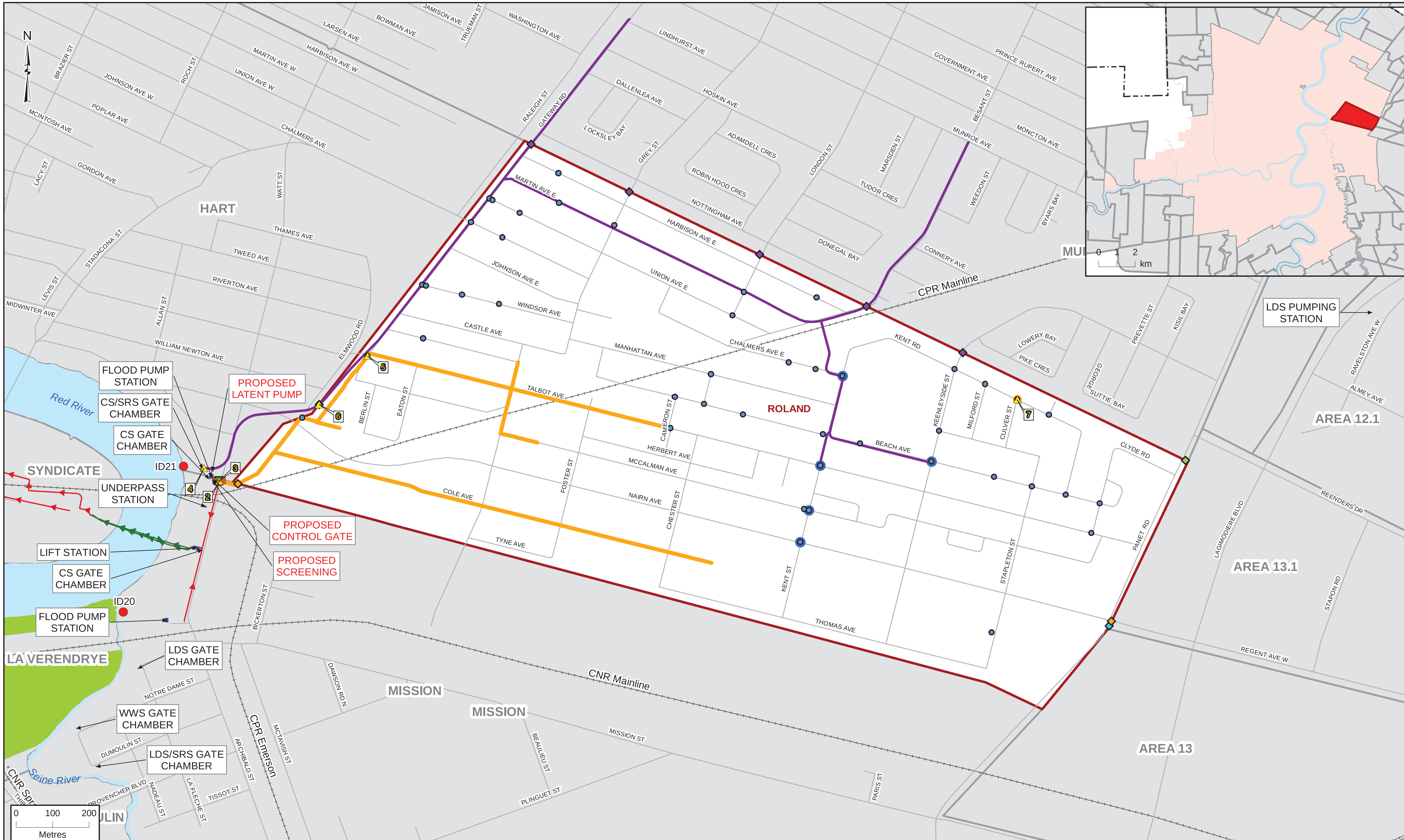
Table 1-13. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	R	R	-	-	-	-	-	-
2	Existing Lift Station	-	R	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	-	-	-	-
4	Construction Disruption	-	-	-	-	-	-	-	-
5	Implementation Schedule	-	-	-	-	-	-	R	-
6	Sewer Condition	R	R	-	-	-	-	-	-
7	Sewer Conflicts	R	R	-	-	-	-	-	-
8	Program Cost	O	O	-	-	-	-	-	O
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	R	-	-	-	-	O	O	-
12	Operations and Maintenance	R	R	-	-	-	R	O	R
13	Volume Capture Performance	O	O	-	-	-	O	O	-
14	Treatment	R	R	-	-	-	O	O	R

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

Wardrop Engineering Consultants. 1985. *Munroe, Roland, Hart Combined Sewer Relief Study.* Prepared for the City of Winnipeg, Waterworks, Waster and Disposal Department. June.



LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Low CS Manhole
- Low SRS Connection

Inter-System Connection
- SRS - CS

District Boundary Crossing
- CS
- LDS
- SRS
- WWS

- Interceptor Sewer
- Force Main
- Street
- Railway
- District Boundary
- Watercourse
- Greenspace

CSO MASTER PLAN PROPOSED SOLUTIONS

- Proposed Control Gate
- Latent Storage Limit
- Extent of In-line Storage

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 36
District Overview Map
Sewer District: Roland
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Manhole
- Flap Gate
- Sluice Gate
- Pump Location

Sewer By Type
- CS
- SRS

Control Structure Type
- Gate Chamber

Pump Station Type
- Flood Pump Station

CSO MASTER PLAN
PROPOSED SOLUTIONS
- Proposed Latent Force Main
- Control Gate
- Screening
- Latent Pump

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg
THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 36-01
Control Gate, Screening, and Latent Pump
Sewer District: Roland
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Selkirk District Plan

August 2019

City of Winnipeg

CSO Master Plan

Project No:	470010CH
Document Title:	Selkirk District Plan
Revision:	03
Date:	August 22, 2019
Client Name:	City of Winnipeg
Project Manager:	John Berry
Author:	Scott Begg
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Document History and Status

Revision	Date	Description	By	Review	Approved
0	09/14/2018	DRAFT for City Comment	DT	SB MF SG	
1	02/20/2019	DRAFT 2 for City Review	SB	SG	MF
2	07/2019	Final Draft Submission	DT	MF	MF
3	08/19/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

Tables

Figure

1. Selkirk District

1.1 District Description

Selkirk district is located in the northwest section of the combined sewer (CS) area west of the Red River and north of Alexander and Syndicate districts. Selkirk is approximately bounded by the Canadian Pacific Railway (CPR) Winnipeg Yards to the south, Sinclair Street and McPhillips Street to the west, Alfred Avenue to the north, and the Red River to the east.

Selkirk district includes a mix of commercial, industrial, and residential land use. Residential areas are mainly two-family and multi-family. Industrial manufacturing facilities are located primarily south of Dufferin Avenue. A heavy manufacturing land use area located south of Sutherland Avenue includes the CPR Winnipeg Yards. Commercial areas are found along Main Street and Selkirk Avenue. Greenspace areas include the Old Exhibition Grounds and Redwood Park, and various school parks, playgrounds, and community areas throughout the district.

This district is located in proximity to the downtown and has many transportation routes. The CPR Mainline passes through the southern end of Selkirk district. Regional roads in the district include Main Street, Salter Street, McGregor Street, Arlington Street, and McPhillips Street in a north-south direction and Selkirk Avenue and Dufferin Avenue in the east-west direction. Arlington Street includes the Arlington Bridge that extends over the CPR Winnipeg Yards into the Selkirk district.

1.2 Development

There is limited land area available for new development within the Selkirk district. However, some significant redevelopments that could impact the Combined Sewer Overflow (CSO) Master Plan are in the planning stages:

A study has been completed to construct a more improved bridge to replace the Arlington Bridge. The study began in 2014 with construction projected to be completed in 2024. The Arlington bridge is nearing the end of its usable life and plans to construct a more detailed bridge that allows for increased transportation and improvements for walking and cycling were considered in the study. The development of the bridge will have minimal impact on the CSO Master Plan.

There are several areas within the Selkirk CS district which have been identified as a General Manufacturing Lands as part of OurWinnipeg. Focused intensification within these areas is to be promoted in the future, with a particular focus on mixed use development. This is to verify that adequate employment lands are available to support future population growth.

A portion of Main Street is located within the Selkirk District. Main Street is identified as a Regional Mixed Use Corridor as part of the OurWinnipeg future development plans. As such, focused intensification along Main Street is to be promoted in the future.

1.3 Existing Sewer System

Selkirk district encompasses an area of 310 ha[1] and includes a CS system and a storm relief sewer (SRS) system. This district does not include any areas that may be identified as LDS separated. There is approximately 6 ha (2.0 percent) identifiable as separation-ready and approximately 20 ha of greenspace.

The CS system includes a diversion structure, a flood pump station (FPS), four CS outfalls, and outfall gate chambers. The CS system drains towards the Selkirk outfall and diversion chamber, located at the

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

east end of Selkirk Avenue at the Red River. At the outfall, sewage is diverted to the Main Interceptor or may be discharged by gravity/via the FPS adjacent to the CS outfall into the Red River.

A single sewer trunk collects flow from most of the district and flows east to the diversion chamber on Selkirk Avenue. The main 1600 mm by 2000 mm CS trunk extends from the diversion chamber to McKenzie street. Multiple secondary sewers extend from the main CS trunk along Selkirk Avenue to the north and south to service the entire area. There are also two secondary CS outfalls at the east end of Aberdeen Avenue and Pritchard Avenue respectively. Each of these secondary outfalls provide local relief to the CS laterals on Aberdeen Avenue and Pritchard Avenue. A positive gate alone is constructed on the Pritchard secondary outfall, and there is no flap gate or sluice gates constructed on the Aberdeen secondary outfall. Frequent silting issues are encountered at the Aberdeen secondary outfall, and for periods of time this outfall is not operational. This outfall is to be further investigated and potentially decommissioned if found to not currently be in operation.

During runoff events, the SRS system provides relief to the CS system in the Selkirk district. The SRS system extends throughout the district and has multiple interconnections with the CS system. Most catch basins are still connected to the CS system, so no partial separation has been completed. The SRS system includes a dedicated SRS outfall at Burrows Avenue and discharges directly to the Red River. A flap gate and sluice gate are installed on the Burrows SRS outfall pipe to control backflow into the SRS system under high river level conditions in the Red River.

During dry weather flow (DWF), the SRS is not required; sanitary sewage flows to the diversion chamber and is diverted by the weir to a 600 mm interceptor pipe, where it flows by gravity west to the Main Street interceptor and on to the North End Sewage Treatment Plant (NEWPCC) for treatment.

During wet weather flow (WWF), any flows that exceeds the diversion capacity overtops the weir and is discharged to the river. Sluice and flap gates are installed on the CS outfall to prevent back-up of the Red River into the CS system When the Red River levels are particularly high the flap gate prevents gravity discharge from the Selkirk CS outfall. Under these conditions the excess flow is pumped by the Selkirk FPS to a point in the Selkirk CS Outfall downstream of the flap gate, where it can be discharged to the river by gravity.

The four outfalls to the Red River (three CS and one SRS) are as follows:

- ID23 (S-MA70007427) – Selkirk CS Outfall
- ID26 (S-MA00017914) – Aberdeen CS Outfall
- ID24 (S-MA00017936) – Pritchard CS Outfall
- ID25 (S-MA00017926) – Burrows SRS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Selkirk and the surrounding districts. Each interconnection is shown on Figure 37 and shows locations where gravity flow can cross from one district to another. Each interconnection is listed as follows:

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

St Johns

- The 2250 mm Main Interceptor flows by gravity into St. Johns district north on Main Street towards the NEWPCC for treatment:
  - Invert at Selkirk district boundary – 219.83 m (S-MH000162165)

1.3.1.1 Interceptor Connections – Upstream of Primary Weir

Syndicate

- The 2250 mm Main Interceptor pipe flows by gravity north on Main Street into Selkirk district to carry sewage to the NEWPCC for treatment:
  - Invert at Syndicate district boundary 220.13 m (S-TE00005699)

1.3.1.2 District Interconnections

Syndicate

<u>CS to CS</u>

- High sewer overflow:
  - 375 mm CS on Main Street at Dufferin Avenue – 228.52 m (S-MH00012094)

<u>CS To SRS</u>

- High sewer overflow:
  - 500 mm SRS on Euclid Avenue at Lusted Avenue – 228.60 m (S-MA00013582)
  - 250 mm SRS on Austin Street N at Euclid Avenue – 228.62 m (S-MA00013587)

St. Johns

<u>CS to CS</u>

- A 300 mm CS flows north by gravity on Arlington Street into St. Johns district from Selkirk district:
  - Invert at Selkirk district boundary 228.65 m (S-MA00014590)
- A 300 mm CS flows by gravity northbound on Aikins Street into St. Johns district:
  - Invert at Selkirk district boundary 227.20 m (S-MA00015124)
- A 300 mm CS flows by gravity north on Main Street and connects to the CS network in St. Johns district at the intersection of Main Street and Redwood Avenue:
  - Invert at Selkirk district boundary 227.60 m (S-MA00015398)
- High point manhole:
  - 300 mm CS on Selkirk Avenue – 229.19 m (S-MH00008778)
  - 300 mm CS on McGregor Street – 228.33 m (S-MH00013219)

<u>CS to SRS</u>

- High sewer overflow:
  - 450 mm SRS on Artillery Street – 229.34 m (S-MH00012613)
  - 250 mm SRS on Alfred Avenue – 229.84 m (S-MH00012868)

<u>SRS to SRS</u>

- A 2150 mm SRS flows by gravity eastbound on Burrows Avenue from St. Johns district into Selkirk district:
  - Invert at Selkirk district boundary 223.64 m (S-MA00014318)
- A 2150 mm SRS flows by gravity northbound on Arlington Street into St. Johns district:
  - Invert at Selkirk district boundary 223.57 m (S-MA00014588)

A district interconnection schematic is included as Figure 1-1.The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing system.

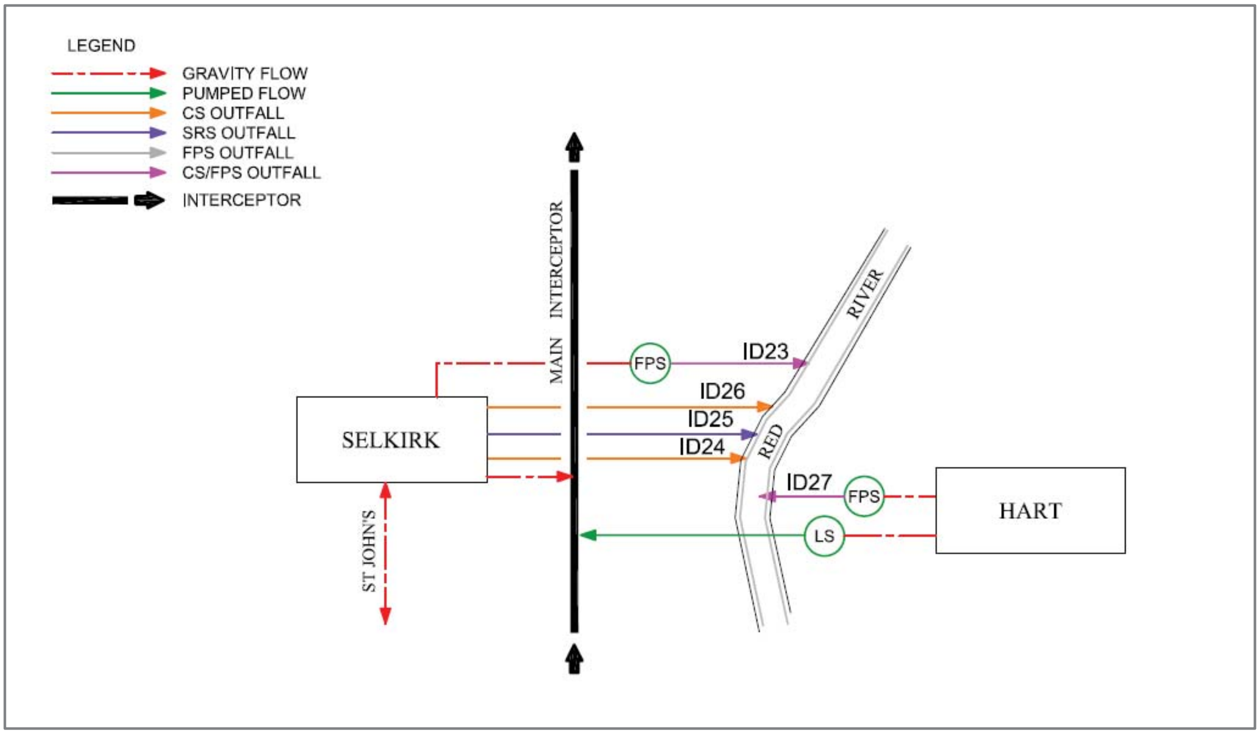


Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 37 and listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID23)	S-CO70003073.1	S-MA70007427	1800 mm	Red River Invert: 221.80 m
Flood Pumping Outfall (ID23)	S-CO70003073.1	S-MA70007427	1800 mm	Red River Invert: 221.80 m
Other Overflows (ID24 & ID26))	S-MH00012354.1 S-MH00014696.1	S-MA00017936 S-MA00017914	250 mm 200 mm	Invert: 222.99 m Invert: 223.29 m
Main Trunk	S-MH00012339.1	S-MA00013835	1600 x 2000 mm	Main CS that flows east on Selkirk Avenue Egg-shaped Invert: 223.67 m
SRS Outfalls (ID25)	S-BE00007701.1	S-MA00017926	2400 mm	Invert: 221.03 m
SRS Interconnections	N/A	N/A	N/A	54 SRS - CS
Main Trunk Flap Gate	S-AC70007831.1	S-CG00000997	1525 mm	Invert: 223.90 m
Main Trunk Sluice Gate	SELKIRK_GC.1	S-CG00001065	1600 x 1600 mm	Invert: 223.70 m
Off-Take	N/A	S-MA70049021	600 mm	Invert: 223.70 m
Dry Well	N/A	N/A	N/A	

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Lift Station Total Capacity	N/A	S-MA70049021 [(1)]	600 mm [(1)]	0.57 m^3/s [(1)]
ADWF	N/A	N/A	0.0316 m^3/s	
Lift Station Force Main	N/A	N/A	N/A	
Flood Pump Station Total Capacity	N/A	N/A	3.84 m^3/s	2 x 0.52 m^3/s 2 x 1.40 m^3/s
Pass Forward Flow – First Overflow	N/A	N/A	0.474 m^3/s	

Notes:

[(1)] – Gravity pipe replacing Lift Station as Selkirk is a gravity discharge district
ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Selkirk – 223.69 Burrows – 223.69 Pritchard – 223.69 Aberdeen – 223.69
2	Trunk Invert at Off-Take	223.68
3	Top of Weir	224.38
4	Relief Outfall Invert at Flap Gate (Burrows SRS Outfall)	221.71
5	Low Relief Interconnection (S-MH00012136)	225.24
6	Sewer District Interconnection (St Johns)	223.57
7	Low Basement	228.90
8	Flood Protection Level (Selkirk)	229.20

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed in Selkirk was the *Sewer Relief Study: Selkirk Combined Sewer District* (I.D. Engineering Canada Inc., 1993). The study's purpose was to develop sewer relief options that provide a 5-year level of protection against basement flooding and to develop alternatives for reducing and eliminating pollutants from CSOs. No other work has been completed on the district sewer system since that time.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Selkirk Combined Sewer District was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations has a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Planned Completion
37 – Selkirk	1993	Future Work	2013	Study Complete	N/A

Source: Report on *Sewer Relief Study: Selkirk Combined Sewer District*, 1993

1.5 Ongoing Investment Work

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Selkirk district. This consists of monthly site visits in confined entry spaces to verify that physical readings concur with displayed transmitted readings, and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The Selkirk district has latent storage, in-line storage via control gate, floatable control via screening, gravity flow control and green infrastructure (GI) projects proposed to meet CSO Control Option 1. Table 1-4 provides an overview of the control options included in the 85 percent capture in a representative year option.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage	Storage / Transport Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	✓	-	✓	✓	✓	-	-	-	✓	-	✓

Notes:

- = not included
✓ = included

The existing CS and SRS systems are suitable for use as in-line and latent storage. These proposed control options will take advantage of the existing CS and SRS pipe networks for additional storage volume. Existing DWF from the collection system will remain the same, and overall district operations will remain the same, although additional WWF will be collected from the SRS/CS systems and forwarded to the NEWPCC for treatment.

The Selkirk district discharges to the interceptor by gravity; therefore, it will also require a method of flow control to optimize and control the discharge rate to the interceptor for future dewatering RTC controls. Refer to Section 3.3.5 of Part 2 of the CSO Master Plan for discussion on the interaction of the gravity control on the system for all gravity discharge locations.

Floatable control will be necessary to capture any undesirable floatables in the sewage. Floatables will be captured with all implemented control options to some extent, but screening may be added as required to reach the desired level of capture.

GI and RTC will be applied within each district on a system wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.1 Latent Storage

Latent storage is proposed as a control option for the Selkirk district. Latent storage will use the Burrows SRS outfall and associated SRS system. The latent storage level in the system is controlled by the river level on the Red River, which has been modelled as the NSWL for the 1992 representative year, and the resulting backpressure of the river level on the Burrows SRS outfall flap gate, as explained in Part 3C. The latent storage design criteria are identified in Table 1-5.

Table 1-5. Latent Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	Burrows – 221.84 m	Flap Gate invert
NSWL	223.69 m	
Trunk Diameter	2400 mm	
Design Depth in Trunk	1846 mm	
Maximum Storage Volume	1680 m^3	
Force main	100 mm	
Flap Gate Control	N/A	
Lift Station	Yes	
Nominal Dewatering Rate	0.015 m^3/s	Based on 24 hour emptying requirement
RTC Operational Rate	TBD	Future RTC/ dewatering assessment

Note:

NSWL - normal summer water level

RTC – Real Time Control

Latent storage is readily accessible and has lower risk for implementation than other combined sewage temporary storage means. In order to facilitate an operational latent system, a latent pump station and interconnecting pipes will be required to access the storage. The latent storage pumping system would connect to the SRS outfall chamber and discharge back to the CS system once capacity allows. A conceptual layout for the pump station and force main is shown on Figure 37-02. The pump station will be located adjacent to the SRS outfall gate chamber at the edge of Burrows Avenue. The latent force main will pump the stored combined sewage back into the Selkirk CS system via the upstream manhole on the CS lateral on Burrows Avenue immediately adjacent to the SRS outfall (S-MH00012329). The pump station will operate to dewater the SRS system in preparation for the next runoff event, the requirement for the system to be ready for the next event within a 24-hour period after completion of the previous event.

Figure 37 identifies the extent of the SRS system within Selkirk district that would be used for latent storage. The maximum storage level is directly related to the NSWL under the 1992 representative year conditions, and the size and depth of the SRS system. Once the level in the SRS exceeds the river level, the flap gate opens, and the combined sewage is discharged to the river. At this point the latent storage in the system is no longer utilized.

As described in the standard details in Part 3C wet well sizing will be determined based on the final pump selection, operation and dewatering capacity required. The interconnecting piping between the new gate chamber and the pump station would be sized to provide sufficient flow to the pumps while all pumps are operating.

1.6.2 In-Line Storage

In-line storage is proposed as a CSO control for the Selkirk district. The in-line storage will require the installation of a control gate at the CS outfall. The gate will increase the storage level in the existing CS and provide an overall higher volume capture. The control gate installation will also provide the necessary additional hydraulic head for screening operations.

A standard design was assumed for the control gate, as described in Part 3C. A standard approach was used for conceptual gate sizing by assuming it to be the lesser of the height of half of the site-specific trunk diameter or the maximum height of the gate available. The design criteria for the in-line storage are listed in Table 1-6.

Table 1-6. In-Line Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	223.69 m	Downstream invert of lowest pipe at diversion chamber
Trunk Diameter	1600 x 2000 mm	Egg shaped sewer
Gate Height	0.41 m	Gate height based on half trunk diameter assumption
Top of Gate Elevation	224.79 m	
Bypass Weir Level	224.69 m	
Maximum Storage Volume	287 m^3	
Nominal Dewatering Rate	0.57 m^3/s	Based on minimum pass forward rate for gravity discharge district
RTC Operational Rate	TBC	Future RTC / dewatering

The proposed control gate will cause combined sewage to back-up within the collection system to the extent shown on Figure 37. The extent of the in-line storage and volume is related to the top elevation of the bypass side weir. The level of the top of the bypass side weir and adjacent control gate level are determined in relation to the critical performance levels in the system for basement flooding protection: when the system level increases above the bypass weir crest and proceeds above the top of the control gate during high flow events, the control gate drops out of the way. At this point, the district will only provide its original interception capacity via the primary weir for the district, and all ecess CS would flow over the weir and discharge to the river. After the sewer levels in the system drops back below the bypass side weir critical performance level, the control gate moves back to its original position to capture the receding limb of the WWF event. The existing DWF diversion will continue with its current operation, with all DWF being diverted to the Main Interceptor.

Figure 37-01 provides an overview of the conceptual location and configuration of the control gate and screening chambers. The proposed control gate will be installed in a new chamber within the existing trunk sewer alignment and located west of the Selkirk FPS. The dimensions of a new chamber to provide an allowance for a side weir for floatables control are 5.0 m in length and 3.0 m in width to accommodate the gate, with an allowance for a longitudinal overflow weir. The existing sewer configuration may have to be modified to allow the installation of the in-line gate and screening chambers. The physical requirements for the off-take and station sizing for a modification to pumping capacity have not been considered in detail, but they will be required in the future as part of an RTC program or FPS rehabilitation or replacement project.

The nominal rate for dewatering is determined by the performance of the existing pipe capacity as the district is a gravity discharge district. As such the flows will vary over the duration of a rainfall event and has been nominated for a gravity flow control device. Any future consideration for RTC improvements would be completed with spatial rainfall as any reduction to the existing pipe capacity/operation for large events will adversely affect the overflow at this district. The control device would be set to a rate similar to the existing pipe full capacity to allow the set limit to be known. This would allow the future RTC control the ability to capture and treat more volume for localized storms in other districts by using the excess interceptor capacity made available by restricting the pass forward flows through the control device where the runoff is less.

1.6.3 Gravity Flow Control

Selkirk district does not include a lift station (LS) and discharges directly to the Main Interceptor by gravity. A flow control device will be required to control the diversion rate for future RTC and dewatering assessment. A standard flow control device was selected as described in Part 3C. This has been taken as part of the City's future vision to develop a fully integrated CS system network and will be needed to review flows during spatial rainfall WWF scenarios. The CSO Master Plan assessment utilized a uniform rainfall event and no further investigative work has been completed within the CSO Master Plan.

The flow controller would be installed at an optimal location on the connecting sewer between the diversion chamber and the Main Interceptor pipe on Selkirk Avenue. Figure 37-01 identifies a conceptual location for flow controller installation. A small chamber or manhole with access for cleaning and maintenance will be required. The flow controller will operate independently and require minimal operation interaction. The diversion weir at the CS outfall may have to be adjusted to match the hydraulic performance of the flow controller.

A gravity flow controller has been included as a consideration in developing a fully optimized CS system as part of the City's long-term objective. The operation and configuration of the gravity flow controller will have to be further reviewed for additional flow and rainfall scenarios.

1.6.4 Floatables Management

Floatables management will require installation of a screening system to capture floatable materials. The off-line screens would be designed to maintain the current level of basement flooding protection. The overflows which would normally discharge over the existing primary weir will be directed to the screens via a new side overflow weir located in a new screening chamber, with screened flow discharged to the downstream side of the weir chamber to the river.

The type and size of screens depend on the LS and the hydraulic head available for operation. A standard design was assumed for screening and is described in Part 3C. The design criteria for screening with gate control implemented, are listed in Table 1-7.

Table 1-7. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Top of Gate	224.79 m	
Bypass Weir Crest	224.69 m	
NSWL	223.69 m	
Maximum Screen Head	1.00 m	
Peak Screening Rate	1.00 m3/s	
Screen Size	1.5 m x 1.0 m	Modelled Screen Size

The proposed side overflow weir and screening chamber will be located adjacent to the existing combined trunk sewer, as shown on Figure 37-01. The screens will operate once levels within the sewer surpassed the bypass side weir elevation. The side weir will be located upstream of the control gate and will direct the overflow to the screens located in the new screening chamber, with screened flow discharged to the downstream side of the gate to the river. The screening chamber would include screenings pumps with a discharge returning the screened material back to the interceptor and on to the NEWPCC for removal.

The dimensions for the screen chamber to accommodate influent from the side weir, the screen area, and the routing of discharge downstream of the gate are 3.3 m in length and 3.1 m in width. The existing sewer configuration may have to be modified to accommodate the new chamber**.**

1.6.5 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district will be reviewed to identify applicable GI controls.

Selkirk has been classified as a high GI potential district. Land use in Selkirk is mix of residential, commercial, and institutional. The east end of the district is bounded by the Red River. This district would be an ideal location for cisterns/rain barrels, and rain garden bioretention within the residential areas. Commercial areas are suitable to green roofs and parking lot areas are ideal for paved porous pavement.

1.6.6 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

The latent storage would take advantage of the SRS infrastructure already in place, therefore, minimal additional maintenance will need to be anticipated. The proposed latent LSPS will require regular maintenance that would depend on the frequency of operation. The flap control gate will require maintenance inspection for continued assurance that the flap gate would open during WWF events.

In-line storage will impact the existing sewer and will require the addition of a new chamber and a moving gate at the outfall. In-line storage dewatering will be controlled with the existing Clifton CS LS, which will require more frequent and longer duration pump run times. Lower velocities will occur in the CS trunk in the vicinity of the control gate due to lower pass forward flows, and may create additional debris deposition requiring cleaning. Additional system monitoring, and level controls will be installed, which will require regular scheduled maintenance.

The flow controller will require the installation of a chamber, flow control equipment and monitoring and control instrumentation. The flow controller will operate independently and require minimal operation interaction. Regular maintenance of the flow controller chamber and appurtenances will be required.

Floatable control with outfall screening will require the addition of another chamber with screening equipment installed. The chamber will be installed adjacent to the control gate chamber and will operate in conjunction with it. Screening operation will occur during WWF events that surpass the in-line storage control level. WWF will be directed from the main CS trunk, over the side weir in the control gate chamber and through the screens to discharge into the river. The screens will operate intermittently during wet weather events and will likely require operations review and maintenance after each event. The frequency of a screened event will correlate to the number overflows identified for the district. Having the screenings pumped back to the interceptor system via a small LS and force main will be required. The screenings return will require O&M inspection after each event to assess the performance of the return pump system.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. Two versions of the sewer system model were created and used to measure system performance. The 2013 Baseline model represents the sewer system baseline in the year 2013 and the 2037 Master Plan – Control Option 1 model, which includes the proposed control options in the year 2037. A summary of relevant model data is summarized in Table 1-8.

Table 1-8. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Added to Model
2013 Baseline	256	256	10,500	70	N/A
2037 Master Plan – Control Option 1	256	256	10,500	70	Lat St, IS, SC

Notes:
Lat St = Latent Storage

IS = In-line Storage

SC = Screening

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-9 are for the hydraulic model simulations using the year-round 1992 representative year. The table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan – Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. The table also includes overflow volumes specific to each individual control option: these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-9. Performance Summary – Control Option 1

Control Option	Preliminary Proposal	Master Plan			
	Annual Overflow Volume (m^3)	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [b]
Baseline (2013)	159,995	172,507	-	21	0.537 m^3/s
Latent Storage	143,086	157,563 [b]	14,944	18	0.537 m^3/s
In-Line Storage & Latent Storage		150,161	22,346	18	0.540 m^3/s
Latent, In-line & Off-line Storage	29,210	N/A[d]	N/A[d]	N/A[d]	N/A[d]
Control Option 1	**29,210**	**150,161**	**22,346**	**18**	**0.540 m^3/s**

[a] Pass forward flows assessed on the 1-year design rainfall event.

[b] Assessment completed with individual district models and reductions attributed to full model impact overflows provided

[c] In-line and Off-line storage not assessed independently during the Preliminary Proposal

[d] Off-line storage removed as recommendation during Master Plan assessment.

The percent capture performance measure is not included in Table 1-9, as it is applicable to the entire CS system and not for each district individually. It is noted that the location and gravity discharge nature of the Selkirk district are affected by the control options selected for both the upstream and downstream districts. The improvement or worsening of this district's performance will be affected and once all Control Option 1 recommended works are implemented will the overflow volumes be achieved.

The selection of an off-line storage tank during Preliminary Proposal has been reconsidered during the CSO Master Plan phase as it was found to not be required to meet the Control Option 1 limit.

1.9 Cost Estimates

The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-10Table 1-10. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 to plus 100 percent.

Table 1-10. Cost Estimate – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year Period)
Latent Storage	$1,290,000	$1,830,000	$70,000	$1,510,000
In-Line Storage	$- [a]	$2,460,000 [b]	$43,000	$930,000
Screening		$3,030,000 [c]	$53,000	$1,130,000
Gravity Flow Control	N/A	$1,280,000	$34,000	$740,000
Off-Line Storage	$13,450,000	N/A [d]	N/A [d]	N/A [d]
Subtotal	**$14,740,000**	**$8,600,000**	**$201,000**	**$4,310,000**
Opportunities	N/A	$860,000	$20,000	$430,000
District Total	**$14,740,000**	**$9,460,000**	**$221,000**	**$4,740,000**

[a] Solutions developed as refinement to Preliminary Proposal work following submission of Preliminary Proposal costs. Preliminary Proposal recommended in-line storage and screening for CO1 PP. Costs for these items of work found to be $4,520,000 in 2014 dollars

[b] Cost associated with new off-take construction, as required, to accommodate control gate and screening chambers in location and allow intercepted CS flow to reach Selkirk gravity discharge interceptor was not included in Master Plan

[c] Cost for bespoke screenings return/force main not included in Master Plan as will depend on selection of screen and type of screening return system selected

[d] Off-line storage removed as recommendation during Master Plan assessment.

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional cost for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014 dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019 dollar values.

- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-11.

Table 1-11. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	In-Line Storage	A control gate was not included in the preliminary proposal estimate.	Added for the MP to further reduce overflows and optimize in-line.
	Screening	Not included in the preliminary proposal estimate.	Added in conjunction with the In-Line Storage Control Gate.
	Gravity Flow Control	A flow controller was not included in the preliminary proposal estimate	Added for the Master Plan to control and monitor pass forward flows
	Removal Of Off-Line Tank Storage	Removed from the Master Plan assessment	Not needed to achieve 85 percent capture target.
Opportunities	A fixed allowance of 10 percent has been included for program opportunities.	Preliminary Proposal estimate did not include a cost for GI opportunities.	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years.	City of Winnipeg Asset Management approach.	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation.	Preliminary Proposal estimates were based on 2014 dollar values.	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, the future performance target is 98 percent capture for the representative year measured on a system-wide basis. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-12 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified in Control Option 1.

Overall the Selkirk district would be classified as a low potential for implementation of complete sewer separation as the only feasible approach to achieve the 98 percent capture future performance target in the representative year. However, opportunistic sewer separation within a portion of the district may be completed in conjunction with other major infrastructure work to address future performance targets. In addition, green infrastructure and off-line tank or tunnel storage may be utilized in key locations to provide additional storage and increase capture volume to meet future performance targets.

Table 1-12. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Increased use of GI • Opportunistic Sewer Separation • Off-line Storage (Tank/Tunnel)

The Selkirk district has been aligned to meet the 85 percent capture on a system wide basis. The applicability of the listed migration options will also be dependent on other district options as these interact and would be required to be assessed on a system wide basis rather than individual district option basis.

The cost for upgrading to meet an enhanced performance target depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-13.

Table 1-13. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	R	R	-	-	-	-	-	-
2	Existing Lift Station	-	R	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	-	-	-	-
4	Construction Disruption	-	-	-	-	-	-	-	-
5	Implementation Schedule	-	-	-	-	-	-	R	-
6	Sewer Condition	R	R	-	-	-	-	-	-
7	Sewer Conflicts	R	R	-	-	-	-	-	-
8	Program Cost	O	O	-	-	-	-	-	O
9	Approvals and Permits	-	-	-	-	-	R	-	-

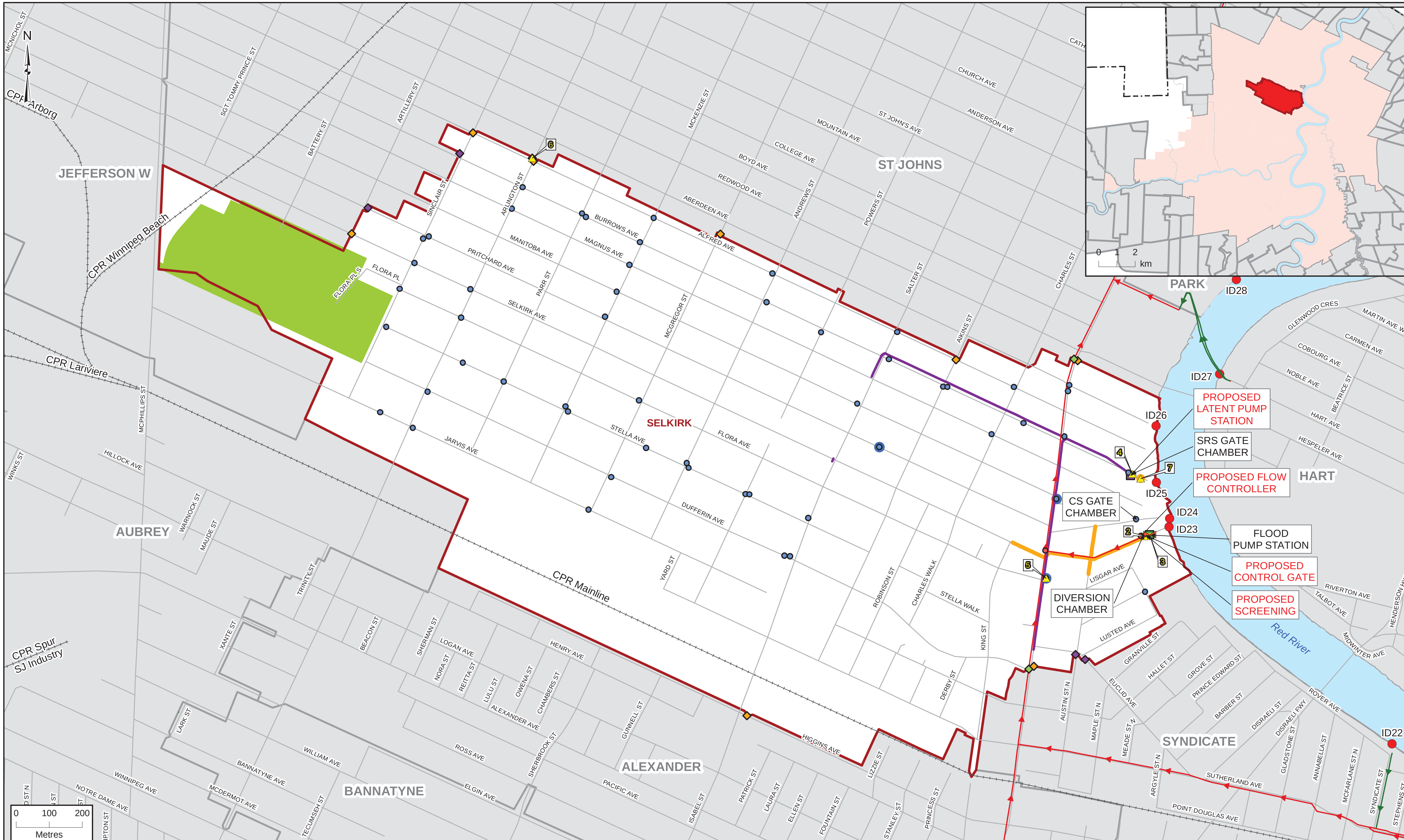
Table 1-13. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	R	-	-	-	-	O	O	-
12	Operations and Maintenance	R	R	-	-	-	R	O	R
13	Volume Capture Performance	O	O	-	-	-	O	O	-
14	Treatment	R	R	-	-	-	O	O	R

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

I.D. Engineering Canada Inc. 1993. *Sewer Relief Study: Selkirk Combined Sewer District*. Prepared for the City of Winnipeg, Waterworks, Waster and Disposal Department. July.



LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Low CS Manhole
- Low SRS Connection

Inter-System Connection
- CS - WWS
- SRS - CS

District Boundary Crossing
- CS
- SRS
- WWS

- Interceptor Sewer
- Force Main
- Street
- Railway

- District Boundary
- Watercourse
- Greenspace

CSO MASTER PLAN PROPOSED SOLUTIONS

- Proposed Control Gate
- Proposed SRS Latent Storage Pump
- Latent Storage Limit
- Extent of In-line Storage
- Latent Force Main

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 37
District Overview Map
Sewer District: Selkirk
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Manhole
- Flap Gate
- Sluice Gate
- Pump Location

Sewer By Type
- CS
- SRS

Control Structure Type
- Gate Chamber

Pump Station Type
- Diversion Chamber
- Flood Pump Station

CSO MASTER PLAN PROPOSED SOLUTIONS
- Control Gate
- Screening
- Flow Controller

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 37-01
Control Gate, Screening, and Flow Control
Sewer District: Selkirk
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- Critical Elevation
- CSO Outfall
- Manhole
- Sluice Gate
- Sewer By Type
  - CS
  - SRS
- Control Structure Type
  - Gate Chamber
- Land Parcel

CSO MASTER PLAN
PROPOSED SOLUTIONS

- Proposed Latent Force Main
- Latent Pump

ALL PROPOSED SOLUTIONS
SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

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WATER AND WASTE DEPARTMENT

FIGURE 37-02
Latent SRS Control
Sewer District: Selkirk
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

St. Johns District Plan

August 2019

City of Winnipeg

CSO Master Plan

Project No:	470010CH
Document Title:	St. Johns District Plan
Revision:	04
Date:	August 22, 2019
Client Name:	City of Winnipeg
Project Manager:	John Berry
Author:	Scott Begg
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0	09/14/2018	DRAFT for City Comment	DT	SB MF SG	
1	03/12/2019	DRAFT 2 for City Review	SB	MF	MF
2	07/2019	Final Draft Submission	DT	MF	MF
3	08/15/2019	Revised Final Draft Submission	MF	MF	MF
4	08/19/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

Tables

Figure

1. St. Johns District

1.1 District Description

The St. Johns district is located in the northwest sector of the combined sewer (CS) area along the western edge of the Red River and north of Selkirk district. The St. Johns district is approximately bounded by Alfred Avenue and Selkirk Avenue to the south, McPhillips Street to the west, Church Avenue and Atlantic Avenue to the north, and the Red River to the east.

The St. Johns district is primarily residential with single-family residential buildings located from McPhillips Street to Power Street and two-family residential buildings located from McGregor Street to Main Street. Commercial areas are located along Main Street and Mountain Avenue. Greenspace is distributed throughout St. Johns and includes Sinclair Park and Machray Park. There is approximately 9 ha of greenspace.

The Canadian Pacific Railway (CPR) Winnipeg Beach extends north-south through the western portion of the district. Regional roads in the district include Main Street, Salter Street, McGregor Street, Arlington Street and McPhilips Street in a north-south direction and Mountain Avenue and Redwood Avenue in the east-west direction.

1.2 Development

A portion of Main Street is located within the St. John's District. Main Street is identified as Regional Mixed Use Corridor as part of the OurWinnipeg future development plans. As such, focused intensification along Main Street is to be promoted in the future.

1.3 Existing Sewer System

St. John's district encompasses an area of 343 ha[1] and includes a CS system and a storm relief sewer (SRS) system. This district does not include any areas that may be identified as LDS separated or separation ready. St. John's contains a combined SRS and CS outfall pipe, where both systems connect upstream of the outfall gate chamber and are discharged through a single outfall. Additionally, the outfall may act as a high-level relief overflow for the Main Street interceptor. The Hart sewage pump station also discharges to the 2250 mm WWS main interceptor within the St. John's district via a 375 mm WWS secondary interceptor that connects to the interceptor just south of Mountain Avenue at Main Street but has no interaction with the St. John's District CS System.

The CS system includes a diversion chamber, flood pump station (FPS), a combined SRS/CS outfall and outfall gate chamber. A flap gate and sluice gate are installed on this outfall pipe in the outfall gate chamber to control backflow into the CS and SRS systems under high river level conditions along the Red River. The CS system drains towards the St. Johns diversion chamber located on the east side of Main Street at the intersection of Main Street and St. John's Avenue. At this diversion chamber combined sewage from the St. John's district is diverted to the Main Street interceptor under DWF conditions. All CS in excess of the district primary weir capacity spills over the primary weir for the district and flows by gravity through the St. John's CS outfall and may overflow to the Red River. The CS trunk extends from the diversion chamber to the CS outfall located at the eastern end of St. Johns Avenue.

A single CS sewer trunk collects flow from most of the district and flows to the diversion chamber on St. John's Avenue. This 1625 mm by 2025 mm CS trunk extends along St. John's Avenue from the outfall gate chamber to McGregor Street. Multiple lateral sewers extend north and south from this main trunk.

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur

The SRS system includes various interconnections to the CS throughout the district. The main 2900 mm SRS trunk sewer for the district runs along Mountain Avenue with SRS laterals extending north and south. During wet weather flow (WWF) events, the SRS system provides relief to the CS system via the interconnections. Most catch basins are still connected to the CS system; no partial separation has been completed. The SRS uses the same outfall as the CS system and may discharge directly to the Red River. The St. John's SRS System is connected with a portion of SRS system in the Selkirk District on Arlington Avenue and Burrows Avenue, and with the majority of the SRS System in the Jefferson West District via an interconnection at Mountain Avenue and McPhillips Street. There is also a 375 mm diversion pipe within the SRS that will send the SRS flow into the Main Street Interceptor. This diversion pipe is located just west of the intersection of Mountain Avenue and Charles Street. Under WWF conditions this diversion pipe will become surcharged, and all excess CS collected in the SRS will continue to the St. John's outfall to discharge to the river.

During dry weather flow (DWF), the SRS is not required; sanitary sewage flows to the diversion chamber upstream of the CS outfall and is diverted by the primary weir for the St. John's district to a1800 mm secondary interceptor pipe, where it flows by gravity west to connect to the Main Interceptor and eventually to the North End Sewage Treatment Plant (NEWPCC) for treatment.

During wet weather flow, any flows that exceeds the diversion capacity overtops the primary weir and may be discharged to the river. When the river levels in the Red River adjacent to the St. John's CS/SRS outfall is high, the flap gate on the outfall gate chamber will prevent gravity discharge to the river. Under these conditions, the excess flow is pumped by the St Johns FPS to a point in the St Johns CS Outfall downstream of the flap gate, where it can be discharged to the river by gravity.

The one CS outfall to the Red River (combined CS and SRS outfall) is as follows:

- ID28 (S-MA70007551) – St. Johns CS/SRS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between St. Johns and the surrounding districts. Each interconnection is shown on Figure 38 and shows locations where gravity and pumped flow can cross from one district to another. Each interconnection is listed as follows:

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

Polson

- The 2250 mm Main Interceptor flows by gravity north on Main Street from St. Johns district into Polson district towards the NEWPCC:
  - Invert at St. Johns district boundary 218.82 m (S-MA70008105)

1.3.1.2 Interceptor Connections – Upstream of Primary Weir

Selkirk

- The 2250 mm Main Interceptor flows by gravity into St. Johns district north on Main Street towards the NEWPCC for treatment:
  - Invert at Selkirk district boundary 219.83 m (S-MA00016856)

1.3.1.2 District Interconnections

Selkirk

<u>CS to CS</u>

- A 300 mm CS flows north by gravity on Arlington Street into St. Johns district from Selkirk district:

  - Invert at Selkirk district boundary 228.65 m (S-MA00014590)
- A 300 mm CS flows by gravity northbound on Aikins Street into St. Johns district:
  - Invert at Selkirk district boundary 227.20 m (S-MA00015124)
- A 300 mm CS flows by gravity north on Main Street and connects to the CS network in St. Johns district at the intersection of Main Street and Redwood Avenue:
  - Invert at Selkirk district boundary 227.60 m (S-MA00015398)

<u>SRS to SRS</u>

- A 2150 mm SRS flows by gravity eastbound on Burrows Avenue from St. Johns district into Selkirk district:
  - Invert at Selkirk district boundary 223.64 m (S-MA00014318)
- A 2150 mm SRS flows by gravity northbound on Arlington Street into St. Johns district:
  - Invert at Selkirk district boundary 223.57 m (S-MA00014588)
- High point manhole:
  - 300 mm CS on Selkirk Avenue – 229.19 m (S-MH00008778)
  - 300 mm CS on McGregor Street – 228.33 m (S-MH00013219)
- High sewer overflow:
  - 450 mm SRS on Artillery Street – 229.34 m (S-MH00012613)
  - 250 mm SRS on Alfred Avenue – 229.84 m (S-MH00012868)

Jefferson West

<u>SRS to SRS</u>

- A 2900 mm SRS trunk flows by gravity from Jefferson West district into St. Johns district on Mountain Avenue and connects to the SRS network in St. Johns district:
  - Invert at Jefferson West district boundary 224.78 m (S-MA00010486)

<u>SRS to CS</u>

- A 2150 mm SRS diverts from the CS system in Jefferson West district and flows eastbound by gravity on Burrows Avenue into St. Johns district:
  - Invert at Jefferson West district boundary 224.50 m (S-MA70015831)
- High sewer overflow:
  - Selkirk Avenue and McPhillips Street – 229.68 m (S-MH00008715)
  - Manitoba Avenue and McPhillips Street – 229.43 m (S-MH00008744)
  - Alfred Avenue and McPhillips Street – 229.49 m (S-MH00008303)
  - Aberdeen Avenue and McPhillips Street – 229.19 m (S-MH00008304)
  - McPhillips Street and Mountain Avenue – 225.46 m (S-MH00008426)
  - McPhillips Street and Mountain Avenue – 225.43 m (S-MH00008425)

Polson

<u>CS to WWS</u>

- The 750 mm Interceptor flows west by gravity on Polson Street from Polson district into St. Johns district into the 2250 mm Main Interceptor on Main Street:

  - Invert at St. Johns district boundary 219.54 m (S-MA00018028)

<u>CS to CS</u>

- The main 1675 mm by 2150 mm CS trunk in Polson district flows by gravity into St. Johns district at the corner of Polson Avenue and Main Street:
  - Invert at Polson district boundary 222.99 m (S-MA00009348)
- A 925 mm by 1200 mm CS flows southbound on Main Street servicing sections of Polson district and crosses into St. Johns district where it connects to the main CS trunk at the corner of Polson Avenue and Main Street:
  - Invert at St. Johns district boundary 223.45 m (S-MA00009340)

<u>CS to SRS</u>

- A 750 mm SRS relieves the CS system on Machray Avenue in Polson district and flows by gravity southbound on Kildarroch Street into St. Johns district where it connects to the main 2900 mm SRS on Mountain Avenue:
  - Invert at St. Johns district boundary 225.20 m (S-MA00012123)
- A 750 mm SRS flows northbound by gravity on Salter Street and connects to the CS system in Polson district at the intersection of Salter Street and Polson Avenue:
  - Invert at Polson district boundary 224.55 m (S-MA00009212)
- A 450 mm SRS provides relief from the manhole at the intersection of Atlantic Avenue and Aikins Street in St. Johns district and flows by gravity to connect to the main CS in Polson district:
  - Invert at Polson district boundary 224.21 m (S-MA00009270)
- A 375 mm SRS flows southeast by gravity at Cathedral Avenue and Emslie Street from Polson district into St. Johns district:
  - Invert at St. Johns district boundary 225.69 m (S-MA00016728)
- A 450 mm SRS flows south by gravity on Emslie Street from Polson district into St. Johns district:
  - Invert at St. Johns district boundary 225.43 m (S-MA00015777)

<u>CS to CS</u>

- A 450 mm SRS flows by gravity from a manhole at the intersection of Main Street and Luxton Avenue where it relieves the CSs and connects to the 925 mm by 1200 mm CS in Polson district:
  - Invert at Polson district boundary 224.05 m (S-MA00009352)
- High point manhole:
  - Tinniswood Street – 229.48 m (S-MH00008542)
  - Radford Street – 229.45 m (S-MH00008556)
  - Monreith Street at Church Avenue – 229.24 m (S-MH00008543)
  - Robertson Street at Church Avenue – 228.90 m (S-MH00010474)
  - Kildarroch Street – 229.08 m (S-MH00010481)
  - Airlies Street at Church Avenue – 228.78 m (S-MH00010493)
  - Minnigaffe Street at Church Avenue – 229.271 m (S-MH00010536)
  - Penninghame Street at Church Avenue – 228.82 m (S-MH00010604)
  - Luxton Avenue – 228.34 m (S-MH00011069)
  - Atlantic Avenue – 227.71 m (S-MH00014025)
  - Bannerman Avenue at Emslie Street – 228.19 m (S-MH00014033)

- Cathedral Avenue at Emslie Street – 227.68 m (S-MH00014021)

- High sewer overflow:
  - Dalton Street at Machray Avenue – 229.35 m (S-MH00010407)
  - Bannerman Avenue – 227.96 m (S-MH00006413)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing system.

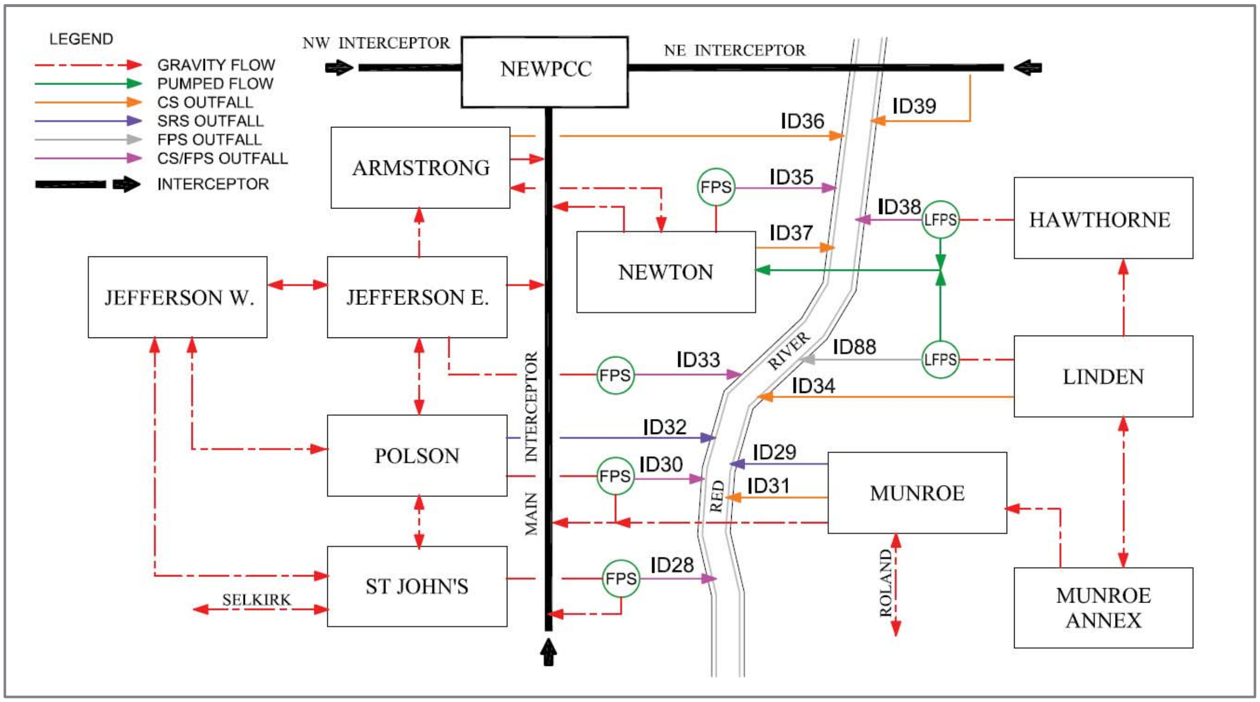


Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 11 and listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer/SRS Outfall (ID28)	S-CO70007985.1	S-MA70007551	3000 mm	Red River Invert: 220.66 m
Flood Pumping Outfall (ID28)	S-CO70007985.1	S-MA70007551	3000 mm	Red River Invert: 220.66 m
Other Overflows	N/A	N/A	N/A	
Main Trunk	S-TE00006659.1	S-MA00015615	1625 x 2025 mm	Egg-shaped Invert: 223.28 m
SRS Interconnections	N/A	N/A	N/A	89 SRS - CS
Main Trunk Flap Gate	S-TE70026922.2	S-CG00000886	3000 mm	Invert: 221.97 m
Main Trunk Sluice Gate	S-CS00000450.1	S-CG00001019	1330 x 1330 mm	Invert: 221.17 m
Off-Take	S-TE00006662.2	S-MA70017206	600 mm	Invert 223.06 m
Dry Well	N/A	N/A	N/A	

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Lift Station Total Capacity	N/A	S-MA70017206 [(1)]	600 mm [(1)]	2.265 m3/s [(1)] (minimum pff 0.058 m^3/s downstream)
ADWF	N/A	N/A	0.045 m^3/s	
Lift Station Force Main	N/A	N/A	N/A	St Johns is a gravity discharge district.
Flood Pump Station Total Capacity	N/A	N/A	3.8 m^3/s	2 x 1.4 m^3/s 2 x 0.52 m^3/s
Pass Forward Flow – First Overflow	N/A	N/A	0.311 m^3/s	

Notes:

[(1)] – Gravity pipe replacing Lift Station as St Johns is a gravity discharge district

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	St. Johns – 223.68
2	Trunk Invert at Off-Take	N/A
3	Top of Weir	223.77
4	Relief Outfall Invert at Flap Gate	N/A
5	Low Relief Interconnection (S-MH00013765)	221.76
6	Sewer District Interconnection (Polson)	222.96
7	Low Basement	229.97
8	Flood Protection Level (St. Johns)	229.14

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed in St. Johns was the Flood Relief Study (IDE, 1980). A storm relief sewer (SRS) system was installed in the district as a result of this study. No other work has been completed on the district sewer system since that time.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the St. John's Combined Sewer District was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations has a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Planned Completion
38 – St. Johns	1980	Future Work	2013	Study Complete	N/A

Source: Report on Flood Relief Study, 1980

1.5 Ongoing Investment Work

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the St. John's district. This consists of monthly site visits in confined entry spaces to ensure physical readings concur with displayed transmitted readings, and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The St. Johns district has latent storage, in-line storage via control gate, gravity flow control, and floatable control via screening proposed to meet CSO Control Option 1. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4 provides an overview of the control options included in the 85 percent capture in a representative year option.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage	Storage / Transport Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	✓	-	✓	✓	✓	-	-	-	✓	✓	✓

Notes:
- = not included
✓ = included

The existing CS and SRS systems are suitable for use as in-line and latent storage. These control options will take advantage of the existing CS pipe network for additional storage volume. Existing DWF from the collection system will remain the same, and overall district operations will remain the same.

A gravity flow controller is proposed on the CS system to optimize the dewatering rate from the district back into the Main Street interceptor. St. Johns district discharges to the interceptor by gravity; therefore, it will also require a method of flow control to optimize and control the discharge rate to the interceptor for future dewatering RTC controls. Refer to Section 3.3.5 of Part 2 for discussion on the interaction of the gravity control on the system for all gravity discharge locations.

Floatable control will be necessary to capture any undesirable floatables in the sewage. Floatables will be captured with all implemented control options to some extent, but screening may be added as required to reach the desired level of capture. Screens will be installed downstream of the diversion chamber located near Main Street and St. Johns Avenue.

GI and RTC will be applied within each district on a system wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.1 Latent Storage

Latent storage is proposed as an alternative control option for the St. Johns district. Latent storage will use the existing St. Johns SRS system. It is proposed to isolate the SRS from the CS outfall system, the St Johns district has a shared CS outfall (S-MA70007551) via the installation of a new flap gate. The proposed location of the new flap gate chamber is shown on Figure 38-02. The latent storage level in the system is controlled by river level and the resulting backpressure of the river level on the St. Johns SRS outfall flap gate, as explained in Part 3C. The latent storage design criteria are identified in Table 1-5. As noted in Section 1.3, the district has a gravity connection directly to the Main Interceptor sewer. This proposal allows the City to control and monitor the latent storage discharge needed as part of the future RTC controls. This will also isolate the SRS system from reverse flow and acting as overflow from Main Street Interceptor under spatial rainfall conditions.

Table 1-5. Latent Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	221.97 m	New Flap Gate invert
NSWL	223.68 m	
Trunk Diameter	2900 mm	
Design Depth in Trunk	1710 mm	
Maximum Storage Volume	8204 m^3	
Force main	300 mm	
Flap Gate Control	N/A	
Lift Station	Yes	
Nominal Dewatering Rate	0.085 m^3/s	Based on 24-hour emptying requirement
RTC Operational Rate	TBD	Future RTC/ dewatering assessment.

Note:

NSWL - normal summer water level
RTC – Real Time Control

Latent storage is accessible and has a lower risk than other storage types. In order to facilitate an operational latent system, a latent pump station and interconnecting pipes will be required to access the storage. A conceptual layout for the pump station and force main is shown on Figure 38-02. The pump station will be located adjacent to the SRS outfall gate chamber at the edge of St. Johns Avenue. The latent force main will pump to the manhole along the Main Interceptor on Main Street (S-TE00006649). The pump station will operate to dewater the SRS system in preparation for the next runoff event, the requirement for the system to be ready for the next event within a 24-hour period after completion of the previous event. The existing SRS system has a gravity discharge connection directly to the Main Interceptor via a 375mm diameter pipe and this has been replaced in this latent storage proposal. However, the inclusion of the latent pump station will allow the City to control the discharge flows for the future RTC considerations.

Figure 38 identifies the extent of the SRS system within Selkirk district that would be used for latent storage. The maximum storage level is directly related to the NSWL, and the size and depth of the SRS system. Once the level in the SRS exceeds the river level, the flap gate opens, and the combined sewage in the SRS system is discharged to the river.

The river level backpressure will keep the SRS flap gate closed and system level maintained at or below the NSWL. This level utilizes 59 percent of the SRS pipe height and it was found that additional flap gate control is not recommended as required to meet the Control Option 1 requirements. In situations where non modelled assessments are to be completed, the actual river levels will be both lower and higher than the NSWL level at various points throughout an annual year. Where the level is below NSWL, the latent volume will be less than predicted during the MP assessment, while conversely when the level is above the NSWL, the latent volume will be more than predicted. The continuous assessment is seen as a conservative approach since the majority of the representative year rainfall events occur when the river levels are higher than the NSWL.

The lowest interconnection between the combined sewer and relief pipe systems is higher than the proposed latent and in-line storage control levels, meaning that the two systems would function independently.

As described in the standard details in Part 3C wet well sizing for the latent pump station will be determined based on the final pump selection, operation and dewatering capacity required. The interconnecting piping between the new gate chamber and the pump station would be sized to provide sufficient flow to the pumps while all pumps are operating.

1.6.2 In-Line Storage

In-line storage is proposed as a CSO control for the St. Johns district. In-line storage will require the installation of a control gate at the CS outfall. The gate will increase the storage level in the existing CS and provide an overall higher volume capture and provide additional hydraulic head for screening operations.

A standard design was assumed for the control gate, as described in Part 3C. The standard approach used for conceptual gate sizing was to assume it to be the lesser of the height of half of the site-specific trunk diameter or the maximum height of the gate available. The design criteria for the in-line storage are listed in Table 1-6.

Table 1-6. In-Line Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	223.28 m	Downstream invert of lowest pipe at diversion chamber
Trunk Diameter	1625 x 2025 mm	
Gate Height	0.62 m	Gate height based on half trunk diameter assumption
Top of Gate Elevation	224.39 m	
Maximum Storage Volume	188 m^3	
Nominal Dewatering Rate	0.058 m^3/s	Based on minimum pass forward rate for gravity discharge district (pipe full capacity)
RTC Operational Rate	TBD	Future RTC/ dewatering assessment

Notes:

NSWL = normal summer water level
RTC = real time control

The proposed control gate will cause combined sewage to back-up within the collection system to the extent shown on Figure 38. The extent of the in-line storage and volume is related to the top elevation of the bypass side weir. The level of the top of the bypass side weir and adjacent control gate level are determined in relation to the critical performance levels in the system for basement flooding protection: when the system level increases above the bypass weir crest and proceeds above the top of the control gate during high flow events, the gate drops out of the way. At this point, the district will only provide its original interception capacity via the primary weir for the district, and all excess CS would flow over the weir and discharge to the river. After the sewer levels in the system drops back below the bypass side weir critical performance level, the control gate moves back to its original position to capture the receding limb of the WWF event. The existing DWF diversion will continue with its current operation, with all DWF being diverted to the Main Interceptor.

Figure 38-01 provides an overview of the conceptual location and configuration of the control gate and screening chambers. The proposed control gate will be installed in a new chamber within the trunk sewer alignment and located west of the Selkirk FPS. The dimensions of a new chamber to provide an allowance for a side weir for floatables control are 5.1 m in length and 3.0 m in width to accommodate the gate, with an allowance for a longitudinal overflow weir. The existing sewer configuration may have to be modified to allow the installation of the in-line gate and screening chambers. The physical requirements for the off-take and station sizing for a modification to pumping capacity have not been considered in detail, but they will be required in the future as part of an RTC program or FPS rehabilitation or replacement project. It is envisaged that a road closure would be necessary to allow construction activities to occur with minor disruptions to local residents. Road access could be achieved via adjacent local roads and the location within the local street is adjacent to the St John's Park reducing resident disruptions.

The lowest interconnection between the combined sewer and relief pipe systems is higher than the proposed latent and in-line storage control levels, meaning that the two systems would function independently.

The nominal rate for dewatering is determined by the performance of the existing pipe capacity as the district is a gravity discharge district. As such the flows will vary over the duration of a rainfall event and has been nominated for a gravity flow control device. Any future consideration, for RTC improvements, would be completed with spatial rainfall as any reduction to the existing pipe capacity/operation for large events will adversely affect the overflow at this district. The control device would be set to a rate similar to the existing pipe full capacity to allow the set limit to be known. This would allow the future RTC control the ability to capture and treat more volume for localized storms in other districts by using the excess interceptor capacity made available by restricting the pass forward flows through the control device where the runoff is less.

1.6.3 Gravity Flow Control

St. Johns district does not include a lift station (LS) and discharges directly to the Main interceptor by gravity. A flow control device will be required to control the diversion rate and the level of in-line storage for future RTC and dewatering assessments.

A standard flow control device was selected as described in Part 3C. This controller is considered suitable for the immediate dewatering rate control and future RTC applications. The device will include flow measurement and a gate to control the flow rate. This has been taken as part of the City's future vision to develop a fully integrated CS system network and will be needed to review flows during spatial rainfall WWF scenarios. The CSO Master Plan assessment utilized a uniform rainfall event and no further investigative work has been completed within the CSO Master Plan.

The flow control will be installed at an optimal location on the connecting sewer downstream of the diversion chamber within the offtake pipe or secondary interceptor, but upstream of the Main interceptor. Figure 38-01 identifies a conceptual location for the installation of the flow controller. A small chamber or manhole with access for cleaning and maintenance will be required. The flow controller will operate independently and require minimal operation interaction. The diversion weir height at the St. Johns CS outfall may have to be adjusted to match the hydraulic performance of the flow controller. The structure would be located on the boulevard of Main Street and minor road closures would be required to provide sufficient working space during construction. This would cause disruptions to the street traffic along Main Street, but this would only be for a minimum amount of time during construction.

1.6.4 Floatables Management

Floatables management will require installation of a screening system to capture floatable materials. The off-line screens would be designed to maintain the current level of basement flooding protection. The overflow which discharges over the existing weir will be directed to the screens located in a new screening chamber, with screened flow discharged to the downstream side of the screening chamber to the river.

The type and size of screens depend on the LS and the hydraulic head available for operation. A generic design was assumed for screening and is described in Part 3C. The design criteria for screening with gate control implemented, are listed in Table 1-7.

Table 1-7. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Top of Gate	224.39 m	
Bypass Weir Crest	224.29 m	
NSWL	223.68 m	
Maximum Screen Head	0.607 m	
Peak Screening Rate	1.2 m^3/s	
Screen Size	1.5 m x 1.0 m	Modelled Screen Size

The proposed side overflow weir and screening chamber would be located adjacent to the existing combined trunk sewer, as shown on Figure 38-01. The screens will operate once levels within the sewer surpassed the in-line control elevation. A side weir upstream of the gate will direct the overflow to the screens located in the new screening chamber, with screened flow discharged to the downstream side of the gate to the river. The screening chamber would include screenings pumps with a discharge returning the screened material back to the interceptor and on to the NEWPCC for removal. As this will be constructed with the control gate chamber, construction activity disruptions will be the same.

The dimensions for the screen chamber to accommodate influent from the side weir, the screen area, and the routing of discharge downstream of the gate are 4.3 m in length and 3.1 m in width.

1.6.5 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district will be reviewed to identify applicable GI controls.

St. Johns has been classified as a medium GI potential district. Land use in St. Johns is mix of residential and commercial. The east end of the district is bounded by the Red River. This district would be an ideal location for cisterns/rain barrels, and rain garden bioretention within the residential areas. Commercial areas are suitable to green roofs and parking lot areas are ideal for paved porous pavement.

1.6.6 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

The latent storage would take advantage of the SRS infrastructure already in place, therefore, minimal additional maintenance will need to be anticipated. The proposed latent LSPS will require regular maintenance that would depend on the frequency of operation. The flap gate proposed will require maintenance inspection for continued assurance that the flap gate would open during WWF events.

In-line storage will impact the existing sewer and will require the addition of a new chamber and a moving gate at the outfall. In-line storage dewatering will be controlled with the existing Clifton CS LS, which will require more frequent and longer duration pump run times. Lower velocities will occur in the CS trunk in the vicinity of the control gate due to lower pass forward flows, and may create additional debris deposition requiring cleaning. Additional system monitoring, and level controls will be installed, which will require regular scheduled maintenance.

The flow controller will require the installation of a chamber and flow control equipment. Monitoring and control instrumentation will be required. The flow controller will operate independently and require minimal operation interaction. Regular maintenance of the flow controller chamber and appurtenances will be required.

Floatable control with outfall screening will require the addition of another chamber with screening equipment installed. The chamber will be installed adjacent to the control gate chamber and will operate in conjunction with it. Screening operation will occur during WWF events that surpass the in-line storage control level. WWF will be directed from the main CS trunk, over the side weir in the control gate chamber and through the screens to discharge into the river. The screens will operate intermittently during wet weather events and will likely require operations review and maintenance after each event. The frequency of a screened event will correlate to the number overflows identified for the district. Having the screenings pumped back to the interceptor system via a small LS and force main will be required. The screenings return will require O&M inspection after each event to assess the performance of the return pump system.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. Two versions of the sewer system model were created and used to measure system performance. The 2013 Baseline model represents the sewer system baseline in the year 2013 and the 2037 Master Plan – Control Option 1 model, which includes the proposed control options in the year 2037. A summary of relevant model data is summarized in Table 1-8.

Table 1-8. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	% Impervious
2013 Baseline	325	325	15,929	70	N/A
2037 Master Plan – Control Option 1	325	325	15,929	70	Lat St, SC, IS

Notes:

SC = Screening

IS = In-line Storage
Lat St = Latent Storage

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-9 are for the hydraulic model simulations using the year-round 1992 representative year. The table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan – Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. Table 1-9 also includes overflow volumes specific to each individual control option: these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-9. Performance Summary – Control Option 1

	Preliminary Proposal	Master Plan			
Control Option	Annual Overflow Volume (m^3) [a]	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [c]
Baseline (2013)	332,572	181,444	-	12	0.314 m^3/s
Latent Storage	335,263 [b]	- [d]	-	-	0.314 m^3/s
In-line & Latent Storage		- [d]	-	17	0.157 m^3/s
Tunnel, In-line & Latent Storage	72,428	N/A	N/A	N/A	N/A
Control Option 1	**72,428**	**- [d]**	**- [d]**	**- [d]**	**- [d]**

[a] Direct gravity connection from SRS system to Main Street Interceptor not included in Preliminary Proposal modelling assessment

[b] Latent and In-Line Storage were not simulated independently during the Preliminary Proposal assessment

[c] Pass forward flows assessed on the 1-year design rainfall event

[d] Model instability issues encountered with the St John's district as part of the Master Plan performance evaluation for overall City of Winnipeg sewer network. The individual district performance values were instead utilized for the control option performance evaluation, and are shown in the table below. Improvements to be investigated, CO1MP proposals allows system wide 85 percent capture target to be achieved.

Table 1-10. Performance Summary – Control Option 1 (Individual Model)

Control Option	Master Plan Overflow Reduction (m³)	Overflow Reduction (m³)	Number of Overflows	Pass Forward Flow at First Overflow [a]
Revised Baseline (2013)	149,432	-	17	0.314 m³/s
Latent Storage	146,112	3,320		0.314 m³/s
Latent & In-line Storage	125,828	20,284	17	0.157 m³/s
Control Option 1	**125,828**	**23,604**	**17**	**0.157 m³/s**

[a] Pass forward flows assessed on the 1-year design rainfall event

The revisions to the baseline model performance is attributed to the updates to the InfoWorks model through the model maintenance process including the addition of a gravity discharge from the St Johns SRS system directly to the Main Interceptor. The performance of the district is seemingly negative due to the interaction of this gravity discharge district with the adjacent districts. No single change to the adjacent system for the 85 percent capture has been selected as the main contributor. The reduction in pass forward flows is attributed to the increase in CS in-line storage and the overflow profile being the same but the interaction with the Main Interceptor sewer being at a higher level for an extended period while other districts are contributing to the flows in the interceptor.

The percent capture performance measure is not included in Table 1-9, as it is applicable to the entire CS system and not for each district individually.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-11. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 to plus 100 percent.

Table 1-11. Cost Estimate – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period)
Latent Storage	N/A [a]	$3,140,000 [c]	$88,000	$1,890,000
Gravity Flow Control	N/A	$1,350,000	$34,000	$740,000
In-Line Storage	$7,740,000 [b]	$2,570,000 [d]	$44,000	$940,000
Screening		$3,220,000 [e]	$48,000	$1,040,000
Offline Tunnel Storage	$6,960,000	N/A	N/A	N/A
Offline Tank Storage	$21,550,000	N/A	N/A	N/A
Subtotal	**$36,240,000**	**$10,280,000**	**$215,000**	**$4,610,000**
Opportunities	N/A	$1,030,000	$21,000	$460,000
District Total	**$36,240,000**	**$11,310,000**	**$236,000**	**$5,070,000**

[a] Latent Storage not included in the Preliminary Proposal

[b] In-line Storage and Screening not costed separately in the Preliminary Proposal

Table 1-11. Cost Estimate – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period)

[c] Flap gate at new latent storage chamber not included in Master Plan costs.

[d] Cost associated with new off-take construction, as required, to accommodate control gate and screening chambers in location and allow intercepted CS flow to reach existing St John's gravity discharge was not included in Master Plan

[e] Cost for bespoke screenings return/force main not included in Master Plan as will depend on selection of screen and type of screening return system selected

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI opportunities, with no additional cost for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014 dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019 dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-12.

Table 1-12. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Latent Storage	Not included in the preliminary estimate.	Added for the Master Plan to ensure the flows can be controlled for future RTC measures.
	Gravity Flow Controller	A flow controller was not included in the preliminary estimate	Added for the Master Plan to further reduce overflows.
	In-Line Storage	Updates to pricing and scope of work as part of Master Plan assessment.	
	Removal of Offline Tunnel Storage	Found to not be required to meeting Control Option 1 target during Master Plan assessment.	

Table 1-12. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
	Removal of Offline Tank Storage	Found to not be required to meeting Control Option 1 target during Master Plan assessment.	
Opportunities	A fixed allowance of 10 percent has been included for program opportunities.	Preliminary Proposal estimate did not include a cost for GI opportunities.	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years.	City of Winnipeg Asset Management approach.	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation.	Preliminary Proposal estimates were based on 2014-dollar values.	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, the future performance target is 98 percent capture for the representative year measured on a system-wide basis. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-13 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified in Control Option 1.

Overall the St Johns district would be classified as a low potential for implementation of complete sewer separation as the only feasible approach to achieve the 98 percent capture future performance target in the representative year. However, opportunistic sewer separation within a portion of the district may be completed in conjunction with other major infrastructure work to address future performance targets. In addition, green infrastructure and off-line tank or tunnel storage may be utilized in key locations to provide additional storage and increased capture volume. The existing SRS system could potentially be further utilized via the inclusion of flap gate control and flows to the Main Interceptor controlled further through the isolation of the gravity connection from the SRS to CS system on Mountain Avenue, although the removal of this connection will require additional infrastructure to ensure overflow volumes are improved.

Table 1-13. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Opportunistic Sewer Separation • Increased use of GI • Further revisions to latent storage (flap gate control) • Off-Line Storage (Tank/Tunnel)

The control options for the St Johns district has been aligned for the 85 percent capture performance target based on the system wide evaluation basis. The interaction with the main interceptor and adjacent districts makes the expandability of this district to meet the 98 percent capture target potentially difficult without the increased isolation of the district or removal/storing of wet weather flows in the system.

The cost for upgrading to meet an enhanced performance target depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed as part of the CSO Master Plan and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-14.

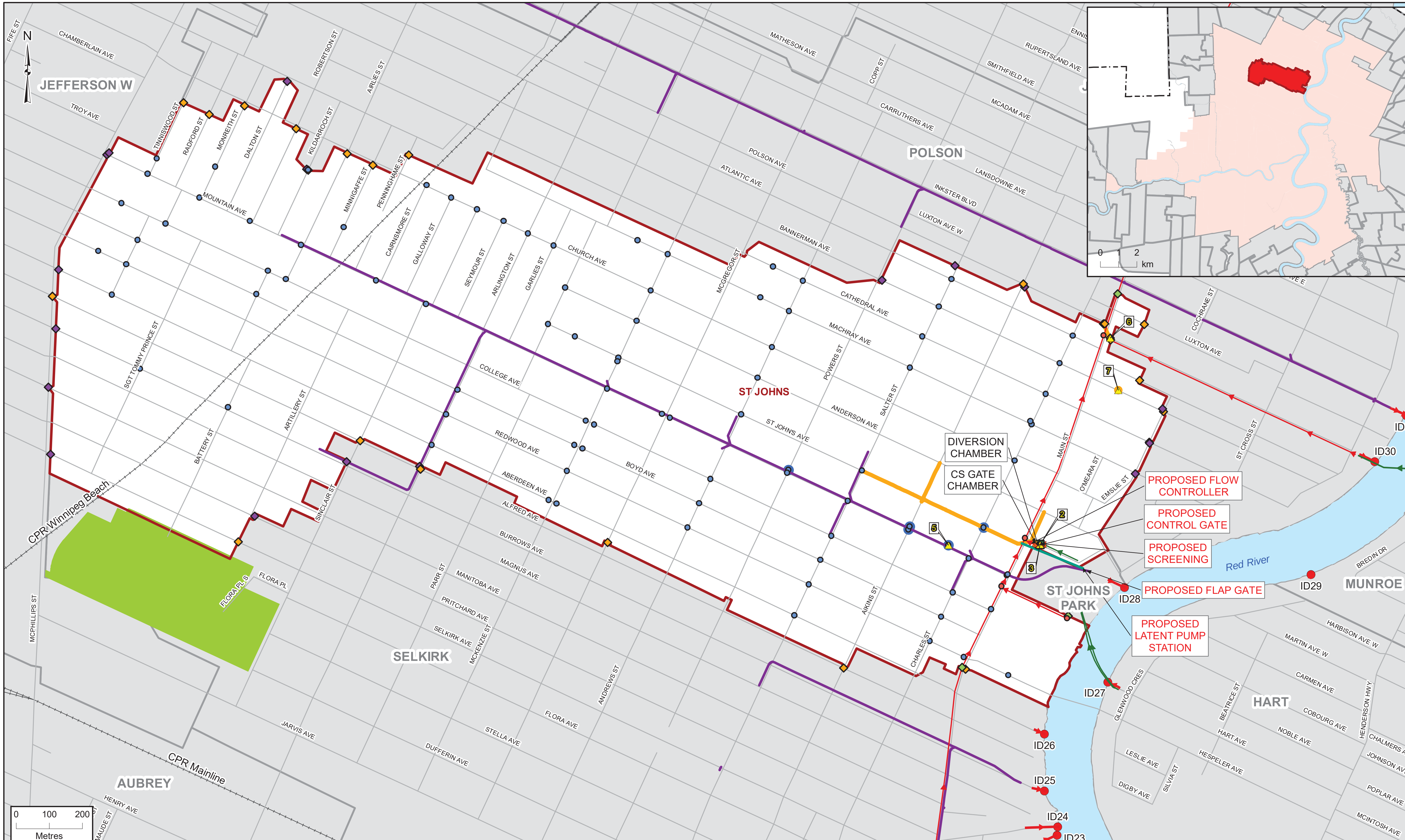
Table 1-14. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	R	R	-	-	-	-	-	-
2	Existing Lift Station	-	R	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	-	-	-	-
4	Construction Disruption	-	-	-	-	-	-	-	-
5	Implementation Schedule	-	-	-	-	-	-	R	-
6	Sewer Condition	R	R	-	-	-	-	-	-
7	Sewer Conflicts	R	R	-	-	-	-	-	-
8	Program Cost	O	O	-	-	-	-	-	O
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	R	-	-	-	-	O	O	-
12	Operations and Maintenance	R	R	-	-	-	R	O	R
13	Volume Capture Performance	O	O	-	-	-	O	O	-
14	Treatment	R	R	-	-	-	O	O	R

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

I.D. Engineering (IDE). 1980. *Flood relief study - St. John's and Polson districts and the Sisler ward*. Prepared for the City of Winnipeg.



LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Low CS Manhole
- Low SRS Connection

Inter-System Connection
- CS - WWS
- SRS - CS

District Boundary Crossing
- CS
- SRS
- WWS

- Interceptor Sewer
- Force Main
- Street
- Railway

- District Boundary
- Watercourse
- Greenspace

CSO MASTER PLAN PROPOSED SOLUTIONS

- Proposed Control Gate
- Latent Force Main
- Latent Storage Limit
- Extent of In-line Storage

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 38
District Overview Map
Sewer District: St. Johns
City of Winnipeg
Combined Sewer Overflow Master Plan

Y:\WINNIPEGCITYOF\470010MASTERPLANCSO\500DESIGNWORKFILES\503STUDIES\MASTER PLAN CONCEPTUAL DEVELOPMENT\MAPPING\MAPS\PACKAGE6\STJOHNS\STJOHNS_DISTRICT_OVERVIEW_MAP.MXD DT072410 8/15/2019 10:56:33 AM

LEGEND

Primary Weir
Critical Elevation
Manhole
Force Main
Sewer By Type
CS
WWS
Control Structure Type
Gate Chamber
Pump Station Type
Diversion Chamber

CSO MASTER PLAN
PROPOSED SOLUTIONS
Proposed Latent Force Main
Control Gate
Screening
Flow Controller

ALL PROPOSED SOLUTIONS
SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 38-01
Control Gate, Screening and Flow Control
Sewer District: St. Johns
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- Primary Weir
- Critical Elevation
- Manhole
- Force Main

Sewer By Type
- CS
- SRS
- WWS

Control Structure Type
- Gate Chamber

Pump Station Type
- Diversion Chamber

CSO MASTER PLAN
PROPOSED SOLUTIONS
- Proposed Latent Force Main
- Flap Gate
- Control Gate
- Screening
- Flow Controller
- Latent Pump

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 38-02
Latent SRS Control
Sewer District: St. Johns
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Strathmillan District Plan

August 2019

City of Winnipeg

CSO Master Plan

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1. Strathmillan District

1.1 District Description

Strathmillan district is located on the western edge of the combined sewer (CS) area. The district is bounded by Moorgate district to the east, Ainslie district to the north and west, and the Assiniboine River to the south. Ness Avenue is the northern border, Davidson Street and Conway Street are the eastern border, and Olive Street is the western border. This district has been developed primarily as a residential area, with a small commercial corridor located along Portage Avenue. Figure 39 provides an overview of the sewer district and the location of the proposed Combined Sewer Overflow (CSO) Master Plan control options.

Portage Avenue is the major transportation route that passes through the southern end of Strathmillan district and intersects with Mt. Royal Road, a high traffic route that connects Ness Avenue to Portage Avenue.

Land use in Strathmillan is mostly single-family residential. Approximately 6 ha of this district is classified as greenspace which includes the Strathmillan Lodge Park.

1.2 Development Potential

A portion of Portage Avenue is located within the Strathmillan District. Portage Avenue is identified as Regional Mixed-Use Corridor as part of the OurWinnipeg future development plans. As such, focused intensification along Portage Avenue is to be promoted in the future.

1.3 Existing Sewer System

Strathmillan has an approximate area of 81 ha[1] based on the district boundary. The system consists of a CS system and a land drainage (LDS) system. There is approximately 63 percent (51 ha) separated and no separation ready areas.

The CS system includes a diversion chamber, CS lift station (LS), and two CS outfalls. All domestic wastewater and CS flows collected in Strathmillan districts is routed to Portage Avenue, where the diversion chamber and main CS outfall are located

Two separate LDS systems provide CS separation and stormwater collection for a large portion of the district. The main 1350 mm LDS trunk runs south along Strathmillan Road through the whole of the district, commencing at Ness Avenue and discharges to the Assiniboine River at the district CS outfall. The CS outfall from the diversion chamber was connected to the LDS system during the construction of the LDS system. A second LDS system collects stormwater from the adjacent Ainslie district (between Silver Avenue and Ness Avenue) and discharges through the Strathmillan district in a 2100 mm and 2250 mm LDS trunk located in the back lane between Olive Street and Whytewold Road. The second LDS system discharges to the Assiniboine River via a dedicated LDS outfall, situated east of the Olive LS CS outfall.

A wastewater interceptor passes through the district along Portage Avenue flowing from east to west from the Moorgate district. The diversion chamber is located on Portage Avenue south of intersection with Strathmillan Road. The CS system for the district converges at this diversion chamber where flow is diverted to the interceptor. The interceptor continues west and drains to the Olive LS situated on the district border between Ainslie and Strathmillan.

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[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

During dry weather flow (DWF) wastewater flows are directed by the diversion chamber weir to the Olive CS LS. DWF wastewater flows from the Ainslie district also discharge into the Olive LS. These flows are then pumped into the 900 mm St. James interceptor sewer on Assiniboine Avenue and transported ultimately to the West End Sewage Treatment Plant (WEWPCC) for treatment.

During wet weather flow (WWF), the diversion chamber weir may be overtopped, and the combined sewage is directed through the 900 mm combined sewer to the 1350 mm Strathmillan CS outfall. The CS outfall pipe connects with the 1350mm LDS trunk sewer pipe. The Strathmillan CS outfall pipe only has a positive gate protection, and must be manually activated under high river level conditions to protect the CS system. Under the conditions where the positive gate is closed however, gravity discharge from the CS outfall is not possible, due to sewage backing up against the positive gate. There is no flood station at this location; however, in the case where high river levels are predicted and the positive gate activation will prevent the outfall operation during a WWF event, temporary flood pumping can be put in place.

There is an infrequent manual interaction between the Strathmillan district and the 17 Wing Canadian Air Force Base immediately north of the district. A 400 mm force main flows south from 17 Wing in the Ainslie district, passing directly through Strathmillan and connecting to the Strathmillan outfall pipe immediately downstream of the Strathmillan diversion chamber and positive gate structure. The force main is part of the wastewater system surrounding the 17 Wing. 17 Wing has its own on-site wastewater treatment, and the treated sewage is transported via this force main. During normal operating conditions, the treated wastewater is prevented from entering the Strathmillan CS by a valve which is normally kept closed, resulting in the treated wastewater being discharged to the Assiniboine River. The City is instructed to open the valve when treatment capabilities within 17 Wing are offline, at which point the untreated wastewater is allowed to enter the Strathmillan CS upstream of the diversion chamber, so that it may be intercepted with the Strathmillan DWF to the downstream Olive CS LS for treatment by the City of Winnipeg.

The CS outfalls to the Assiniboine River is as follows:

- ID42 (S-MA70053789) – Strathmillan CS Outfall
- ID41 (S-MA20005373) – Ainslie CS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Strathmillan and the surrounding districts. Each interconnection is shown on Figure 39 and shows gravity and pumped flow from one district to another. Each interconnection is listed as follows:

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

Ainslie

- A 400 mm force main from the 17 Wing base pumps sewage from a pump station in Ainslie on Silver Avenue through Strathmillan district to its outfall without connecting to other CS systems:
  - Ness Ave and Strathmillan Street invert at Ainslie district boundary - 231.93 m
- The Olive SPS pumps sewage through a 450 mm force main into the St James interceptor and into the Ainslie district:
  - Assiniboine Crescent at connection to Olive Lift station - 230.43m

1.3.1.2 Interceptor Connections – Upstream of Primary Weir

Moorgate

- A 375 mm force main pumps sewage from the Conway CS LS and along Portage Avenue into the interceptor sewer system within the Strathmillan district from Moorgate district:

- – Portage Avenue and Conway Street invert at Strathmillan district boundary - 232.98 m

1.3.1.3 District Interconnections

Ainslie

CS to CS

- – A 600 mm CS sewer flows by gravity from the Ainslie CS system into the Olive CS LS: Assiniboine Crescent at Olive LS invert at Strathmillan district boundary - 226.89 m

LDS to LDS

- The LDS crosses from Strathmillan into Ainslie by gravity flow to the LDS outfall at the Assiniboine River:
  - – Assiniboine Crescent east of Olive CS LS, invert at Strathmillan district boundary - 228.86 m
- The 600 mm LDS from Ainslie flows by gravity into Strathmillan east of Olive Street and connects to the 2250 mm LDS that discharges into the Assiniboine River:
  - – Olive Street and Portage Avenue invert at Strathmillan district boundary - 228.92 m
- The LDS uses gravity flow and connects to the large LDS in Strathmillan from Ainslie, on the west end of Lodge Avenue:
  - – Lodge Avenue at Olive Street back lane invert at Strathmillan district boundary - 230.16 m
- The large 2100 mm LDS on Ness Avenue uses gravity flow to connect into Strathmillan district from Ainslie:
  - – Ness Ave at Olive Street back lane invert at Ainslie district boundary - 230.52 m

Moorgate

LDS to LDS

- The LDS uses gravity flow to connect into the LDS system in Strathmillan on the eastern end of Lodge Avenue before Strathmillan Street:
  - – Lodge Avenue and Davidson Street invert at Strathmillan district boundary - 231.53 m
- The LDS uses gravity flow to connect into the LDS system in Strathmillan on the eastern end of Bruce Avenue before Strathmillan Street:
  - – Bruce Avenue invert at Strathmillan district boundary - 232.55 m
- A 450 mm LDS flows by gravity into Moorgate District on Mount Royal Road:
  - – Mount Royal Road and Trail Avenue invert at Strathmillan district boundary - 233.16 m

A district interconnection schematic for the district is included as Figure 1-1**Error! Reference source not found.**. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing system.

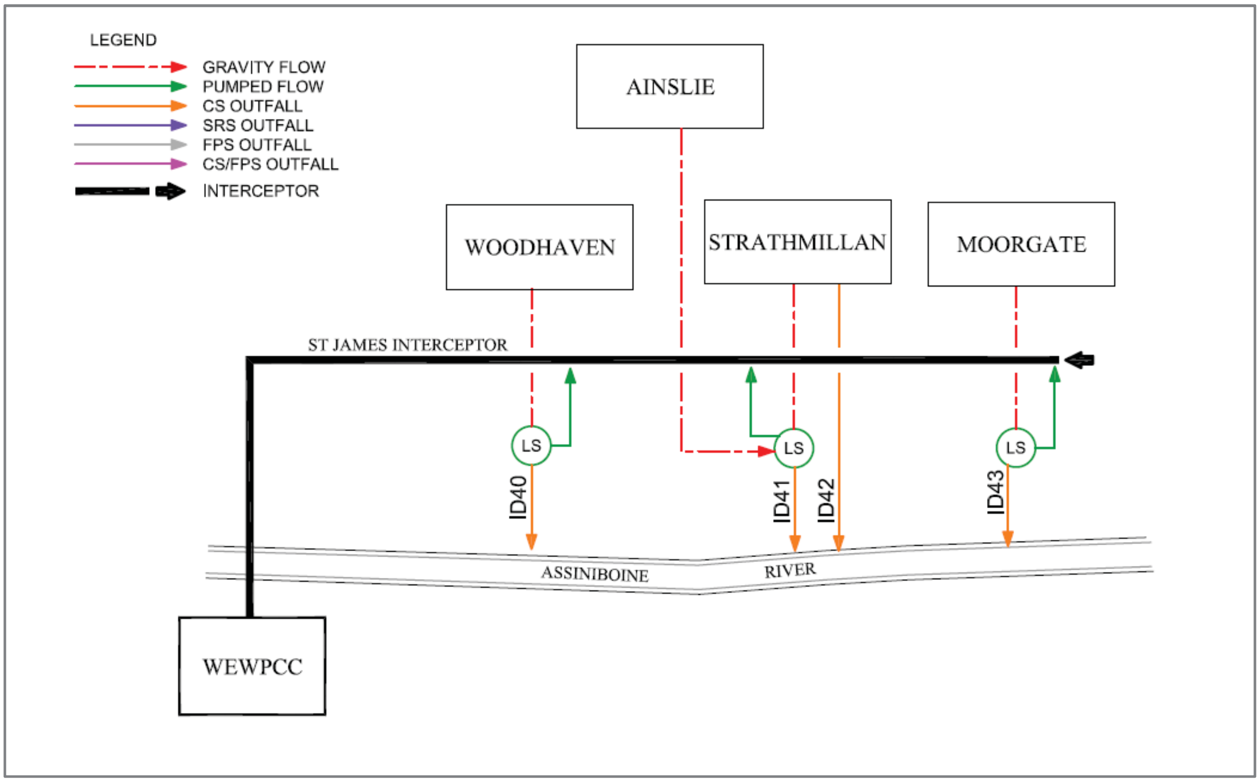

Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 39 and are listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID42)	S-TE70022123.1	S-MA70053789	1350 mm	Invert: 226.32 m Circular
Flood Pumping Outfall	N/A	N/A	N/A	No flood pumping station in this district
Other Overflows (ID41)	S-MA20005373.1	S-MA20005373	750 mm	Invert 228.0 m (model assumption) Circular
Main Sewer Trunk	S-TE70022127.1	S-MA70011333	900 mm	Invert: 228.29 m Circular
Storm Relief Sewer Outfalls	N/A	N/A	N/A	No SRS within district.
Storm Relief Sewer Interconnections	N/A	N/A	N/A	No SRS within district.
Main Trunk Flap Gate	S-CG00000923.1	S-CG00000923	750 mm	Invert: 228.30 m Circular
Main Trunk Sluice Gate	S-CG00001143.1	S-CG00001143	762 mm	Invert: 228.67 m Circular
Off-Take	S-TE70022127.2	S-MA70053808	300 mm	Invert: 228.47 m Circular
Wet Well	Olive Lift US.1	S-MA70016561	7.5 m x 2.14 m	

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Lift Station Total Capacity (Olive CS LS)	N/A	N/A	0.308 m^3/s	2 pumps @ 0.154 m^3/s
Lift Station ADWF (Olive CS LS)	N/A	N/A	0.075 m^3/s	
Lift Station Force Main (Olive CS LS)	Olive Lift DS.1	S-MA20005360	450 mm	Discharge Invert 229.44 m
Flood Pump Station Total Capacity	N/A	N/A	N/A	No flood pumping station in this district
Pass Forward Flow – First Overflow	N/A	N/A	0.093 m^3/s	

Notes:

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	226.06
2	Trunk Invert at Off-Take	228.47
3	Top of Weir	228.86
4	Relief Outfall Invert at Flap Gate	N/A
5	Low Relief Interconnection	N/A
6	Sewer District Low Interconnection	N/A
7	Low Basement	230.43
8	Flood Protection Level	230.98

[a] City of Winnipeg Data, 2013

Due to the absence of an SRS system in the Strathmillan district, the relief outfall invert and relief interconnection are not available.

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study was the *Sewer Relief and CSO Abatement Study* (UMA, 2005). It describes the CSO abatement alternatives and sewer relief implications for both Strathmillan and Moorgate CS districts.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Strathmillan CS district, along with the CS outfall within the Ainslie separate sewer district was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations have a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Planned Completion
38 - Strathmillan	2005- Conceptual	Planned in Next 5 Years	2013	Complete	N/A

Source: Sewer Relief and CSO Abatement Study, 2005

1.5 Ongoing Investment Work

There is no ongoing investment work within Strathmillan district that would impact the CSO Master Plan.

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Strathmillan district, and the primary outfall for the Ainslie district. This consists of monthly site visits in confined entry spaces to verify that physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

1.6 Control Option 1 Projects

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Strathmillan sewer district are listed in **Error! Reference source not found.** The proposed CSO control projects will include in-line storage via a control gate with screening.. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage	Storage / Transport Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	-	-	-	✓	✓	-	-	-	✓	✓	✓

The Strathmillan district plan includes implementing floatable control and in-line storage to meet the CSO Control Option 1 performance target.

Floatable control will be necessary to capture floatables in the sewage. The primary CS overflow for the district is to be screened under the current CSO control plan to address the floatables management requirements. The installation of a control gate at the primary CS outfall will be required for the screen operation in the Strathmillan district. This control gate installation will provide the mechanism for capture of minor additional in-line storage. It should be noted however that in-line storage for the Strathmillan district is not a cost-effective solution for additional volume capture. The control gate installation is recommended primarily to provide the necessary hydraulic head for screen operations. Should the screening option no longer be required in the Strathmillan district to address the floatables management requirements, it is recommended that alternative measures such as off-line storage or complete separation be investigated in the Strathmillan district to provide the additional volume capture in a more cost effective manner. Additional pass forward capacity at the CSO location provides an improvement to this district's performance.

GI and RTC will be applied within each district on a system wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design. RTC is not included in detail within each plan and is described further in Section 3 of Part 3A.

1.6.1 In-Line Storage

In-line storage has been proposed as a CSO control for the Strathmillan district. The in-line storage will require the installation of a control gate at the CS outfall. The gate will increase the storage level in the existing CS to provide a slightly higher volume capture, but will primarily be used to provide additional hydraulic head for screening operations.

A standard design was assumed for the control gate, as described in Part 3C. A standard approach was used for conceptual gate sizing by assuming it to be the lesser of the height of half of the site-specific trunk diameter or the maximum height of the gate available. The design criteria for in-line storage are listed in Table 1-5.

Table 1-5. In-Line Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	228.29 m	
Trunk Height	900 mm	Circular
Gate Height	0.11 m	Gate height based on half trunk diameter assumption
Top of Gate Elevation	228.97 m	
Bypass Weir Height	228.87 m	
Maximum Storage Volume	19 m^3	Option has small storage volume as by-produce of proposed screening installation requirement
Nominal Dewatering Rate	0.353 m^3/s	Based on pass forward flow at Strathmillan CS overflow
RTC Operational Rate	TBD	Future RTC / dewatering review with future assessment

Note:
RTC = Real Time Control
TBD = to be determined

The proposed control gate will cause combined sewage to back-up in the collection system to the extent shown on Figure 39. The extent of the in-line storage and volume is related to the top elevation of the bypass side weir. The level of the top bypass side weir and adjacent control gate level are determined in relation to the critical performance level in the system for basement flooding protection: when the system level increases above the bypass weir crest and proceeds above the top of the control gate during high flow events, the gate drops out of the way. At this point, the district will only provide its original interception capacity via the primary weir for the district, and all excess CS would flow over the weir and discharge to the river. After the sewer levels in the system drops back below the bypass side weir critical performance level, the control gate moves back to its original position to capture the receding limb of the WWF event. The existing gravity discharge will continue with its current operation while the control gate is in either position, with all DWF being diverted to the interceptor pipe.

Figure 39-01 provides an overview of the conceptual location and configuration of the control gate, bypass weir and screening chambers. The proposed control gate will be installed in a new chamber within the existing trunk sewer alignment near the existing primary weir. The dimensions of the chamber will be 5 m in length and 2.5 m in width to accommodate the gate, with an allowance for a longitudinal overflow weir. The existing sewer configuration including the off-take, 300 mm CS sewer, proposed 300 mm relief pipe and the CS LS force main may have to be modified to accommodate the new chamber. Further optimization of the gate chamber size may be provided if a decision is made not to include screening.

The physical requirements for the off-take and chamber sizing for a modification to existing pipe capacity have not been considered in detail, but they will be required in the future as part of an RTC program or LS rehabilitation or replacement project. The proposed location adjacent to the existing gate chamber has been situated entirely within the City owned land. However, the location of the existing infrastructure is within a residential area and will cause local disruptions which may require relocation to the main street or if the alternative floatables management approach is adopted not implemented at this location.

It should also be noted that the existing 300 mm offtake pipe at the Strathmillan primary weir is under capacity due to the high levels of groundwater inflow this district receives in the summer months. This will restrict the performance of the overflow, and not allow for the required levels of in-line storage. To counter this, it is also recommended that a 15 m section of 300 mm relief pipe be connected from the diversion weir to the existing interceptor, to complement the existing 300 mm offtake. This will allow for reduced overflows at the Strathmillan outfall and increase the amount of intercepted CS transported into the interceptor system, fully utilizing the in-line storage provided by the control gate. The addition of this pipe was assessed and does not cause additional overflows at the Olive outfall downstream for the representative year assessment. The existing sewer configuration may also require the relocation of the existing off-take pipe to be completed, if the future detailed design establishes that the proposed gate chamber cannot encompass the existing primary weir chamber. This will allow CS flows captured by the proposed control gate to be diverted to the Olive CS LS, ensuring that the system performs as per the existing conditions. The existing primary weir would remain in place to allow flow diversion to continue when the control gate is in its lowered position.

The nominal rate for dewatering of the district is set at the existing CS LS capacity. This allows dewatering through the existing interceptor system within 24 hours following the runoff event, allowing it to recover in time for a subsequent event. Future RTC / dewatering assessment will be necessary to define additional rates. This would provide some flexibility in the ability to increase the dewatering rate for spatial rainfall events. This would dewater the district more quickly, to capture and treat more volume for these localized storms by using the excess interceptor capacity where the runoff is less.

1.6.2 Floatables Management

Floatables management will require installation of a screening system to capture floatable materials. The off-line screens would be designed to maintain the current level of basement flooding protection.

The type and size of screens depend on the specific station configuration and the head available for operation. A standard design was assumed for screening and is described in Part 3C. The design criteria for screening, with an in-line control gate implemented, are listed in Table 1-6.

Table 1-6. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Top of Gate	228.97 m	
Bypass Weir Crest	228.87 m	
Normal Summer River Level	226.06 m	
Maximum Screen Head	2.81 m	
Peak Screening Rate	0.55 m^3/s	
Screen Size	1.5 m wide x 1 m high	Modelled Screen Size

The proposed side bypass overflow weir and screening chamber will be located adjacent to the proposed control gate and existing CS trunk, as shown on Figure 39-01. The screens will operate with the control gate in its raised position. A side bypass weir upstream of the gate will direct the flow to the screens located in the new screening chamber, with screened flow discharged to the downstream side of the gate to the river. The screening chamber may include screenings pumps with a discharge returning the screened material to the CS LS for routing to the WEWPCC for removal.

The dimensions for the screen chamber to accommodate influent from the side weir, the screen area, and the routing of the discharge piping downstream of the gate are 3 m in length and 3 m in width. The existing sewer configuration including the off-take, connection from the 17 Wing area, the 300 mm CS sewer and the proposed 300 mm relief pipe, may have to be modified to accommodate the new chamber.

1.6.3 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district was reviewed to identify the most applicable GI controls.

Strathmillan has been classified as a high GI potential district. Land use in Strathmillan is mostly single-family residential. Portage Avenue corridor includes a mix of apartments and commercial businesses. This means the district would be an ideal location for bioswales, permeable paved roadways, cisterns/rain barrels, and rain gardens. The flat roof commercial buildings along Portage Avenue would also be an ideal location for green roofs.

1.6.4 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

In-line storage will impact the existing sewer and will require the addition of a new chamber and a moving gate at the outfall. In-line storage dewatering will be controlled with the existing Clifton CS LS, which will require more frequent and longer duration pump run times. Lower velocities will occur in the CS trunk in the vicinity of the control gate due to lower pass forward flows, and may create additional debris deposition requiring cleaning. Additional system monitoring, and level controls will be installed, which will require regular scheduled maintenance.

Floatable control with outfall screening will require the addition of another chamber with screening equipment installed. The chamber will be installed adjacent to the control gate chamber and will operate in conjunction with it. Screening operation will occur during WWF events that surpass the in-line storage control level. WWF will be directed from the main CS trunk, over the side weir in the control gate chamber and through the screens to discharge into the river. The screens will operate intermittently during wet weather events and will likely require operations review and maintenance after each event. The frequency of a screened event will correlate to the number overflows identified for the district. Having the screenings pumped back to the interceptor system via a small LS and force main will be required. The screenings return will require O&M inspection after each event to assess the performance of the return pump system.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. Two versions of the sewer system model were created and used to measure system performance. The 2013 Baseline model represents the sewer system baseline in the year 2013 and the 2037 Master Plan – Control Option 1 model, which includes the proposed control options in the year 2037. A summary of relevant model data is provided in Table 1-7.

Table 1-7. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Added To Model
2013 Baseline	473	473	12,227	19	N/A
2037 Master Plan – Control Option 1	473	473	12,227	19	IS, SC

Notes:
IS = In-line Storage
SC = Screening

No influence from the 17 Wing site was modelled as part of the 1992 representative year assessment as this has a controlled discharge to the Strathmillan system which can be programmed to coincide with DWFW periods and not influence the CSO performance.

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-8 are for the hydraulic model simulations using the year-round 1992 representative year. The table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options, the table also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

As mentioned in the Section 1.3 there is an interaction with the Strathmillan district and the 17 Wing on-site private wastewater treatment system. Since the discharge of untreated sewage from 17 Wing base to the Strathmillan district is infrequent based on the 17 Wing treatment system maintenance requirements, no flows from 17 Wing have been included in the Strathmillan district assessment of the 1992 representative year.

Table 1-8. Performance Summary – Control Option 1

Control Option	Preliminary Proposal Annual Overflow Volume (m^3)	Master Plan Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [c]
Baseline (2013)	39,590	39,684	-	18	0.042 m^3/s
In-line Storage	41,117	43,678	- 3,994 [b]	18	0.042 m^3/s
In-line & Relief Pipe	N/A [a]	18,936	24,742	15	0.130 m^3/s
Control Option 1	**41,117**	**18,936**	**20,745**	**15**	**0.130 m^3/s**

[a] Relief sewer pipe was not simulated during the Preliminary Proposal assessment.

[b] Minor improvement to district on individual district model basis. Influenced by upstream Moorgate district and proposed options. Districts of Strathmillan and Moorgate to be developed as one project to ensure that the temporary worsening of the CSO performance does not occur at this district

[c] Pass forward flows assessed on the 1-year design rainfall event

The percent capture performance measure is not included in Table 1-8, as it is applicable to the entire CS system and not for each district individually.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-9. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-9. Cost Estimates – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Costs	2019 Total Operations and Maintenance Cost (Over 35-year Period)
In-line Control Gate	$0 [a]	$2,190,000 [b]	$39,000	$840,000
Screening	$0 [a]	$2,360,000 [c]	$48,000	$1,020,000
Relief Pipe	N/A	$30,000	$0	$0
Subtotal	**$0**	**$4,580,000**	**$87,000**	**$1,860,000**
Opportunities	N/A	$460,000	$9,000	$190,000
District Total	**$0 [a]**	**$5,040,000**	**$95,000**	**$2,050,000**

[a] Screening and In-line not included in the initial Preliminary Proposal 2015 costing. Solution developed as refinement to Preliminary Proposal work following submission of Preliminary Proposal costs. Costs for these items of work found to be $1,710,000 in 2014 dollars

[b] Cost associated with new off-take construction, as required, to accommodate control gate and screening chambers in location and allow intercepted CS flows to reach existing Strathmillan gravity pipe was not included in Master Plan

[c] Cost for bespoke screening return/force main not included in Master Plan as will depend on selection of screen and type of screening return system selected

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional costs for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014-dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019-dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-10.

Table 1-10. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Control Gate	A control gate was not included in the Preliminary Proposal estimate	Added for the MP to further reduce overflows
	Screening	Screening was not included in the Preliminary Proposal estimate	Added in conjunction with the Control Gate
	Relief pipe	Requirement for additional off-take relief pipe not known in Preliminary Proposal assessment.	Added in conjunction with the Control Gate
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management Approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation.	Preliminary Proposal estimates were based on 2014-dollar values.	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, the future performance target is 98 percent capture for the representative year measured on a system-wide basis. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-11 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified for Control Option 1.

Overall the Strathmillan district would be classified as a high potential for implementation of complete sewer separation as a feasible approach to achieve the 98 percent capture in the representative year future performance target. The non-separation measures recommended as part of this district engineering plan to meet Control Option 1, specifically in-line storage via control gate and additional relief piping and floatables management via off-line screening, are therefore at risk of becoming redundant and unnecessary when the measures to achieve future performance targets are pursued. As a result, these measures should not be pursued until the requirements to meet future performance targets are more defined. Should it be confirmed that complete separation is the recommended solution to meet future performance targets, then complete separation will likely be pursued to address Control Option 1 instead of implementing the non-separation measures. This will be with the understanding that while initially complete separation is less cost-effective to meet Control Option 1, it is the most cost effective solution to meet the future performance target and removes the capital costs on short term temporary solutions. The focused use of green infrastructure at key locations would also be utilized to provide volume capture benefits.

Table 1-11. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Complete Sewer Separation • Increased use of GI

The Strathmillan district control options have been aligned for the 85 percent capture performance target based on the system wide basis. The expandability of this district to meet the 98 percent capture would not align with the proposed options for the 85 percent capture target. The future higher level of percent capture indicate that complete sewer separation would be most applicable in this district.

The cost for upgrading to meet an enhanced performance target depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-12.

Table 1-12. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	R	-	-	-	-	-	-
2	Existing Lift Station	-	R	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	-	-	-	-
4	Construction Disruption	-	-	-	-	-	-	-	-
5	Implementation Schedule	-	-	-	-	-	-	R	-
6	Sewer Condition	-	R	-	-	-	-	-	-
7	Sewer Conflicts	-	R	-	-	-	-	-	-
8	Program Cost	-	O	-	-	-	-	-	O
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	-	-	-	-	-	O	O	-
12	Operations and Maintenance	-	R	-	-	-	R	O	R
13	Volume Capture Performance	-	O	-	-	-	O	O	-
14	Treatment	-	R	-	-	-	O	O	R

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

UMA Engineering, Ltd. (UMA). 2005. *Sewer Relief and CSO Abatement Study*. Prepared for. Month of publication.

LEGEND

Primary Weir	Inter-System Connection	District Boundary Crossing	Interceptor Sewer	District Boundary
Critical Elevation	CS - LDS	CS	Force Main	Watercourse
CSO Outfall	CS - WWS	LDS	Street	Greenspace
Low CS Manhole		WWS		

CSO MASTER PLAN PROPOSED SOLUTIONS

- Proposed Control Gate
- Duplicate Pipe
- Extent of In-line Storage
- Sewer Separation - Complete

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 39
District Overview Map
Sewer District: Strathmillan
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Manhole
- Flap Gate
- Force Main

Sewer By Type
- CS
- LDS
- WWS

Control Structure Type
- Gate Chamber

CSO MASTER PLAN PROPOSED SOLUTIONS
- Duplicate Pipe
- Control Gate
- Screening

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 39-01
Control Gate and Screening
Sewer District: Strathmillan
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Syndicate District Plan

August 2019

City of Winnipeg

CSO Master Plan

Project No:	470010CH
Document Title:	Syndicate District Plan
Revision:	03
Date:	August 19, 2019
Client Name:	City of Winnipeg
Project Manager:	John Berry
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Document History and Status

Revision	Date	Description	By	Review	Approved
0	08/30/2018	Version 1 DRAFT	DT	SG	
1	02/15/2019	DRAFT 2 for City Review	MF	SG	MF
2	06/2019	Final Draft Submission	JT	MF	MF
3	08/19/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

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1. Syndicate District

1.1 District Description

The Syndicate combined sewer (CS) district is located adjacent to the Red River and north of Alexander district. Syndicate is approximately bounded by the Red River to the north, east, and south; and by King Street to the west.

Syndicate has been developed primarily as residential and industrial, with general and light manufacturing located south of Sutherland Avenue and in the southeastern corner of the district; two-family residential buildings are found north of Sutherland Avenue. Some small commercial businesses are located along Main Street. The greenspace in Syndicate runs along the riverbank on the northern and southern sections.

The Canadian Pacific Railway Mainline runs through the centre of the district and crosses the Red River into Mission district. Main Street, Higgins Avenue, and Disraeli Freeway are the major regional transportation routes within the Syndicate CS district.

1.2 Development

Syndicate district includes a significant portion of the downtown area and the potential for redevelopment in the future is high. The OurWinnipeg development plan has prioritized the Downtown for opportunities to create complete, mixed-use, higher density communities. Redevelopment within this area could impact the CS and will be investigated on a case-by-case basis for potential impacts to the combined sewer overflow (CSO) Master Plan. All developments within the CS districts are mandated to offset any peak combined sewage discharge by adding localized storage and flow restrictions, in order to comply with Clause 8 of the Environment Act Licence 3042.

A portion of Main Street is located within the Syndicate District. Portage Avenue is identified as Regional Mixed-Use Corridor as part of the OurWinnipeg future development plans. As such, focused intensification along Main Street is to be promoted in the future.

One area within the Syndicate CS district has also been identified as a Major Redevelopment Site with OurWinnipeg, the South Point Douglas Lands. This site includes the lands adjacent to the Assiniboine River north of the Waterfront neighbourhood. This Major Redevelopment Site is considered underused and will be prioritized to be developed into a higher density, mixed-use community.

Higgins Avenue within the Alexander district has been identified as part of the potential routes for the Eastern Corridor of Winnipeg's Bus Rapid Transit. The work along Higgins Avenue could result in additional development in the area. This could also present an opportunity to coordinate sewer separation works alongside the transit corridor development, providing further separation within Alexander district. This would reduce the extent of the Control Options listed in this plan required.

1.3 Existing Sewer System

Syndicate district encompasses an area of 111 ha[1] based on the district boundary GIS information. This includes an area of approximately 21 percent by area (24 ha) that contains a separate land drainage sewer (LDS) system and is partially separated, approximately 5 percent (5 ha) that is considered separation ready and approximately 13 percent (14 ha) of greenspace.

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The collection system in the district includes CS, LDS and storm relief sewer (SRS) systems. The CS system includes a flood pump station (FPS), a CS lift station (LS) system and a combined CS/FPS outfall.

The CS system flows towards the Syndicate outfall, located at the northern end of Syndicate Street, where combined sewage is pumped to the Main Interceptor or may be discharged into the Red River. The Syndicate CS LS is located beside the Syndicate FPS at the outfall.

There are three main flow paths for CS connecting to the pump station. A 1050 mm CS trunk flows north on Syndicate Street, servicing the district east of that street; a 1350 mm CS trunk also flows north on Syndicate Street, servicing the district south of Euclid Avenue and Sutherland Avenue; and a 600 mm CS trunk flows east on Rover Avenue servicing the district north of Euclid Avenue. An interceptor pipe flows west on Sutherland Avenue through the Syndicate district, carrying pumped flows from the Montcalm CS LS in the Mission district to the Main Interceptor pipe on Main Street. This interceptor does not interact with the CS system in the Syndicate district.

During dry weather flow (DWF), LDS and SRS are not required; sanitary sewage passes through the main CS trunk sewers and is diverted by the primary diversion weir for the district through the 1350 mm off-take pipe to the Syndicate CS LS, where it is pumped to the Main Interceptor pipe and on to the North End Sewage Treatment Plant (NEWPCC) for treatment. During wet weather flow (WWF), any flow that exceeds the diversion capacity overtops the primary weir and is discharged to the river. A sluice gate and flap gate are installed on the CS outfall. The flap gate prevents flow from entering the CS system from the Red River when river levels are above the flap gate invert. When the river level are above the flap gate invert, gravity discharge through the CS outfall is not possible. The excess flow under these high river level conditions is instead pumped by the Syndicate FPS to discharge to the river at point downstream of the flap gate.

Approximately 21 percent of Syndicate district is separated with land drainage sewers installed to collect the surface runoff. These sewers discharge directly to the Red River through a separate LDS outfall located on the northern end of Disraeli Street. The southwestern section of Syndicate includes SRS pipework that relieve the CS network during runoff events but do not interconnect with other district SRS systems.

The one outfall to the Red River (one CS) is as follows:

- ID22 (S-MA70003283) – Syndicate CS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between the Syndicate district and the surrounding districts. Each interconnection is shown on Figure 40 and shows locations where gravity and pumped flow can cross from one district to another. Each interconnection is listed in the following subsections.

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

Selkirk

- The 2250mm Main Interceptor pipe flows by gravity from the Syndicate district into the Selkirk district and on to the North End Sewage Treatment Plant (NEWPCC) for treatment.
  - Main Street interceptor invert – 220.406 m (S-MH00012082)

1.3.1.2 Interceptor Connections – Upstream of Primary Weir

Alexander

The 1950mm Main Interceptor pipe flows by gravity north on Main Street into the Syndicate district from the Alexander district and carries sewage to the NEWPCC for treatment

- Main Street interceptor invert – 220.861 m (S-MH20017433-CG)

Mission

- Two 600 mm force mains cross the Red River carrying pumped sewage from Montcalm CS LS in Mission district to the 1200 mm interceptor sewer in Syndicate:
  - Across Red River – Invert at Syndicate district boundary 227.28 m (S-MH20012321)
  - Across Red River – Invert at Syndicate district boundary 227.50 m (S-MH20012321)

1.3.1.3 District Interconnections

Selkirk

<u>CS to CS</u>

- A 375 mm CS sewer acts as an overflow pipe from the Selkirk CS system into the Syndicate CS system.
  - 375 mm CS on Main Street at Dufferin Avenue – 228.52 m (S-MH00012094)

<u>CS to SRS</u>

- A 250 mm SRS sewer acts as an overflow pipe from the Syndicate CS system into the Selkirk SRS system.
  - Euclid Avenue at Lusted Avenue – 228.60 m (S-MH00012247)
- A 250 mm SRS sewer acts as an overflow pipe from the Syndicate CS system into the Selkirk SRS system
  - Austin Street N at Euclid Avenue – 228.62 m (S-MH00012114)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing district.

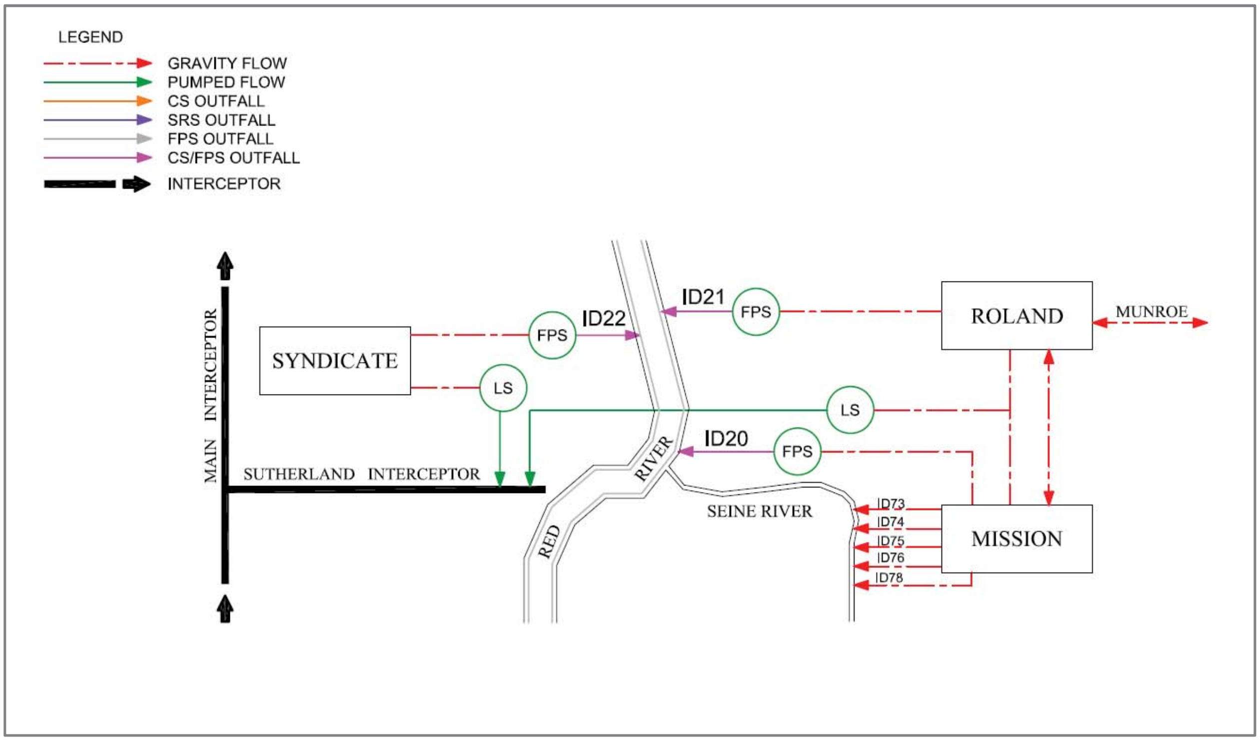


Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 40 and listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID57)	S-YY70021031.1	S-MA70003283	1800 mm	Red River Invert: 223.39 m
Flood Pumping Outfall (ID82)	S-YY70021031.1	S-MA70003283	1800 mm	Red River Invert: 223.39 m
Other Overflows	N/A	N/A	N/A	
Main Trunk	S-TE70026975.2 S-YY70021032.1	S-MA70003270 S-MA70003278	1500 mm 1350 mm	Invert: 223.61 m Invert: 223.66 m
SRS Outfalls	N/A	N/A	N/A	
SRS Interconnections	N/A	N/A	N/A	2 SRS – CS
Main Trunk Flap Gate	S-TE70026956.1	S-CG00000789	1525 mm	Invert: 223.53 m
Main Trunk Sluice Gate	S-CG00000789.1	S-CG00000788	1800 x 1800 mm	Invert: 223.30 m
Off-Take	S-TE70026975.1	S-MA70003269	1350 mm	Circular Invert: 223.61 m
Wet Well	S-TE70026978	S-TE70026978	Chamber Area 12.7 m^2	
Lift Station Total Capacity	N/A	N/A	0.040 m^3/s	1 x 0.019 m^3/s 1 x 0.021 m^3/s
Lift Station ADWF	N/A	N/A	0.004 m^3/s	
Lift Station Force Main	S-YY70021034.1	S-MA70003269	250 mm	Invert: 225.80 m

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Flood Pump Station Total Capacity	N/A	N/A	0.910 m^3/s	1 x 0.230 m^3/s 1 x 0.680 m^3/s
Pass Forward Flow – First Overflow	N/A	N/A	0.128 m^3/s	

Notes:ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO Control Options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Syndicate – 223.70
2	Trunk Invert at Off-Take	223.61
3	Top of Weir	224.15
4	Relief Outfall Invert at Flap Gate	N/A
5	Relief Interconnection (S-MH00012247)	228.60
6	Sewer District Low Interconnection (Selkirk)	220.41
7	Low Basement	227.08
8	Flood Protection Level (Boyle, Syndicate)	229.61

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed in Syndicate was the *Boyle/Syndicate Combined Sewer Relief Program* (UMA Engineering Ltd., 2007). The turnover package describes the summary for all works completed under the program and construction costs relating to the past studies and reports for Syndicate district that provided stabilization works for the Boyle site from 1989 to 1993 and CS relief. The Contract 4 construction to provide CS relief in the catchment area known as Higgins West was the most recent work and was completed in June 2002 (UMA Engineering Ltd., 2007). No other work has been completed on the district sewer system since that time.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Syndicate Combined Sewer District was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations have a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Expected Completion
40 – Syndicate	2007	Future Work	2013	Study Complete CS Relief Work Complete 2002	N/A

1.5 Ongoing Investment Work

There is ongoing maintenance and calibration of the permanent instruments installed within the primary outfall within the Syndicate district. This consists of monthly site visits in confined entry spaces to verify that physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet the Control Option 1 – 85 Percent Capture in a Representative Year for the Syndicate sewer district are listed in Table 1-4. The proposed CSO control projects will include in-line storage via a control gate and screening. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85% Capture in a Representative Year	-	-	-	✓	✓	-	-	-	✓	✓	✓

Notes:

- = not included
✓ = included

An assessment indicated that the combination of the relatively high separation costs and the lower ranking (volumetric based) concluded that sewer separation work in this district to achieve 85 percent capture is not cost effective.

The existing CS systems are suitable for use as in-line storage. This control option will take advantage of the existing CS pipe network for additional storage volume. Existing DWF from the collection system will remain the same, and overall district operations will remain the same.

Floatable control will be necessary to capture any undesirable floatables in the sewage. Floatables will be captured with all implemented control options to some extent, but screening may be added as required to reach the desired level of capture. Screens will be installed only on the primary outfall located on the eastern end of Syndicate Street.

GI and RTC will be applied within each district on a system-wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 In-Line Storage

The existing CS system is suitable for use as in-line storage. This control option will take advantage of the existing CS pipe network for additional storage volume. The existing CS LS will be used to dewater the in-line storage volume and direct it to the interceptor. Existing DWF from the collection system and overall district operations will remain the same.

In-line storage has been proposed as a CSO control for the Syndicate district. In-line storage will require the installation of a control gate at the CS outfall. The gate will increase the storage level in the existing CS and provide an overall higher volume capture than that already provided by the primary weir.

A standard design was assumed for the control gate, as described in Part 3C of the CSO Master Plan. A standard approach was used for conceptual gate sizing by assuming it to be the lesser of the height of half of the site-specific trunk diameter or the maximum height of the gate available. The design criteria for the in-line storage are listed in Table 1-5.

Table 1-5. In-Line Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	223.62 m	Downstream invert of pipe at weir
Trunk Diameter	1,350 mm	
Gate Height	0.74 m	Based on half pipe diameter assumption
Top of Gate Elevation	224.46 m	
Bypass Weir Elevation	224.36	
Maximum Storage Volume	329 m^3	
Nominal Dewatering Rate	0.040 m^3/s	Based on existing CS LS capacity
RTC Operational Rate	TBD	Future RTC / dewatering review on performance

Note:
TBD – to be determined

The proposed control gate will cause combined sewage to back-up within the collection system to the extent shown on Figure 40. The extent of the in-line storage and volume is related to the top elevation of the bypass side weir. The level of the top of bypass side weir and adjacent control gate level are determined in relation to the critical performance levels in the system for basement flooding protection: when the system level increases above the bypass weir crest and proceeds above the top of the control gate during high flow events, the gate drops out of the way. At this point, the district will only provide its original interception capacity via the primary weir for the district, and all excess CS would flow over the weir and discharge to the river. After the sewer levels in the system drops back blow the bypass side weir critical performance level, the control gate moves back to its original position to capture the receding limb of the WWF event. The CS LS would continue with its current operation while the control gate is in either position, with all DWF being diverted to the CS LS and pumped to the Main Interceptor on Main Street. The CS LS will further dewater the in-line storage provided during a WWF event as downstream capacity becomes available.

Figure 40-01 provides an overview of the conceptual location and configuration of the control gate, bypass weir and screening chambers. The proposed control gate will be installed in a new chamber within the trunk sewer alignment and located south of the Syndicate outfall gate chamber. The dimensions of a new chamber to provide an allowance for a side weir for floatables control are 5 m in length and 2.5 m in width. The existing sewer configuration may require the construction of an additional off-take pipe to be completed, if the future detailed design establishes that the proposed gate chamber cannot encompass the existing primary weir. This will allow CS flows captured by the proposed control gate to still be diverted to the CS LS, ensuring that the system performs as per the existing conditions. The existing primary weir would remain in place to allow flow diversion to continue when the control gate is in its lowered position. The proposed chambers (control gate and screening) are to be located within the existing City of Winnipeg Right-of-Way (ROW) adjacent to the existing infrastructure. The construction will have a minor impact on the local street traffic, and there are alternative routes that can be taken to bypass this area.

The physical requirements for the off-take and station sizing for a modification to pumping capacity have not been considered in detail, but they may be required in the future as part of an RTC program or CS LS rehabilitation or replacement project.

The nominal rate for dewatering is set at the existing CS LS capacity. This allows dewatering through the existing interceptor system within 24 hours following the runoff event, allowing it to recover in time for a subsequent event. Additionally, for RTC, an initial estimate of two times the nominal dewatering rate has been selected This allows individual districts to be dewatered within 12 hours, rather than within 24 hours. It will provide the ability to capture and treat more volume for localized storms by using the excess interceptor capacity where the runoff is less. Further assessment of the impact of the RTC and future dewatering arrangement will be necessary to review the downstream impacts on the existing force main and interceptor system.

1.6.3 Floatables Management

Floatables management will require installation of a screening system to capture floatable materials., Off-line screens will be proposed to maintain the current level of basement flooding protection.

The type and size of screens depend on the CS LS configuration and the hydraulic head available for operation. A standard design was assumed for screening and is described in Part 3C of the CSO Master Plan.

The design criteria for screening with an in-line control gate implemented, are listed in Table 1-6.

Table 1-6. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Top of Gate	224.46 m	
Bypass Weir Crest	224.36	
Normal Summer Water Level	223.70 m	
Maximum Screen Head	0.74 m	
Peak Screening Rate	0.30 m^3/s	
Screen Size	1.5 m wide x 1 m high	Modelled Screen Size

The proposed side bypass overflow weir and screening chamber will be located adjacent to the proposed control gate and existing combined trunk sewer, as shown on Figure 40-01. The screens will operate with the control gate in the raised position. A side bypass weir upstream of the gate will direct the overflow to the screens located in a new screening chamber, with screened flow discharged to the downstream side of the gate to the river. The screening chamber will include screenings pumps with a discharge returning the screened material to the CS LS for routing back to the interceptor and on to the NEWPCC for removal.

The dimensions for the screen chamber to accommodate influent from the side weir, the screen area, and the routing of discharge downstream of the gate are 5.5 m in length and 2.5 m in width. The existing sewer configuration including the off-take and the 1350 mm and 1050 mm CS sewers down Syndicate Street, and possibly the 600 mm CS sewer along Rover Avenue and the CS LS force main, may have to be modified to accommodate the new chamber.

1.6.4 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district will be reviewed to identify the most applicable GI controls.

Syndicate has been classified as a medium GI potential district. Syndicate has been developed primarily as residential and industrial. This means the district would be an ideal location for bioswales, permeable paved roadways (in the areas away to the riverbank), cisterns/rain barrels, rain gardens, and green roofs.

1.6.5 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

In-line storage will impact the existing sewer and will require the addition of a new chamber and a moving gate at the outfall. In-line storage dewatering will be controlled with the existing Clifton CS LS, which will require more frequent and longer duration pump run times. Lower velocities will occur in the CS trunk in the vicinity of the control gate due to lower pass forward flows, and may create additional debris deposition requiring cleaning. Additional system monitoring, and level controls will be installed, which will require regular scheduled maintenance.

Floatable control with outfall screening will require the addition of another chamber with screening equipment installed. The chamber will be installed adjacent to the control gate chamber and will operate in conjunction with it. Screening operation will occur during WWF events that surpass the in-line storage control level. WWF will be directed from the main CS trunk, over the side weir in the control gate chamber and through the screens to discharge into the river. The screens will operate intermittently during wet weather events and will likely require operations review and maintenance after each event. The frequency of a screened event will correlate to the number overflows identified for the district. Having the screenings pumped back to the interceptor system via a small LS and force main will be required. The screenings return will require O&M inspection after each event to assess the performance of the return pump system.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. An individual model was created to represent the sewer system baseline as represented in the year 2013 and a second model was created for the CSO Master Plan evaluation purposes, with all the control options recommended for the district to meet Control Option 1 implemented in the year 2037. A summary of relevant model data is provided in Table 1-7.

Table 1-7. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	104	104	1,428	59	N/A
2037 Master Plan – Control Option 1	104	104	1,428	59	IS, SC

Note:

IS = In-line Storage
SC = Screening

No change to the future population was completed as from a wastewater perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance estimates listed in Table 1-8 are for the hydraulic model simulations using the year-round 1992 representative year. This table lists the results for the Baseline, for each individual control option and the proposed CSO Master Plan -Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. Table 1-8 also includes overflow volumes specific to each individual control options; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-8. District Performance Summary – Control Option 1

Control Option	Preliminary Proposal	Master Plan			
	Annual Overflow Volume (m^3)	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [a]
Baseline (2013)	38,645	57,357	-	21	0.058 m^3/s
In-Line Storage	36,861	51,571	5,786	20	0.055 m^3/s
Control Option 1	**32,200**	**51,571**	**5,786**	**20**	**0.055 m^3/s**

[a] Pass forward flows assessed for the 1-year design rainfall event

The difference between the 2014 Preliminary and CSO Master Plan Baseline and Control Option 1 results are directly due to the update in CS LS pump capacity provided via the Clear SCADA data verification.

The percent capture performance measure is not included in Table 1-8, as it is applicable to the entire CS system and not for each district individually.

1.9 Cost Estimates

The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A of the CSO Master Plan. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-9. The cost estimates are a Class 5 planning level estimate with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-9. Cost Estimates – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance (Over 35-year period)
In-line Control Gate	$7,700,000 [a]	$2,360,000 [b]	$40,000	$920,000
Screening		$1,870,000 [c]	$50,000	$1,120,000
Subtotal	**$7,700,000**	**$4,230,000**	**$90,000**	**$2,040,000**
Opportunities	$0	$420,000	$9,000	$200,000
District Total	**$7,700,000**	**$4,650,000**	**$99,000**	**$2,240,000**

[a] Screening and In-line costs were combined in the Preliminary Proposal 2015 costing

[b] Cost associated with new off-take construction, as required, to accommodate control gate location and allow intercepted CS flow to reach existing Aubrey LS not included.

[c] Cost for bespoke screenings return pump/force main not included in Master Plan as will depend on selection of screen and type of screening return system selected

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value
- A fixed allowance of 10 percent has been included for GI, with no additional costs for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014-dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019-dollar values
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master Plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-10.

Table 1-10. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Control Gate	Preliminary estimate was based on a standard cost per district, which has been updated to a site-specific district cost estimate.	

Table 1-10. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
	Screening	Preliminary estimate was based on a standard cost per district, which has been updated to a site-specific district cost estimate.	
Opportunities	A fixed allowance of 10 percent has been included for program opportunities.	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation.	Preliminary Proposal estimates were based on 2014-dollar values.	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, the future performance target is 98 percent capture for the representative year measured on a system-wide basis. This target will permit the number of overflows and percent capture to vary by district to meet the 98 percent capture. Table 1-11 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified in Control Option 1.

Overall the Syndicate district would be classified as low to medium for implementation of complete sewer separation as the only feasible approach to achieve the 98 percent capture in the representative year future performance target. The relatively high cost of sewer separation for the remaining district points to a low potential, however, the extent of the existing SRS system with CS connections may have potential for cost effective opportunistic separation that would point to a medium potential. This would require further study to evaluate the district runoff performance. Should it be confirmed that complete separation is the recommended solution to meet future performance targets, then complete separation will likely be pursued to address Control Option 1 instead of implementing the non-separation measures recommended in this district engineering plan. This will be with the understanding that while initially complete separation is less cost-effective to meet Control Option 1, it is the most cost effective solution to meet the future performance target and removes the capital costs on short term temporary solutions.

Opportunistic separation of portions of the district may also be achieved with synergies with other major infrastructure work to address future performance targets. The inclusion of off-line storage elements such as an underground tank or storage tunnel with dewatering pump infrastructure could be utilized to provide any additional volume capture. As with all districts, the use of green infrastructure will be investigated in the future as a potential benefit to meet future performance targets.

Table 1-11. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Opportunistic separation • Increased use of GI • Increased use of In-line • Off-Line Storage (Tunnel/Tank)

The control options for the Syndicate district have been aligned for the 85 percent capture performance target and the expandable nature to the 98 percent capture would be based on the system wide basis. The applicability of the listed viable migration options will be stepped rather than full district solutions.

The cost for upgrading to meet an enhanced performance target depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-12.

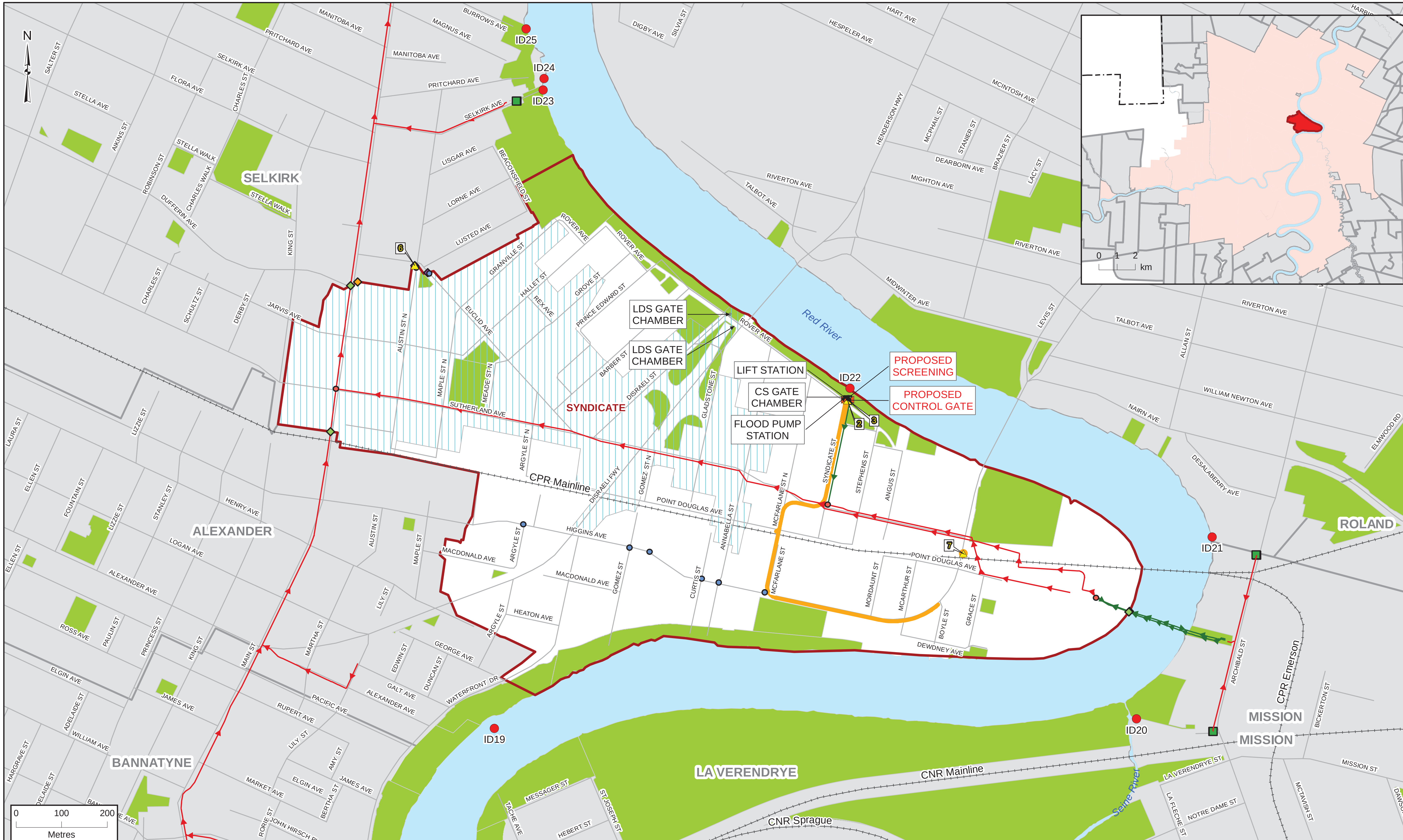
Table 1-12. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	R	-	-	-	-	-	-
2	Existing Lift Station	-	R	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	-	-	-	-
4	Construction Disruption	-	-	-	-	-	-	-	-
5	Implementation Schedule	-	-	-	-	-	-	R	-
6	Sewer Condition	-	R	-	-	-	-	-	-
7	Sewer Conflicts	-	R	-	-	-	-	-	-
8	Program Cost	-	O	-	-	-	-	-	O
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	-	-	-	-	-	O	O	-
12	Operations and Maintenance	-	R	-	-	-	R	O	R
13	Volume Capture Performance	-	O	-	-	-	O	O	-
14	Treatment	-	R	-	-	-	O	O	R

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

UMA Engineering Ltd. 2007. *Boyle/Syndicate Combined Sewer Relief Program Final Turnover Package*. Prepared for the City of Winnipeg. July.



LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Low CS Manhole

Inter-System Connection
- CS - WWS
- SRS - CS

District Boundary Crossing
- CS
- SRS
- WWS

- Interceptor Sewer
- Force Main
- Street
- Railway

- District Boundary
- Watercourse
- Greenspace

CSO MASTER PLAN PROPOSED SOLUTIONS
- Proposed Control Gate
- Extent of In-line Storage
- Sewer Separation - Complete

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 40
District Overview Map
Sewer District: Syndicate
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Manhole
- Flap Gate
- Sluice Gate
- Pump Location
- Force Main

Sewer By Type
- CS
- WWS

Control Structure Type
- Gate Chamber

Pump Station Type
- Flood Pump Station
- Lift Station

CSO MASTER PLAN
PROPOSED SOLUTIONS
- Control Gate
- Screening

ALL PROPOSED SOLUTIONS
SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 40-01
Control Gate and Screening
Sewer District: Syndicate
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Tuxedo District Plan

August 2019

City of Winnipeg

CSO Master Plan

Project No:	470010CH
Document Title:	Tuxedo District Plan
Revision:	03
Date:	August 15, 2019
Client Name:	City of Winnipeg
Project Manager:	John Berry
Author:	Scott Begg
File Name:	Tuxedo_Plan_Final_CO1MP_08152019

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Document History and Status

Revision	Date	Description	By	Review	Approved
0	08/2018	Version 1 DRAFT	SG	ES	
1	12/2018	Version 2 DRAFT	SB	ES / JB / DT / SG / MAF	
2	05/2019	Final Draft Submission	SB / JT	MF	SG
3	08/15/2019	Final Submission For CSO Master Plan	MF	MF	SG

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Contents

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Figure

1. Tuxedo District

1.1 District Description

Tuxedo district is located towards the southwestern limit of the combined sewer (CS) area. Regional roadways bordering the district are Wellington Crescent to the north, Corydon Avenue to the south, Park Boulevard North to the west, and Edgeland Boulevard to the east. The major transportation routes passing through Tuxedo are Corydon Avenue and Tuxedo Avenue, each of which conveys a high volume of traffic. Figure 41 provides an overview of the sewer district and the location of the proposed Combined Sewer Overflow (CSO) Master Plan options. Tuxedo district is directly adjacent to Assiniboine Park and bounded by the Assiniboine River on the north.

Land use in Tuxedo is mainly residential with a small amount of commercial near major transportation routes. Commercial lands are located along Corydon Avenue and on the eastern side of Tuxedo Avenue including the large Tuxedo Park Shopping Centre and other smaller businesses. The district consists mostly of single-family homes with apartment complexes situated between Tuxedo Avenue and Edgeland Boulevard. Most of the area was developed in the 1960s to the early 1970s. Aside from the river bank along Assiniboine River, the district only has a few small parcels of green space.

1.2 Developments

A Route 90 Improvement Study is currently underway that will lead to a significant amount of construction and right of way adjustments along Route 90/Kenaston Boulevard. This work, which will impact both Doncaster and Ash districts but should not affect Tuxedo substantially as there is limited land area available for development within Tuxedo district.

Updates to the land drainage system along Wellington Crescent are anticipated to occur, and this will have a potential impact on control options selected.

1.3 Existing Sewer System

Tuxedo district has an approximate service area of 52 ha[1], based on the district boundary, making it the third smallest CS district and includes combined sewers (CSs), wastewater sewers (WWS), and land drainage sewers (LDSs). Approximately 27 percent (14 ha) of the total district is already separated. While approximately 28 percent (15 ha) of the total district area is considered separation ready. Approximately 3 ha of the district is classified as greenspace.

The CS system includes a dual flood and lift pump station (LFPS) (referred to as Chataway LFPS), primary diversion weir, and an outfall gate chamber located at Wellington Crescent adjacent to the Assiniboine River. All domestic wastewater and combined sewage flows collected in Tuxedo district converge to the 900 mm circular trunk sewer located along Nanton Boulevard, which then converts into an egg-shaped 2280 mm by 1520 mm main trunk flowing north along the back lane of Chataway Boulevard toward the CS outfall.

During dry weather flow (DWF), the Tuxedo primary weir diverts flow to the lift station pumps of the CS LFPS through a 200 mm off-take pipe. The 150 mm force main from the CS LFPS then pumps the combined sewage to the Doncaster interceptor sewer that flows by gravity into the Doncaster district and eventually to the Ash district. Flow is then pumped across the Assiniboine River to the North End Sewage Treatment Plant (NEWPCC) for treatment.

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[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

During wet weather flow (WWF) events, any flow that exceeds the diversion capacity overtops the weir and is discharged to the river from the 900 mm CS primary outfall. Sluice and flap gates are installed on the CS outfall to prevent back-up of the Assiniboine River into the CS system under high river level conditions. When the river level is high however gravity discharge is not possible due to the flap gate, the excess flow is then pumped through a 200 mm pipe by the flood chamber of the CS LFPS into the gate chamber downstream of the sluice gate and to the river via the CS primary outfall. The flood chamber component of the CS LFPS contains one pump to accommodate WWF.

Figure 41 shows the separate area located on the west and east boundaries of the district. The first separate area along the west boundary discharges LDS flow via gravity at a 2400 mm LDS outfall located along Park Boulevard North to the Assiniboine River. A second separate area located on the southeastern boundary of the district near Tuxedo Avenue and Edgeland Boulevard routes LDS flow by gravity into Tuxedo South separate sewer district through a 750 mm pipe and back through to the Tuxedo district eventually discharging at the Assiniboine River through the same 2400 mm LDS outfall along Park Boulevard North. There are three locations in Tuxedo where the separate WWSs connect into the CS system.

A central portion of the district is considered separation ready with LDS installed but flowing back into the CS system. LDS on Handsart Boulevard, Grenfell Boulevard and Girton Boulevard connect into the CS trunk along Nanton Boulevard.

The single CS outfall to the Assiniboine River is as follows:

ID47 (S-MA70029012) – Tuxedo CS Outfall

1.3.1 District-to-District Interconnections

There are several sewer system interconnections between Tuxedo district and the adjacent districts; see Figure 41. Interconnections include gravity and pumped flow from one district to the other. Each interconnection is listed in the following subsections:

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

Doncaster

- A 150 mm force main from the CS LFPS pumps CS to the Doncaster interceptor sewer along Wellington Crescent and flows by gravity into the Doncaster district and then on to the Ash district. Flow is then pumped across the Assiniboine River to the North End Sewage Treatment Plant (NEWPCC) for treatment.
  - Wellington Crescent and Doncaster boundary interceptor invert - 228.57 m (S-CO70008639)

1.3.1.2 District Interconnections

Tuxedo South

<u>CS to CS</u>

- High point CS manhole (flow is directed into both districts from this manhole): A 750 mm CS pipe will either flow by gravity north to the NEWPCC service area or south to the West End Sewage Treatment Plant (WEWPCC) service area.
  - Corydon Avenue and Lamont Boulevard invert at Tuxedo district boundary - 228.98 m (S-MH60005864)

<u>LDS to LDS</u>

- A 750 mm LDS pipe from Tuxedo South district LDS system at Corydon Avenue and Park Boulevard North flows by gravity eastbound into Tuxedo LDS system and does not interact with the CS system.

– Corydon Avenue and Park Boulevard North invert at Tuxedo district boundary - 227.65 m (S-MH60003117)

- A 2400 mm LDS pipe from Tuxedo South district LDS system at Corydon Avenue and Park Boulevard North flows by gravity northbound into Tuxedo LDS system and does not interact with the CS system.
  – Corydon Avenue and Park Boulevard North invert at Tuxedo district boundary - 227.65 m (S-MH60003117)
- A 750 mm LDS pipe from Tuxedo district LDS system at Southport Boulevard and Corydon Avenue flows by gravity southbound into Tuxedo South LDS system and does not interact with the CS system.
  – Corydon Avenue and Southpoint Boulevard invert at Tuxedo district boundary - 228.79 m (S-MH60005920)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing district.

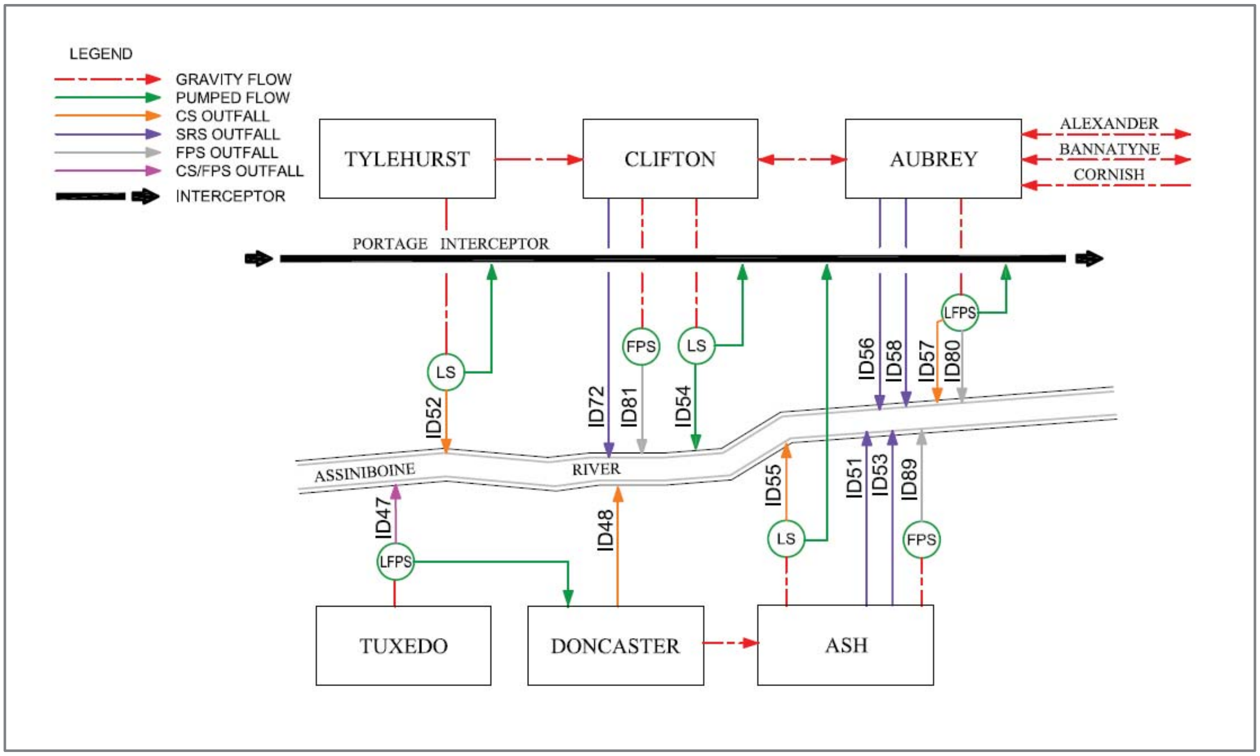


Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 41 and are listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID47)	S-MH70010676.1	S-MA70029012	900 mm	Circular pipe Invert: 225.33 m
Flood Pumping Outfall (ID47)	S-MH70010676.1	S-MA70029012	900 mm	Circular pipe Invert: 225.33 m

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Other Overflows	N/A	N/A	N/A	
Main Sewer Trunk	S-MH6006079.3	S-MA70029065	2280 x 1520 mm	Egg-shaped pipe
Storm Relief Sewer Outfalls	N/A	N/A	N/A	No SRS system within the district.
Storm Relief Sewer Interconnections	N/A	N/A	N/A	No SRS system within the district.
Main Trunk Flap Gate	S-AC70013735.1	S-CG00000749	900 mm	Circular, Invert = 225.51 m
Main Trunk Sluice Gate	TUXEDO_GC.1	S-CG00000750	900 mm	Invert = 225.42 m
Off-Take	S-MH60005247.1	S-MA70018595	200 mm	Circular pipe
Dry Well	N/A	N/A	N/A	
Lift Station Total Capacity	N/A	N/A	0.036 m^3/s	2 pumps x 0.018 m^3/s
Lift Station ADWF	N/A	N/A	0.004 m^3/s	
Lift Station Force Main	S-AC70008688.1	S-MA70018599	150 mm	Dual Flood and Lift Station[a]
Flood Pump Station Total Capacity	N/A	N/A	0.063 m^3/s	1 pump, Force main – 200 mm
Pass Forward Flow – First Overflow	N/A	N/A	0.021 m^3/s	

Notes:

[a] Tuxedo uses a Dual Lift and Flood Pump Station, with the FPS using one pump that connects to its respective 200 mm force main. This force main flows past the sluice gate gates to the outfall.
ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Tuxedo – 224.51
2	Trunk Invert at Off-Take	225.40
3	Top of Weir	225.48
4	Relief Outfall Invert	N/A
5	Relief Interconnection	N/A
6	Sewer District Interconnection (Tuxedo South)	228.98
7	Low Basement	230.67
8	Flood Protection Level	230.53

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study for Tuxedo district was the Report on Separate Sewer Relief Project, Tuxedo Sanitary Sewer District (Reid Crowther, 1982). It describes necessary relief measures to reduce or eliminate basement flooding for the Tuxedo combined sewer district. The report on Basement Flooding Relief Program was then completed in 1986.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Tuxedo CS district was included as part of this program. Instruments installed at each of the thirty nine primary CSO outfall locations has a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Planned Completion
41 – Tuxedo	1986	Future Work	2013	Study Complete	N/A

1.5 Ongoing Investment Work

There is ongoing maintenance and calibration of permanent instruments installed within the Tuxedo outfall. This consists of monthly site visits in confined entry spaces to verify that physical readings concur with displayed transmitted readings and replacing desiccants when necessary.

The Route 90 Widening Project is planned from Carpathia Road to St. James Bridge in Ash district and will improve traffic along Kenaston Avenue. Implementation of sewer separation has yet to be determined at this stage; however, separation would be advantageous to reducing the overflows occurring in Ash as well as Doncaster districts.

The existing CSs will be evaluated for separation potential as part of the Route 90 Widening Project. Opportunistic separation will be incorporated where there is benefit. The separation costs may be reduced if separation work is planned as part of road reconstruction. There will be minimal impacts associated with Tuxedo CSD however.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Tuxedo sewer district are listed in Table 1-4. The proposed CSO control projects will include sewer separation. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	-	-	-	-	-	-	-	✓	✓	✓	-

Notes:

- = not included
✓ = included

The Tuxedo district is not identified as a priority project within the existing Basement Flood Relief Program.

The existing CS system was originally reviewed for in-line storage as well as floatable management. The marginal evaluation indicated that full separation will be similar to the in-line/screening control option even though the majority of the district has already been separated along with its smaller overall area. Operations and maintenance (O&M) costs required with the in-line / screening option are also taken into consideration, and this associated O&M cost results in the selection of full separation is the most preferable in this district.

GI and RTC will be applied within each district on a system wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Sewer Separation

The sewer separation project for Tuxedo will provide immediate benefits to the CSO program when complete. The work includes installation of a new LDS trunk sewer along Nanton Boulevard as well as a new LDS collector sewer along Lamont Boulevard. Current LDS systems will be extended to collect road drainage along Handsart Boulevard, Grenfell Boulevard, and Girton Boulevard. Collected stormwater runoff will be routed to the existing 2400 mm LDS outfall discharging to the Assiniboine River at Park Boulevard North. The approximate area of sewer separation is shown on Figure 41.

The flows to be collected after Tuxedo separation will be as follows:

- Dry weather flows will remain the same for Tuxedo district.
- Tuxedo WWF will consist of sanitary sewage combined with foundation drainage.

This will result in a significant reduction in combined sewage flow received at Chataway LFPS after the separation project is complete. The separation project will provide a full reduction of overflows for the 1992 representative year.

In addition to reducing the CSO volume, the benefits of Tuxedo separation include a reduction of pumped flows entering both the immediate downstream Doncaster and Ash CS districts, as well as reducing the amount of flood pumping required at the Chataway LFPS.

1.6.3 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district will be reviewed to identify applicable GI controls.

Tuxedo has been classified as a medium GI potential district. Land use in Tuxedo is mainly residential with a small amount of commercial, the north end of the district is bounded by the Assiniboine River. This district would be an ideal location for cisterns/rain barrels, and rain garden bioretention. There are a few commercial areas which may be suitable to green roofs and parking lot areas which would be ideal for paved porous pavement.

1.6.4 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System Operations and Maintenance changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

Sewer separation will include the installation of additional sewers that will require inspection, cleaning and rehabilitation. This will result in additional maintenance costs over the long term, but operational costs will be minimal. The existing larger CS pipes within the district may also receive insufficient flows with the separation work for proper scouring velocities in the sewer pipes. This could result in solids settling within the sewers and requiring more frequent cleaning operations. The impacts of the reduced flows in larger CS pipes will be evaluated as part of the sewer separation design for the districts.

The reduction in storm flows entering the CS LFPS will reduce the requirement for operation of the flood pump within the CS LFPS. It is recommended to continue to maintain and operate the flow monitoring instrumentation and assess the results after district separation work has been completed. This will allow the full understanding of the non-separated storm elements (i.e., foundation drain connections to the CS system) within the Tuxedo district.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. Two versions of the sewer system model were created and used to measure system performance. The 2013 Baseline model represents the sewer system baseline in the year 2013 and the 2037 Master Plan – Control Option 1 model, which includes the proposed control options in the year 2037. A summary of relevant model data is provided in Table 1-5.

Table 1-5. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	47	47	932	31	-
2037 Master Plan – Control Option 1	47	18	932	3	SEP

Notes:

Table 1-5. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model

SEP – Separation

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district. While this district is to be separated and as a result Clause 8 of Licence No. 3042 will not be in effect, the wet weather response of the district overall will still need to be assessed.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-6 are for the hydraulic model simulations using the year-round 1992 representative year. The table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. The table also includes overflow volumes specific to each individual control option when simulations were completed; these are listed to provide an indication of benefit gained only and are independent volume reductions unless noted otherwise.

Table 1-6. District Performance Summary – Control Option 1

	Preliminary Proposal	Master Plan			
Control Option	Annual Overflow Volume (m^3)	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow
Baseline (2013)	14,695	13,843	0	18	0.021 m^3/s [b]
In-Line	14,658	N/A	N/A	N/A	N/A
Separation	N/A [a]	0	13,843	0	0.025 m^3/s [c]
Control Option 1	**14,658**	**0**	**13,843**	**0**	**0.025 m^3/s [c]**

[a] Separation was not simulated during the Preliminary Proposal assessment

[b] Pass forward flows assessed with the 1-year design rainfall event

[c] Pass forward flows assessed with the 5-year design rainfall event

The revised CSO Master Plan control option to separate the Tuxedo district has been based on the more focused district assessment as opposed to the previous Preliminary Proposal network performance assessment. In addition, the non-identified improvements (not recorded in Table 1-6) to the overflow performance at the downstream Doncaster and Ash districts were part of the overall selection process.

The percent capture performance measure is not included in Table 1-6, as it is applicable to the entire CS system and not for each district individually. However, the elimination of the district overflows represents 100 percent capture at this district.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and

updated for the CSO Master Plan are identified in Table 1-7. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-7. District Cost Estimate – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period)
Sewer Separation	N/A [a]	$8,790,000	$10,000	$110,000
In-Line Storage	$ [b]	N/A	N/A	N/A
Screening		N/A	N/A	N/A
Subtotal	**$0**	**$8,790,000**	**$10,000**	**$110,000**
Opportunities	N/A	$880,000	$1,000	$10,000
District Total	**$0**	**$9,670,000**	**$11,000**	**$120,000**

[a] Sewer separation not assessed in this district for the Preliminary Proposal

[b] Solution developed as refinement to Preliminary Proposal costs. Costs for these items of work found to be $1,200,000 in 2014 dollars

The estimates include changes to the control option selection since the Preliminary Proposal, and updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional cost for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014 dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019 dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019. Each of these values include equipment replacement and O&M costs.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-8.

Table 1-8. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Separation	Separation was not included in the Preliminary Proposal.	The Master Plan identified sewer separation as the control option.
Opportunities	A fixed allowance of 10 percent has been included for program opportunities.	Preliminary Proposal estimate did not include a cost for GI opportunities.	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years.	City of Winnipeg Asset Management approach.	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation.	Preliminary Proposal estimates were based on 2014-dollar values.	

1.10 Meeting Future Performance Targets

The proposed complete separation of the Tuxedo district will achieve the 100 percent capture figure and no further work will be required to meet the future performance target.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-9.

Table 1-9. Control Option 1 Significant Risks and Opportunities

ID Number	Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	-	-	-	O	-	-	-
2	Existing Lift Station	-	-	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	O	-	-	-
4	Construction Disruption	-	-	-	-	R	-	-	-
5	Implementation Schedule	-	-	-	-	R	-	R	-
6	Sewer Condition	-	-	-	-	-	-	-	-
7	Sewer Conflicts	-	-	-	-	R	-	-	-

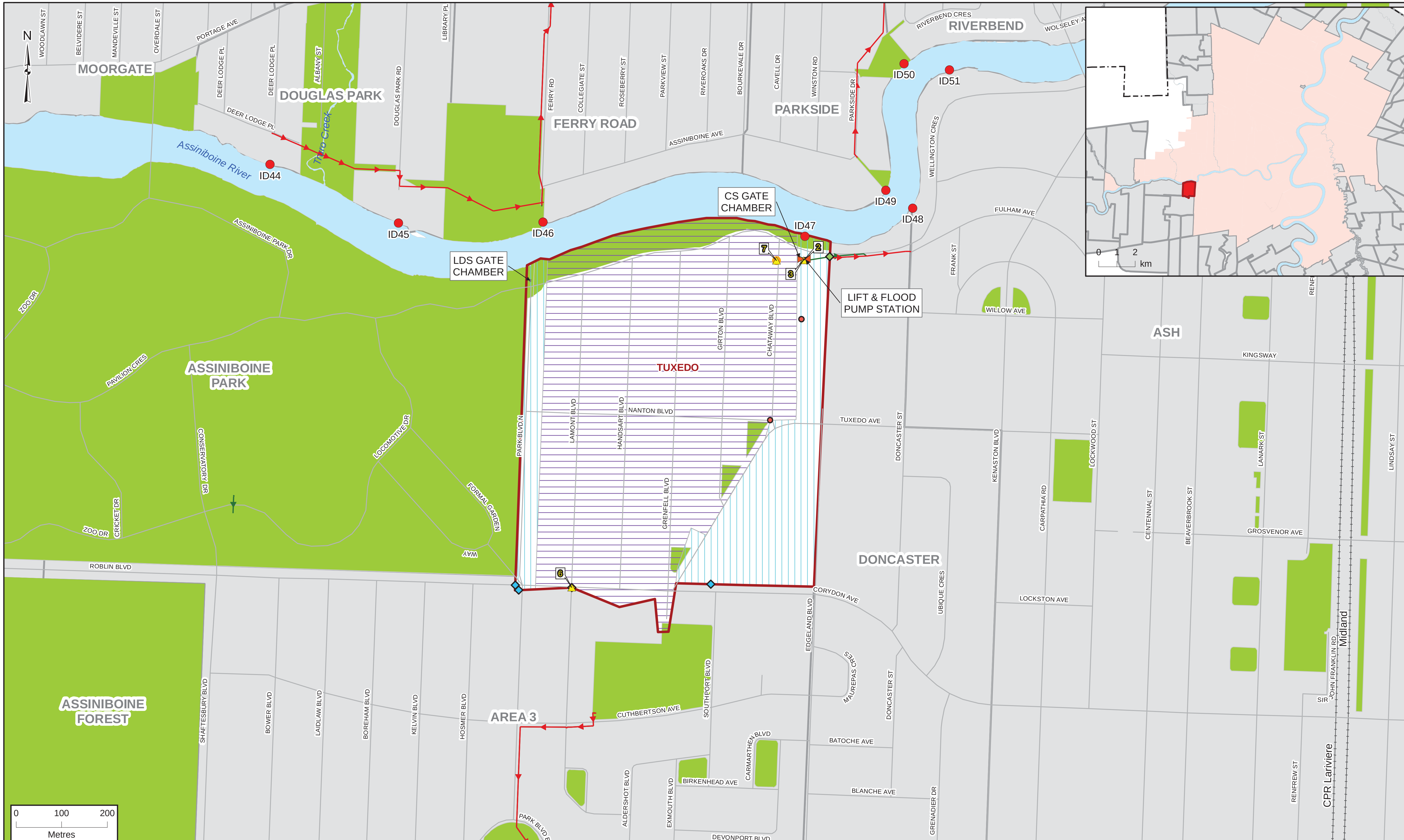
Table 1-9. Control Option 1 Significant Risks and Opportunities

ID Number	Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
8	Program Cost	-	-	-	-	R	-	-	-
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	-	-	-	-	O	O	O	-
12	Operations and Maintenance	-	-	-	-	R / O	R	O	-
13	Volume Capture Performance	-	-	-	-	-	O	O	-
14	Treatment	-	-	-	-	O	O	O	-

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

Reid, Crowther & Partners Limited (Reid Crowther). 1982. *Report on Separate Sewer Relief Project, Tuxedo Sanitary Sewer District*. Prepared for City of Winnipeg. September.



LEGEND

Primary Weir	Inter-System Connection	District Boundary Crossing	Interceptor Sewer	District Boundary
Critical Elevation	CS - WWS	CS	Force Main	Watercourse
CSO Outfall		LDS	Street	Greenspace
Low CS Manhole		WWS	Railway	

CSO MASTER PLAN PROPOSED SOLUTIONS

- Sewer Separation - Planning
- Sewer Separation - Complete

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 41
District Overview Map
Sewer District: Tuxedo
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Tylehurst District Plan

August 2019

City of Winnipeg

CSO Master Plan

Project No:	470010CH
Document Title:	Tylehurst District Plan
Revision:	03
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Document History and Status

Revision	Date	Description	By	Review	Approved
0	08/2018	DRAFT for City Comment	SG	ES	
1	02/15/2019	DRAFT 2 for City Review	SB	MF	MF
2	08/14/2019	Final Draft Submission	DT	MF	MF
3	08/19/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

Tables

Figure

1. Tylehurst District

1.1 District Description

Tylehurst district is located on the western side of the combined sewer (CS) area. It stretches from Bangor Avenue and Notre Dame Avenue in the north to the Assiniboine River in the south and is bounded by the Canadian Pacific Railway (CPR) Lariviere and Midland railway to the east and St. James Street to the west.

Tylehurst includes several rail lines that pass through the district, as follows:

- CPR Lariviere rail line
- Midland rail line
- Canadian National Railway (CNR) Oak Point

Land use in Tylehurst is primarily commercial and industrial with light manufacturing facilities located in the northern section of the district between Wellington Avenue and Notre Dame Avenue. Large commercial businesses are located throughout the district, the most significant being the Polo Park Shopping Mall Complex located just north of Portage Avenue. Tylehurst also includes a small area of residential homes and greenspace. Approximately 24 ha of the district is classified as greenspace. The residential area is found south of Portage Avenue and consists of mostly single- and two-family homes; the greenspace is Westview Park located on Wellington Avenue. Omand's Creek is a major waterway which flows through the district.

Tylehurst has a number of major transportation routes throughout the district. Empress Street and St. James Street are regional roadways that run north-south through the district. Portage Avenue, St. Matthews Avenue, Ellice Avenue, Sargent Avenue, Wellington Avenue and Dublin Avenue are regional roadways that run east-west through the district.

1.2 Development

The Tylehurst district is already considered dense industrial and commercial land use. However, significant developments that would impact the Combined Sewer Overflow (CSO) Master Plan are expected and are listed below.

Empress Street Overpass Reconstruction and Rehabilitation Project:

> This project includes the renewal of the following roads: Empress Street, Empress Street East, Eastway, Westway, and St. John Ambulance Way between Portage Avenue and St. Matthews Avenue. The project will improve the infrastructure of the area and impact the drainage. The construction began in August 2018 and will continue until completion in mid-summer 2020. This project will have impacts on the proposed separation work to Tylehurst and will be implemented in coordination with the CSO Master Plan.

Former Winnipeg Blue Bombers Canad Inns Stadium Site:

> The site in which the Canad Inns football stadium has been demolished, and development of this site into a shopping/entertainment/mixed-use centre is ongoing.

A portion of Portage Avenue is located within the Tylehurst District. Portage Avenue is identified as a Regional Mixed Use Corridor as part of the OurWinnipeg future development plans. As such, focused densification along Portage Avenue will be promoted in the future.

One area within the Tylehurst combined sewer district, the Polo Park Shopping Centre and surrounding areas, are identified as a Regional Mixed-Use Centre as part of OurWinnipeg. As such, focused intensification within this Mixed Used Centre is to be promoted in the future, with a particular focus on mixed use development blending housing with the commercial and light industrial uses already prevalent in the area.

1.3 Existing Sewer System

Tylehurst encompasses an area of 213 ha[1] based on the district boundary extending from Notre Dame Avenue to the Assiniboine River and includes a combined sewer (CS), wastewater sewers (WWS), and land drainage sewer (LDS). As shown in Figure 42, there is approximately 15.5 percent (33 ha) already separated along Omand's Creek. There are no separation ready areas.

The Tylehurst sewer system includes a lift station (CS LS), and a CS outfall gate chamber. The CS system drains towards the Tylehurst outfall, located at the southern end of Tylehurst Street and Wolseley Avenue at the Red River. Sewage flows collected in Tylehurst district converge to the main CS trunk sewer that flows southbound through the centre of the district. The main CS trunk begins as a 1350 mm diameter pipe and flows southbound starting at the upstream end at Bangor Avenue and crosses under Omand's Creek. The trunk increases in diameter as it flows south toward the CS outfall eventually up to 1950 mm diameter at Ellice Avenue as it flows further south along Milt Stegall Drive, Cactus Jacks Place, and directly beneath Polo Park Mall. A 750 mm sewer main flowing east on Portage Avenue and a 2150 mm sewer main flowing west on Portage Avenue interconnect with the main CS trunk at Portage Avenue and Tylehurst Street where they flow into a 2080 mm by 2690 mm egg-shaped trunk. Immediately prior to the Tylehurst CS outfall a 375 mm lateral connection representing the small Wolseley West residential area ties into the main CS trunk sewer.

During dry weather flow (DWF), CS is diverted by the primary weir within the main trunk sewer immediately upstream of the CS outfall. The weir diverts the intercepted flows by gravity through the 525 mm off-take pipe to the Tylehurst CS LS, where it is pumped to the Portage Interceptor pipe along Portage Avenue. The interceptor pipe carries flows to a siphon located under Omand's Creek, and eventually to the North End Sewage Treatment Plan (NEWPCC) for treatment.

During wet weather flow (WWF), flow that exceeds the diversion capacity overtops the weir and is discharged to the river via the CS outfall. A flap gate and a sluice gate are installed on the CS outfall to restrict back-up from the Assiniboine River into the CS system during high river levels. When the river level is high this flap gate structure prevents gravity discharge of excess flow through the outfall, the excess flow in this case will continue to surcharge within the main trunk sewer district. Temporary flood pumps are installed in Tylehurst based on the flood manual high river level triggers to deal with situations such as this. There is no flood pump station at this primary outfall.

LDS networks are found on the eastern portion of the district to relieve surface runoff from parking lots at commercial and industrial facilities. A 600 mm to 750 mm LDS network is located on Empress Street and discharges surface runoff directly to Omand's Creek. It services western Empress Street from Eastway to Jack Blick Place. Where these facilities front Empress Street the LDS network drain directly to Omand's Creek via local outfalls. Elsewhere in the district, these LDS pipes connect back into to the CS system for the district.

The single CS outfall to the Assiniboine River is as follows:

- ID52 (S-MA20020018) – Tylehurst CS Outfall

1.3.1 District-to-District Interconnections

There are several district-to-district interconnections between Tylehurst and the surrounding districts. Each interconnection is shown on Figure 42 and shows locations where gravity and pumped flow can cross from one district to another. Each interconnection is included in the following list:

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System and in Section 1.8 Performance Estimate may occur.

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

Clifton

- The 600 mm WWS Main interceptor passes through the siphon at the district boundary between Clifton and Tylehurst and on to the North End Sewage Treatment Plant (NEWPCC) for treatment:
  - Invert at manhole on Portage Avenue at Clifton district boundary – 228.11 m (S-MH20009684)

1.3.1.2 Interceptor Connections – Upstream of Primary Weir

Riverbend

- The 900 mm WWS Main interceptor sewer flows by gravity eastbound on Portage Avenue from Riverbend into Tylehurst district:
  - Invert at manhole on Portage Avenue at Tylehurst district boundary –229.94 m (S-MH20010407)

1.3.1.3 District Interconnections

Brooklands

<u>WWS to CS</u>

- A 450 mm WWS is pumped from Notre Dame CS LS in Brooklands southbound and connects to the Tylehurst CS system at the intersection of Notre Dame Avenue and St. James Street:
  - Invert at manhole on St. James Street at Tylehurst district boundary – 231.17 m (S-MH20010779)

<u>LDS to CS</u>

- A 450 mm LDS flows westbound by gravity along Notre Dame Avenue from Brooklands district into the Tylehurst CS system at the intersection of Notre Dame Avenue and St. James Street:
  - Invert at manhole on Notre Dame Avenue at Tylehurst district boundary –230.35 m (S-MH20010748)

Clifton

<u>CS to CS</u>

- A 200 mm CS flows eastbound by gravity along Sargent Avenue from Tylehurst district into the Clifton CS system at the intersection of Sargent Avenue and Sanford Street:
  - Invert at manhole on Sargent Avenue at Clifton district boundary – 228.92 m (S-MH20009103)

A district interconnection schematic is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, pumping systems, and discharge points for the existing system.

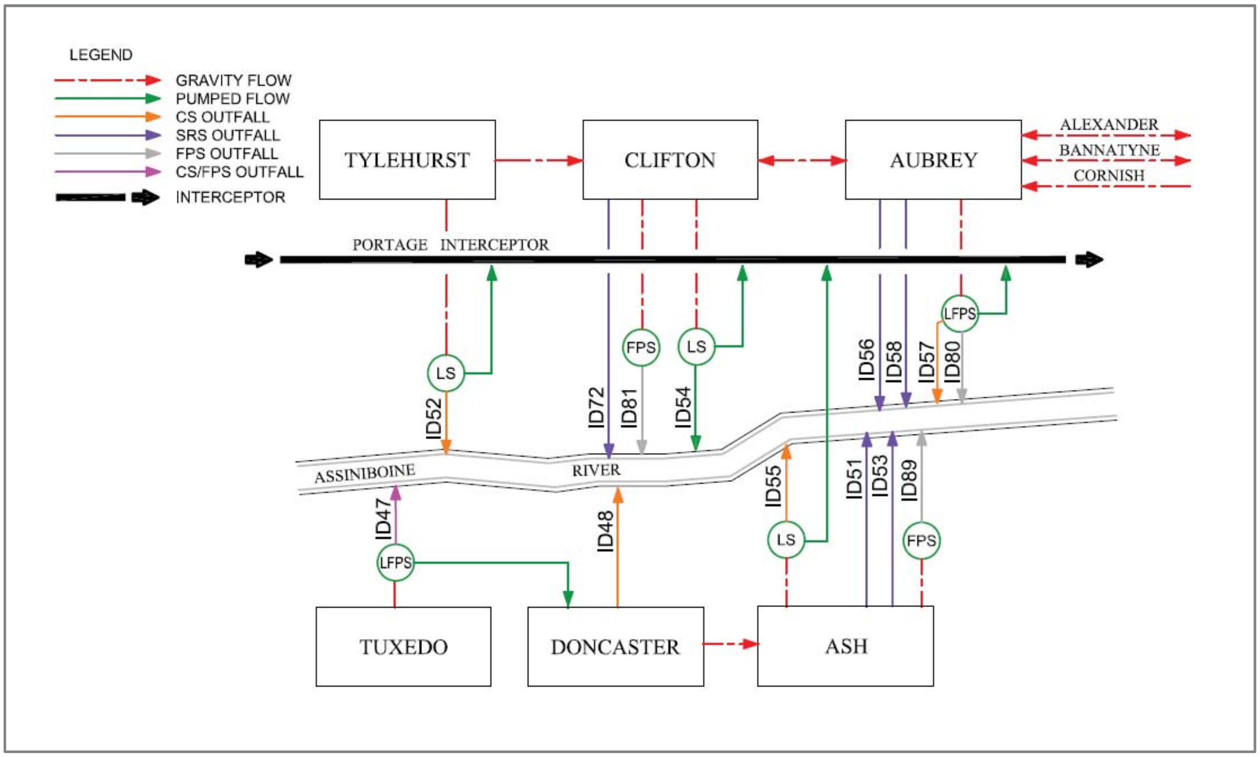


Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 42 and are listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID52)	S-RE70008619.1	S-MA20020018	2080 x 2690 2300 mm	Invert: 224.35 m
Flood Pumping Outfall (ID52)	S-RE70008619.1	S-MA20020018	2080 x 2690 2300 mm	Invert: 224.35 m
Other Overflows	N/A	N/A	N/A	
Main Trunk	S-TE20007540.1	S-MA20020018	2080 x 2690 mm	Egg-shaped Invert: 225.04 m
SRS Outfalls	N/A	N/A	N/A	No SRS within the district.
SRS Interconnections	N/A	N/A	N/A	No SRS within the district.
Main Trunk Flap Gate	S-CG00000920.1	S-CG00000920	2300 mm	Invert: 225.09 m
Main Trunk Sluice Gate	S-CG00000921.1	S-CG00000921	1600 x 1600 mm	Invert: 225.06 m
Off-Take	S-TE70008606.1	S-MA70018463	525 mm	Circular Invert: 225.04 m
Dry Well	N/A	N/A	N/A	
Lift Station Total Capacity	Tylehurst PS.1 Tylehurst PS.2 Tylehurst PS.3	N/A	0.424 m^3/s	1 x 0.158 m^3/s 1 x 0.131 m^3/s 1 x 0.135 m^3/s
Lift Station ADWF	N/A	N/A	0.081 m^3/s	

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Lift Station Force Main	S-RE70008604.1	S-MA70018459	375 mm	Invert: 229.5
Flood Pump Station Total Capacity	N/A	N/A	N/A	No FPS at the Tylehurst primary outfall.
Pass Forward Flow – First Overflow	N/A	N/A	0.183 m^3/s	

Notes:

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Tylehurst – 224.01
2	Trunk Invert at Off-Take	225.04 m
3	Top of Weir	225.23
4	Relief Outfall Invert at Flap Gate	N/A
5	Low Relief Interconnection (S-MH20009801)	229.86
6	Sewer District Interconnection (Clifton)	226.50
7	Low Basement	231.34
8	Flood Protection Level	230.30

[a] City of Winnipeg Data, 2013

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. The most recent study completed for Tylehurst was in 1993 with the *Sewer Relief for Tylehurst Combined Sewer District Conceptual Report* (UMA Engineering LTD, 1993). This study discussed the optimum relief strategy and upgrading the service levels concerning the Tylehurst CS district.

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Tylehurst Combined Sewer District was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations has a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Expected Completion
42 – Tylehurst	1993 - Conceptual	Future Work	2013	Study Complete	N/A

Source: *Sewer Relief for Tylehurst Combined Sewer District Conceptual Report*, 1993

1.5 Ongoing Investment Work

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Tylehurst district. This consists of monthly site visits in confined entry spaces to verify that physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Tylehurst district are listed in Table 1-4. The proposed CSO control projects will include sewer separation only. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage	Storage / Transport Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	-	-	-	-	-	-	-	✓	✓	✓	-

Notes:
- = not included
✓ = included

The Tylehurst district was identified during the Phase 2 work as high potential for future sewer separation based on the City's provided information. The district is not part of the currently planned Basement Flooding Relief (BFR) program but was taken forward for complete separation in the Control Option No.1 proposals. The cost-effectiveness of complete separation of the Tylehurst district in particular should be re-evaluated as part preliminary design of solutions in this district. The complete separation solution life cycle costs should be compared to alternative solutions, such as In-Line Storage via control gate construction.

GI and RTC will be applied within each district on a system-wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design.

1.6.2 Sewer Separation

Complete sewer separation is proposed for the Tylehurst district. This sewer separation will result in a reduction of the runoff and will reduce the pass forward flow to the interceptor and contribution of flow to NEWPCC. Sewer separation in Tylehurst would provide immediate benefits to the CSO program when complete. It would remove all CSO occurrences from the district as it will now be considered a separate district. The work would include the installation of an independent LDS system to separate the surface runoff from the CS system. Collected stormwater would be routed to a separate LDS outfall discharging to either Omand's Creek or Assiniboine River. It is envisaged that the separation would follow the existing separation arrangement where local streets are diverted to the adjacent Omand's Creek at multiple locations rather than a single large collection pipe and outfall location.

The flows to be collected after Tylehurst separation will be as follows:

- Dry weather flows will remain the same for Tylehurst district.
- Tylehurst wet weather flow (WWF) will consist of sanitary sewage combined with foundation drainage.

Potential drawbacks of sewer separation include the high construction cost and the wide-spread disruption to the neighbouring residential homes.

It is proposed that future monitoring of the district is completed to verify that the sewer separation is fully compliant with the modelled simulated elimination of all CSO overflows. A static weir elevation increase may be necessary at the CS diversion to eliminate the occurrence of all CSOs. Any weir elevation raise will also be evaluated in terms of existing basement flood protection to ensure the existing level of basement flood protection remains.

1.6.3 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district will be reviewed to identify applicable GI controls.

Tylehurst has been classified as a medium GI potential district. Land use in Tylehurst is mainly residential and commercial, the south end of the district is bounded by the Assiniboine River. This district would be an ideal location for cisterns/rain barrels, and rain garden bioretention. There are a few commercial areas which may be suitable to green roofs and parking lot areas which would be ideal for paved porous pavement.

1.6.4 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

Sewer separation will include the installation of additional sewers that will require inspection, cleaning and rehabilitation. This will result in additional maintenance costs over the long term, but operational costs will be minimal. The existing larger CS pipes within the district may also receive insufficient flow with the separation work for proper scouring velocities in the sewer pipes. This could result in solids settling within the sewers, and requiring more frequent cleaning operations. The impacts of the reduced flows in larger CS pipes will be evaluated as part of the sewer separation design for the district.

It is recommended to continue to maintain and operate the flow monitoring instrumentation and assess the results after district separation work has been completed. This will allow the full understanding of the non-separated storm elements (foundation drain connections to the CS system) extent within the Tylehurst district.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. Two versions of the sewer system model were created and used to measure system performance. The 2013 Baseline model represents the sewer system baseline in the year 2013 and the 2037 Master Plan – Control Option 1 model, which includes the proposed control options in the year 2037. A summary of relevant model data is provided in Table 1-5.

Table 1-5. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Included in Model
2013 Baseline	461	461	4,149	56	N/A
2037 Master Plan – Control Option 1	461	461	4,149	0	SEP

Notes:

SEP – Sewer Separation

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district. While this district is to be separated and as a result Clause 8 of Licence No. 3042 will not be in effect, the wet weather response of the district overall will still need to be assessed.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City Of Winnipeg GIS Records. Therefore minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-6 are for the hydraulic model simulations using the year-round 1992 representative year. This table lists the results for the Baseline, for each individual control option and for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options. Table 1-6 also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-6. District Performance Summary – Control Option 1

	Preliminary Proposal	Master Plan			
Control Option	Annual Overflow Volume (m^3)	Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow (L/s) [a]
Baseline (2013)	182,607	206,812	-	18	0.183 m^3/s
Separation	0	0	206,812	0	TBD
Control Option 1	**0**	**0**	**206,812**	**0**	**TBD**

[a] Pass forward flows assessed up to 5-year design rainfall event. Possible overflow for larger design events to be confirmed.

The percent capture performance measure is not included in Table 1-6, as it is applicable to the entire CS system and not for each district individually. However, the proposed elimination of CSO overflow results in 100 percent capture at this district.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and

updated for the CSO Master Plan are identified in Table 1-7. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-7. District Cost Estimate – Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance (Over 35-year period)
Separation	N/A [a]	$86,670,000	$52,000	$1,110,000
Subtotal	**$-**	**$86,670,000**	**$52,000**	**$1,110,000**
Opportunities	N/A	$8,670,000	$5,000	$110,000
District Total	**N/A [a]**	**$95,340,000**	**$57,000**	**$1,220,000**

[a] Solution development as refinement to Preliminary Proposal costs, Revised cost for the sewer separation work found to be $48,100,000 in 2014 dollars.

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculation of the cost estimate for the CSO Master Plan includes the following:

- Capital costs reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional cost for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014 dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019 dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-8.

Table 1-8. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Sewer Separation	Separation was not included in the initial Preliminary Proposal costs.	Costs updated to match the Control Option proposals.
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	

Table 1-8. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years.	City of Winnipeg Asset Management approach.	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation	Preliminary estimates were based on 2014-dollar values	

1.10 Meeting Future Performance Targets

The proposed complete separation of the Tylehurst district will achieve the 100 percent capture figure and no further work will be required to meet the future performance target. It is recommended to complete post separation modelling to confirm the target is fully achieved.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been development and is included as Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-9.

Table 1-9. Control Option 1 Significant Risks and Opportunities

ID Number	Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	-	-	-	O	-	-	-
2	Existing Lift Station	-	-	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	O	-	-	-
4	Construction Disruption	-	-	-	-	R	-	-	-
5	Implementation Schedule	-	-	-	-	R	-	R	-
6	Sewer Condition	-	-	-	-	-	-	-	-
7	Sewer Conflicts	-	-	-	-	R	-	-	-
8	Program Cost	-	-	-	-	R	-	-	-
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-

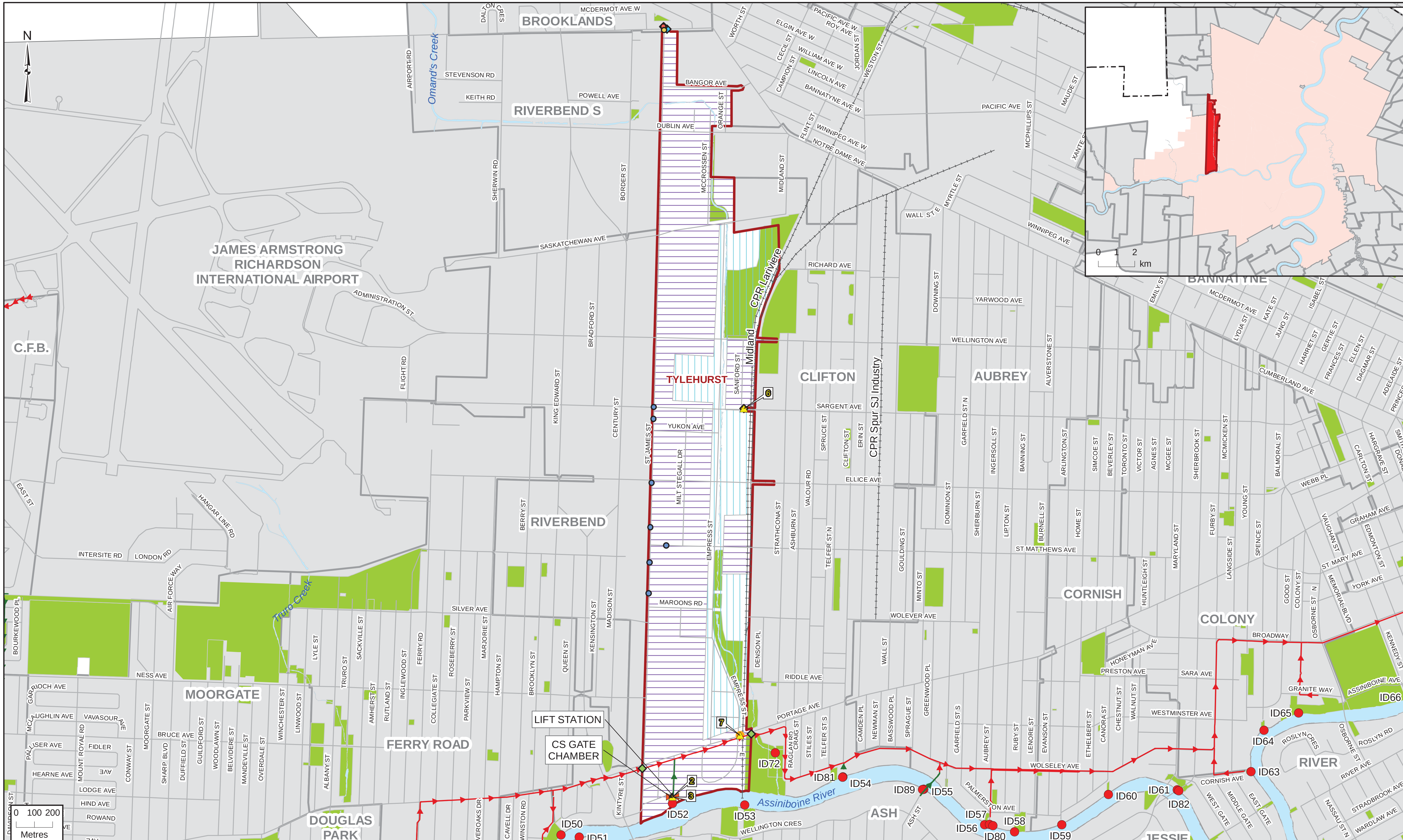
Table 1-9. Control Option 1 Significant Risks and Opportunities

ID Number	Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
11	Technology Assumptions	-	-	-	-	O	O	O	-
12	Operations and Maintenance	-	-	-	-	R / O	R	O	-
13	Volume Capture Performance	-	-	-	-	-	O	O	-
14	Treatment	-	-	-	-	O	O	O	-

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

UMA Engineering Ltd. 1993. *Sewer Relief for Tylehurst Combined Sewer District Conceptual Report*. Prepared for the City of Winnipeg Water and Waste Department. July.



LEGEND

Primary Weir	Inter-System Connection	District Boundary Crossing	Interceptor Sewer	District Boundary
Critical Elevation	CS - LDS	CS	Force Main	Watercourse
CSO Outfall	CS - WWS	LDS	Street	Greenspace
Low CS Manhole	SRS - CS	WWS	Railway	

CSO MASTER PLAN PROPOSED SOLUTIONS

Sewer Separation - Planning

Sewer Separation - Complete

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 42
District Overview Map
Sewer District: Tylehurst
City of Winnipeg
Combined Sewer Overflow Master Plan

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CSO Master Plan

Woodhaven District Plan

August 2019

City of Winnipeg

CSO Master Plan

Project No:	470010CH
Document Title:	Woodhaven District Plan
Revision:	03
Date:	August 15, 2019
Client Name:	City of Winnipeg
Project Manager:	John Berry
Author:	Jack Tinker
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Document History and Status

Revision	Date	Description	By	Review	Approved
0	08/2018	DRAFT for City Comment	SG	ES	
1	02/15/2019	DRAFT 2 for City Review	JT	ES / MF/SG	MF
2	06/2019	Final Draft Submission	JT	MF	MF
3	08/15/2019	Final Submission For CSO Master Plan	MF	MF	SG

Contents

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Figure

1. Woodhaven District

1.1 District Description

Woodhaven is a small district located on the western perimeter of the combined sewer area. It is bounded by Ainslie district and Sturgeon Creek to the north and east, Westwood and Parkdale districts to the west, and the Assiniboine River to the south. Portage Avenue runs along the northern border of this district and is the only significant transportation route that connects with Woodhaven.

This district consists mostly of single family residential, with no industrial or commercial land use. This was one of the first districts to be developed in the history of Winnipeg's west end. Woodhaven also includes approximately 20 ha of greenspace which consists of the Woodhaven Park Community Club and a portion of the St. Charles Country Club on the eastern and western borders, respectively.

1.2 Development Potential

A portion of Portage Avenue is located within the Woodhaven District. Portage Avenue is identified as Regional Mixed-Use Corridor as part of the OurWinnipeg future development plans. As such, focused intensification along Portage Avenue is to be promoted in the future.

1.3 Existing Sewer System

The Woodhaven district has a drainage area of an approximate size of 55 ha[1] based on the district boundary. There is approximately 4 percent (2 ha) considered separated and no separation-ready areas.

The district is predominantly serviced by a CS system with a runoff collection ditch system surrounding the majority of homes, which collects the majority of rainfall runoff from the street right-of-way in the district. The surrounding districts all have separate sewer systems, isolating Woodhaven from the other CS districts. This district has only one CS outfall that goes to the Assiniboine River and no storm relief sewer system. The outfall is serviced by a 1200 mm by 900 mm egg-shaped sewer trunk that receives sewage from three connecting pipes at the intersection of Assiniboine Avenue and Woodhaven Boulevard. The district does not have a flood pump station (FPS).

During dry weather flow (DWF) the Woodhaven primary weir diverts flow at the 300 mm off-take pipe to the CS lift station (LS). Two pumps transport the combined sewage via a short stretch of 150 mm force main to the St James Interceptor sewer that runs through the district along Assiniboine Avenue and eventually transports it to the West End Sewer Treatment Plant (WEWPCC) for treatment.

During wet weather flow (WWF) events, any flow that exceeds the diversion capacity of the primary weir overtops the weir and is discharged to the river via a 900 x 1200 mm primary outfall. The Woodhaven outfall does not have a flap or sluice gate present. A review of the outfall specifically for the CSO Master Plan evaluation found that the normal summer water level (NSWL) is low relative to the invert of the CS outfall.

The single CS outfall to the Assiniboine River is as follows:

- ID40 (S-MA70019662) – Woodhaven CS Outfall

[1] City of Winnipeg GIS information relied upon for area statistics. The GIS records may vary slightly from the city representation in the InfoWorks sewer model. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

1.3.1 District-to-District Interconnections

There are three district-to-district interconnections between Woodhaven and the surrounding districts. Each interconnection is shown on Figure 43 and shows gravity and pumped flow from one district to another. The known district-to-district interconnections are as follows:

1.3.1.1 Interceptor Connections – Downstream of Primary Weir

Westwood

- The 1350 mm St. James Interceptor sewer flows by gravity into Westwood District and eventually to the WEWPCC for treatment:
  - St. James interceptor invert at Westwood/Woodhaven district boundary - 231.03 m (S-MH20002594)

1.3.1.2 Interceptor Connections – Upstream of Primary Weir

Ainslie

- The St. James interceptor system splits into two 450 mm steel river crossing pipes under Sturgeon Creek, and flow into a single 900 mm pipe in the Woodhaven district at Assiniboine Avenue and Woodbridge Road:
  - St. James interceptor invert at Ainslie/Woodhaven district boundary - 231.93 m (S-MH20004628)

A process and flow control drawing is included as Figure 1-1. The drawing illustrates the collection areas, interconnections, flow controls, pumping systems, and discharge points for the existing system.

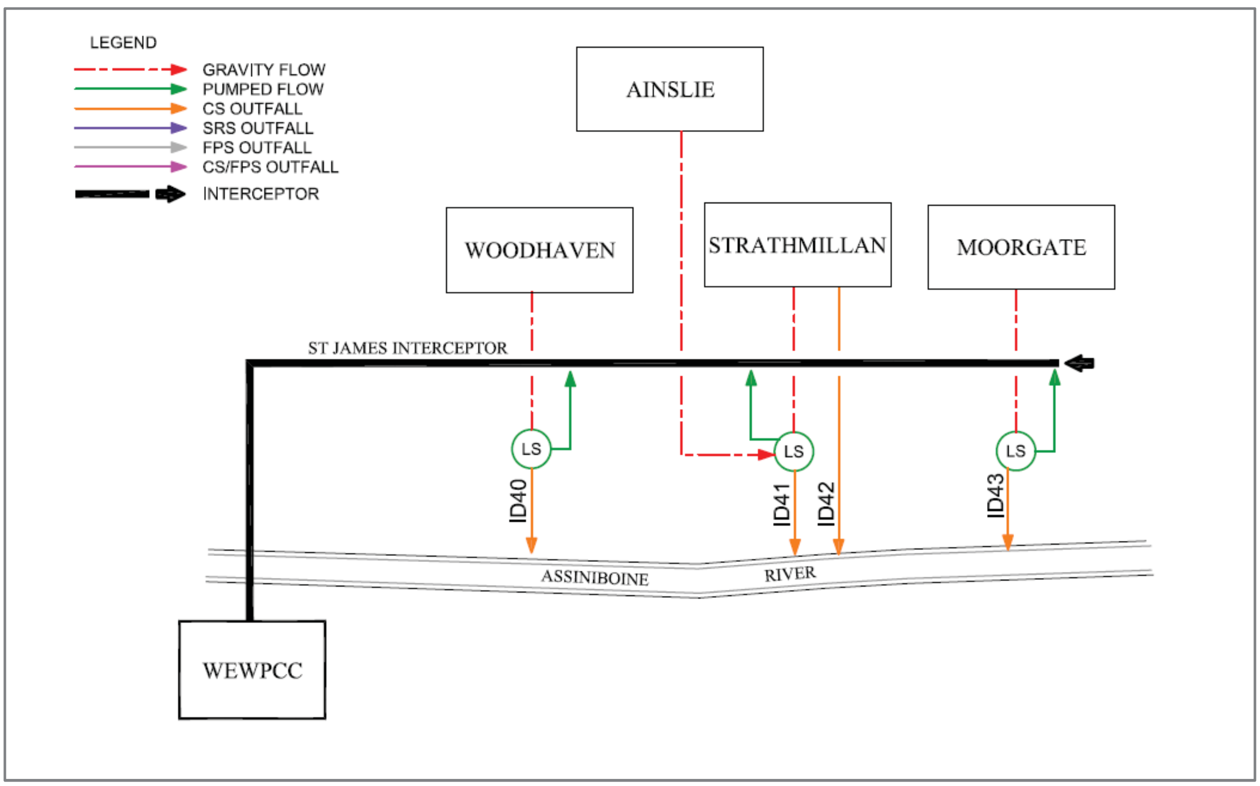

Figure 1-1. District Interconnection Schematic

1.3.2 Asset Information

The main sewer system features for the district are shown on Figure 43 and are listed in Table 1-1.

Table 1-1. Sewer District Existing Asset Information

Asset	Asset ID (Model)	Asset ID (GIS)	Characteristics	Comments
Combined Sewer Outfall (ID40)	S-MH70021569.1	S-MA70019662	900 x 1200 mm	Egg-shaped Invert: 229.59 m
Flood Pumping Outfall	N/A	N/A	N/A	No flood pumping station in this district.
Other Overflows	N/A	N/A	N/A	
Main Sewer Trunk	S-TE20000744.2	S-MA70019661	900 x 1200 mm	Egg-shaped Invert: 229.82 m
Storm Relief Sewer Outfalls	N/A	N/A	N/A	No SRS within district.
Storm Relief Sewer Interconnections	N/A	N/A	N/A	No SRS within district.
Main Trunk Flap Gate	N/A	N/A	N/A	No flap gate constructed on primary outfall.
Main Trunk Sluice Gate	N/A	N/A	N/A	No sluice gate constructed on primary outfall.
Off-Take	S-TE20000744.1	S-MA70019650	300 mm	Invert 229.85 m
Wet Well	Woodhaven PS	S-PS00000294	3.5 m^2 chamber area	
Lift Station Total Capacity	N/A	N/A	0.054 m^3/s	2 x 0.027 m^3/s pumps
Lift Station ADWF	N/A	N/A	0.004 m^3/s	
Lift Station Force Main	WoodhavenPS_RM.1	S-MA20005021	150 mm	Connects to St. James Interceptor Invert: 230.48 m
Flood Pump Station Total Capacity	N/A	N/A	N/A	No flood pumping station in this district.
Pass Forward Flow – First Overflow	N/A	N/A	0.054 m^3/s	

Notes:

ADWF = average dry-weather flow
GIS = geographic information system
ID = identification
N/A = not applicable

The critical system elevations for the existing system relevant to the development of the CSO control options are listed in Table 1-2. Critical elevation reference points are identified on the district overview and detailed maps.

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
1	Normal Summer River Level	Woodhaven – 226.92
2	Trunk Invert at Off-Take	229.85
3	Top of Weir	230.28
4	Relief Outfall Invert at Flap Gate [b,c]	N/A
5	Low Relief Interconnection [b]	N/A
6	Sewer District Interconnection (Interceptor at Ainslie district)	Invert at district boundary: 43-01 = 228.90

Table 1-2. Critical Elevations

Reference Point	Item	Elevation (m)[a]
7	Low Basement	231.98
8	Flood Protection Level	231.43

[a] City of Winnipeg Data, 2013

[b] There is no SRS system in Woodhaven. The Woodhaven CS outfall does not have a positive gate or flap gate.

[c] The normal summer water level (NSWL) is low relative to the CS outfall, so a flap gate is not required to prevent back-up of water from the river.

1.4 Previous Investment Work

Table 1-3 provides a summary of the district status in terms of data capture and study. No work has been completed on the district sewer system since the 1986 Basement Flood Relief Study (Girling,1986).

Between 2009 and 2015, the City invested $12 million in the CSO Outfall Monitoring Program. The program was initiated to permanently install instruments in the primary CSO outfalls. The outfall from the Woodhaven Combined Sewer District was included as part of this program. Instruments installed at each of the 39 primary CSO outfall locations has a combination of inflow and overflow level meters and flap gate inclinometers if available.

Table 1-3. District Status

District	Most Recent Study	Flow Monitoring	Hydraulic Model	Status	Expected Completion
43 - Woodhaven	1986	Future Work	2013	Study Complete	N/A

Source: Report on Basement Flooding Relief Program, 1986

1.5 Ongoing Investment Work

There is ongoing maintenance and calibration of permanent instruments installed within the primary outfall within the Woodhaven district. This consists of monthly site visits in confined entry spaces to verify that physical readings concur with displayed transmitted readings and replacing desiccants where necessary.

1.6 Control Option 1 Projects

1.6.1 Project Selection

The proposed projects selected to meet Control Option 1 – 85 Percent Capture in a Representative Year for the Woodhaven sewer district are listed in Table 1-4. The proposed CSO control projects will include in-line storage via a control gate and floatables management via screening. Program opportunities including green infrastructure (GI) and real time control (RTC) will also be included as applicable.

Table 1-4. District Control Option

Control Limit	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	In-line Storage	Off-line Storage	Storage / Transport Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
85 Percent Capture in a Representative Year	-	-	-	✓	✓	-	-	-	✓	✓	✓

Notes:

- = not included
✓ = included

The Woodhaven district plan includes implementing floatable control and in-line storage to meet the CSO Control Option 1 performance target.

Floatable management will be necessary to capture floatables in the sewage. The primary CS overflow for the district is to be screened under the current CSO control plan to address the floatables management requirements. The installation of a control gate at the primary CS outfall will be required for the screen operation in the Woodhaven district. This control gate installation will also provide the mechanism for capture of minor additional in-line storage. It should be noted however that in-line storage for the Woodhaven district is not a cost-effective solution, specifically for additional volume capture. The control gate installation is recommended primarily to provide the necessary hydraulic head for screen operations. Should the screening no longer be required in the Woodhaven district, it is recommended that alternative measures to in-line storage such as off-line storage be investigated in the Woodhaven district to provide the additional volume capture required to meet the 85 percent capture target in a more cost effective manner.

GI and RTC will be applied within each district on a system wide basis with consideration of the entire CS area. The level of implementation for each district will be determined through evaluations completed through district level preliminary design. RTC is not included in detail within each plan and is described further in Section 3 of Part 3A.

1.6.2 In-Line Storage

In-line storage has been proposed as a CSO control for Woodhaven district. The in-line storage will require the installation of a control gate at the CS outfall. The control gate will primarily be used to maximize the available hydraulic head in the district CS system, such that screening can be effectively operated. The gate will also provide a secondary benefit in a minor increase in the storage level in the existing CS to provide an slight increase to the volume capture. The lack of a flap gate at the Woodhaven outfall was also evaluated and found to not impact the in-line storage arrangement recommended in any way.

A standard design was assumed for the control gate, as described in Part 3C. A standard approach was used for conceptual gate sizing by assuming it to be the lesser of the height of half of the site-specific trunk diameter or the maximum height of the gate available. The design criteria for in-line storage are listed in Table 1-5.

Table 1-5. In-Line Storage Conceptual Design Criteria

Item	Elevation/Dimension	Comment
Invert Elevation	229.82 m	
Trunk Diameter	900 x 1200 mm	
Gate Height	0.24 m	Gate height based on half trunk diameter assumption
Top of Gate Elevation	230.52 m	
Maximum Storage Volume	19 m^3	Option has small storage volume as by-product of screening installation requirement
Nominal Dewatering Rate	0.05 m^3/s	Based on capacity of existing CS LS
RTC Operational Rate	To Be Determined	Future RTC/dewatering review on assessment

Notes:

NSWL – normal summer water level
RTC = Real Time Control

The proposed control gate will cause combined sewage to back-up in the collection system to the extent shown on Figure 43. The extent of the in-line storage and volume is related to the top elevation of the bypass side weir. The level of the top of the bypass side and adjacent control gate level are determined in relation to the critical performance level in the system for basement flooding protection: when the system level increases above the bypass weir crest and proceeds above the top of the control gate during high flow events, the gate drops out of the way. At this point, the district will only provide its original interception capacity via the primary weir for the district, and all excess CS would flow over the weir and discharge to the river. After the sewer levels in the system drops back below the bypass side weir critical performance level, the control gate moves back to its original position to capture the receding limb of the WWF event. The CS LS will continue with its current operation while the control gate is in either position, with all DWF being diverted to the CS LS and pumped. The CS LS will further dewater the in-line storage provided during a WWF event as downstream capacity becomes available.

Figure 43-01 provides an overview of the ideal conceptual location and configuration of the control gate, bypass weir, and screening chambers. The proposed control gate will be installed in a new chamber within the existing trunk sewer alignment upstream of the existing CS LS. The dimensions of the chamber will be 5 m in length and 2 m in width to accommodate the gate, with an allowance for a longitudinal overflow weir. Due to the physical location of the existing infrastructure within the boulevard of Assiniboine Avenue, this does not fully allow the control gate and screening chambers to be located adjacent to the existing off-take (located within residential driveway) and CS LS. Therefore, to accommodate the two chambers, the conceptual location is upstream on the existing sewer on Woodhaven Boulevard. This would require the diversion of the two existing sewers (from east and west along Assiniboine Avenue) to upstream of the proposed control gate chamber, to ensure they are still intercepted. This would increase the construction activities in this area, the work required for the control gate construction is located within a residential street with minor disruptions expected. Further optimization of the gate chamber size may be provided if the decision is made not to include screening.

The physical requirements for the off-take and station sizing for a modification to pumping capacity have not been considered in detail, but they will be required in the future as part of an RTC program or CS LS rehabilitation or replacement project.

The nominal rate for dewatering is set at the existing LS capacity. This allows dewatering through the existing interceptor system within 24 hours following the runoff event, allowing it to recover in time for a subsequent event. Any future considerations, for RTC improvements, would be completed with spatial rainfall as any reduction to the existing pipe capacity/operation for large events will adversely affect the overflows at this district. Similar basis for the rate matching the LS philosophy of two times nominal dewatering rate could be adopted. This future RTC control will provide the ability to capture and treat more volume for localized storms by using the excess interceptor capacity where the runoff is less.

1.6.3 Floatables Management

Floatables management will require installation of a screening system to capture floatable materials. The off-line screens will be proposed to maintain the current level of basement flooding protection.

The type and size of screens depend on the specific station configuration and the head available for operation. A standard design was assumed for screening and is described in Part 3C. The design criteria for screening, with an in-line control gate implemented, are listed in Table 1-6.

Table 1-6. Floatables Management Conceptual Design Criteria

Item	Elevation/Dimension/Rate	Comment
Top of Gate	230.52 m	
Bypass Weir Crest	230.42 m	
Normal Summer River Level	226.92 m	
Maximum Screen Head	0.52 m	
Peak Screening Rate	0.3 m^3/s	
Screen Size	1.5 m x 1 m	Modelled Screen Size

The proposed side bypass overflow weir and screening chamber will be located adjacent to the proposed control gate and existing CS trunk, as shown on Figure 43-01. The screens will operate when the sewer levels surpass the bypass weir elevation. A side bypass weir upstream of the gate will direct initial overflow to the screens located in the new screening chamber, with screened flow discharged to the downstream side of the gate to the river. The screening chamber may include screenings pumps with a discharge returning the screened material to the CS LS for routing to the WEWPCC for removal. The provision of screening pumps is dependent on final level assessment within the existing infrastructure and the Woodhaven trunk. This will be confirmed during future assessment stage.

The dimensions for the screen chamber to accommodate influent from the side weir, the screen area, and the routing of the discharge piping downstream of the gate are 2.5 m in length and 3 m in width. The existing sewer configuration including the off-take, and the CS LS force main will have to be modified to accommodate the new chambers as the control gate will also be located in this location.

If an alternative floatables management approach is pursued in this district, both the control / screening chambers would not be required. This control gate chamber will only provide minor additional volume capture for the district, and has been primarily recommended to provide the necessary hydraulic head for screening operation.

1.6.4 Green Infrastructure

The approach to GI is described in Section 5.2.1 of Part 2 of the CSO Master Plan. Opportunities for the application of GI will be evaluated and applied with any projects completed in the district. Opportunistic GI will be evaluated for the entire district during any preliminary design completed. The land use, topography and soil classification for the district was reviewed to identify the most applicable GI controls.

Woodhaven has been classified as a high GI potential district, the land use mainly consists of single family residential land use, meaning it would be an ideal location for permeable paved roadways, cisterns/rain barrels, and rain gardens. Woodhaven already has a ditch and culvert land drainage system in place that could potentially be further used for bioswale projects further increasing the GI potential.

1.6.5 Real Time Control

The approach to RTC is described in Section 5.2.2 of Part 2 of the CSO Master Plan. The application of RTC will be evaluated and applied on a district by district basis through the CSO Master Plan projects with long term consideration for implementation on a system wide basis.

1.7 System Operations and Maintenance

System operations and maintenance (O&M) changes will be required to address the proposed control options. This section identifies general O&M requirements for each control option proposed for the district. More specific details on the assumptions used for quantifying the O&M requirements are described in Part 3C of the CSO Master Plan.

In-line storage will impact the existing sewer system and will require the addition of a new chamber and a moving gate at the outfall. In-line storage dewatering will be controlled with the existing Woodhaven CS LS, which may require more frequent and longer duration pump run times. Lower velocities will occur in the CS trunk in the vicinity of the control gate due to lower pass forward flows, and may create additional debris deposition requiring cleaning. Additional system monitoring, and level controls will be installed, which will require regular scheduled maintenance.

Floatable control with outfall screening will require the addition of another chamber with screening equipment installed. The chamber will be installed adjacent to the control gate chamber and will operate in conjunction with it. Screening operation will occur during WWF events that surpass the in-line storage control level. WWF will be directed from the main CS trunk, over the side weir in the control gate chamber and through the screens to discharge into the river. The screens will operate intermittently during wet weather events and will likely require operations review and maintenance after each event. The frequency of a screened event will correlate to the number overflows identified for the district. Having the screenings pumped back to the interceptor system via a small LS and force main will be required. The screenings return will require O&M inspection after each event to assess the performance of the return pump system.

1.8 Performance Estimate

An InfoWorks CS hydraulic model was created as part of the CSO Master Plan development. Two versions of the sewer system model were created and used to measure system performance. The 2013 Baseline model represents the sewer system baseline in the year 2013 and the 2037 Master Plan – Control Option 1 model, which includes the proposed control options in the year 2037. A summary of relevant model data is provided in Table 1-7.

Table 1-7. InfoWorks CS District Model Data

Model Version	Total Area (ha)	Contributing Area (ha)	Population	% Impervious	Control Options Added To Model
2013 Baseline	43	43	984	37	N/A
2037 Master Plan – Control Option 1	43	43	984	37	IS, SC

Notes:

IS = In-line Storage
SC = Screening

No change to the future population was completed as from a wastewater generation perspective from the update to the 2013 Baseline Model to the 2037 Master Plan Model. The population generating all future wastewater will be the same due to Clause 8 of Environment Act Licence 3042 being in effect for the CS district.

City of Winnipeg hydraulic model relied upon for area statistics. The hydraulic model representation may vary slightly from the City of Winnipeg GIS Records. Therefore, minor discrepancies in the area values reported in Section 1.3 Existing Sewer System, and in Section 1.8 Performance Estimate may occur.

The performance results listed in Table 1-8 are for the hydraulic model simulations using the year-round 1992 representative year. The table lists the results for the Baseline, for each individual control option and

for the proposed CSO Master Plan - Control Option 1. The Baseline and Control Option 1 performance numbers represent the comparison between the existing system and the proposed control options, the table also includes overflow volumes specific to each individual control option; these are listed to provide an indication of benefit gained only and are independent volume reductions.

Table 1-8. Performance Summary – Control Option 1

Control Option	Preliminary Proposal Annual Overflow Volume (m^3)	Master Plan Annual Overflow Volume (m^3)	Overflow Reduction (m^3)	Number of Overflows	Pass Forward Flow at First Overflow [a]
Baseline (2013)	12,321	12,117	-	18	0.052 m^3/s
In-line Storage	12,874	11,900	217	17	0.054 m^3/s
Control Option 1	**12,874**	**11,900**	**217**	**17**	**0.054 m^3/s**

[a] Pass forward flows assessed on the 1-year design rainfall event

The percent capture performance measure is not included in Table 1-8, as it is applicable to the entire CS system and not for each district individually.

The Woodhaven district has an extensive ditch drainage system, that although not specifically modelled for the CSO Master Plan performance assessment, would be an ideal area for improvement to the hydraulic model when assessing the impact of green infrastructure with a selected district. This would require additional survey, monitoring and modelling to ensure that the parameters are closely matched for conditions prior to and following GI infrastructure construction.

1.9 Cost Estimates

Cost estimates were prepared during the development of the Preliminary Proposal and have been updated for the CSO Master Plan. The CSO Master Plan cost estimates have been prepared for each control option, with overall program costs summarized and described in Section 3.4 of Part 3A. The cost estimate for each control option relevant to the district as determined in the Preliminary Proposal and updated for the CSO Master Plan are identified in Table 1-9. The cost estimates are a Class 5 planning level estimates with a level of accuracy of minus 50 percent to plus 100 percent.

Table 1-9. Cost Estimates - Control Option 1

Control Option	2014 Preliminary Proposal Capital Cost	2019 CSO Master Plan Capital Cost	2019 Annual Operations and Maintenance Cost	2019 Total Operations and Maintenance Cost (Over 35-year period)
In-line Control Gate	N/A [a]	$2,190,000 [b]	$39,000	$840,000
Screening		$1,840,000 [b c]	$48,000	$1,040,000
Subtotal	**$0**	**$4,030,000**	**$87,000**	**$1,880,000**
Opportunities	N/A	$400,000	$9,000	$190,000
District Total	**$0**	**$4,430,000**	**$96,000**	**$2,070,000**

[a] In-Line and Screening not assessed in this district for the Preliminary Proposal. Solution developed as refinement to Preliminary Proposal work following submission of Preliminary Proposal costs. Costs for these items of work found to be $1,290,000 in 2014 dollars

[b] Cost associated with the new off-take construction, and re-routing of existing sewers to accommodate control gate and screening chamber location s proposed was not included in Master Plan cost assessments for control gate or screening chamber work.

[c] Cost for bespoke screenings return/force main not included in Master Plan as will depend on selection of screen and type of screening return system selected.

The estimates include changes to the control option selection since the Preliminary Proposal, updated construction costs, and the addition of GI opportunities. The calculations for the CSO Master Plan cost estimate includes the following:

- Capital costs and O&M costs are reported in terms of present value.
- A fixed allowance of 10 percent has been included for GI, with no additional costs for RTC. This has been listed as part of the Opportunities costs.
- The Preliminary Proposal capital cost is in 2014-dollar values.
- The CSO Master Plan capital cost is based on the control options presented in this plan and in 2019-dollar values.
- The 2019 Total Annual Operations and Maintenance (over 35-year period) cost component is the present value costs of each annual O&M cost under the assumption that each control option was initiated in 2019.
- The 2019 Annual Operations and Maintenance Costs were based on the estimated additional O&M costs annually for each control option in 2019 dollars.
- Future costs will be inflated to the year of construction.

Cost estimates were prepared during the development of the Preliminary Proposal and updated for Phase 3 during the CSO Master plan development. The differences identified between the Preliminary Proposal and the CSO Master Plan are accounting for the progression from an initial estimate used to compare a series of control options, to an estimate focusing on a specific level of control for each district. Any significant differences between the Preliminary Proposal and CSO Master Plan estimates are identified in Table 1-10.

Table 1-10. Cost Estimate Tracking Table

Changed Item	Change	Reason	Comments
Control Options	Control Gate	A control gate was not included in the Preliminary Proposal estimate	Added for the MP to further reduce overflows
	Screening	Screening was not included in the Preliminary Proposal estimate	Added in conjunction with the Control Gate
Opportunities	A fixed allowance of 10 percent has been included for program opportunities	Preliminary Proposal estimate did not include a cost for GI opportunities	
Lifecycle Cost	The lifecycle costs have been adjusted to 35 years	City of Winnipeg Asset Management Approach	
Cost escalation from 2014 to 2019	Capital Costs have been inflated to 2019 values based on an assumed value of 3 percent per for construction inflation.	Preliminary Proposal estimates were based on 2014-dollar values.	

1.10 Meeting Future Performance Targets

The regulatory process requires consideration for upgrading Control Option 1 to another higher-level performance target. For the purposes of this CSO Master Plan, the future performance target is 98 percent capture for the representative year measured on a system-wide basis. This target will permit the number of overflows and percent capture to vary by district to meet 98 percent capture. Table 1-11 provides a description of how the regulatory target adjustment could be met by building off the proposed work identified for Control Option 1.

Overall the Woodhaven district would be classified as a low potential for implementation of complete sewer separation as the only feasible approach to achieve the future performance targets. However, opportunistic sewer separation within a portion of the district may be completed in conjunction with other major infrastructure work to address future performance targets. In addition, green infrastructure and off-line tank or tunnel storage may be utilized in key locations to provide additional storage and increase capture volume.

Table 1-11. Upgrade to 98 Percent Capture in a Representative Year Summary

Upgrade Option	Viable Migration Options
98 Percent Capture in a Representative Year	• Increased use of GI • Opportunistic Separation • Off-line Storage (Tank / Tunnel)

The control options selected for the Woodhaven district has been aligned for the requirement to provide screening on each of the primary outfalls and not specifically for the 85 percent capture performance target based on the system wide basis. The expandability of this district to meet the 98 percent capture would involve a system wide basis analysis to be completed to determine the next phase for the relatively small district of Woodhaven.

The cost for upgrading to meet an enhanced performance target depends on the summation of all changes made to control options in individual districts and has not been fully estimated at this stage of master planning. The Phase In approach is to be presented in detail in a second submission for 98 percent capture in a representative year, due on or before April 30, 2030.

1.11 Risks and Opportunities

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of this section is to identify significant risks and opportunities for each control option within a district.

The CSO Master Plan has considered risks and opportunities on a program and project delivery level, as described in Section 5 of Part 2 of the CSO Master Plan. A Risk And Opportunity Control Option Matrix covering the district control options has been developed and is included as part of Appendix D in Part 3B. The identification of the most significant risks and opportunities relevant to this district are provided in Table 1-12.

Table 1-12. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
1	Basement Flooding Protection	-	R	-	-	-	-	-	-
2	Existing Lift Station	-	R	-	-	-	-	R	-
3	Flood Pumping Station	-	-	-	-	-	-	-	-
4	Construction Disruption	-	-	-	-	-	-	-	-
5	Implementation Schedule	-	-	-	-	-	-	R	-

Table 1-12. Control Option 1 Significant Risks and Opportunities

Risk Number	Risk Component	Latent Storage / Flap Gate Control	In-line Storage / Control Gate	Off-line Storage Tank	Off-line Storage Tunnel	Sewer Separation	Green Infrastructure	Real Time Control	Floatable Management
6	Sewer Condition	-	R	-	-	-	-	-	-
7	Sewer Conflicts	-	R	-	-	-	-	-	-
8	Program Cost	-	O	-	-	-	-	-	O
9	Approvals and Permits	-	-	-	-	-	R	-	-
10	Land Acquisition	-	-	-	-	-	R	-	-
11	Technology Assumptions	-	-	-	-	-	O	O	-
12	Operations and Maintenance	-	R	-	-	-	R	O	R
13	Volume Capture Performance	-	O	-	-	-	O	O	-
14	Treatment	-	R	-	-	-	O	O	R

Risks and opportunities will require further review and actions at the time of project implementation.

1.12 References

Girling, R.M. 1986. *Basement Flooding Relief Program Review – 1986*.

LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Low CS Manhole
- Inter-System Connection: CS - WWS
- District Boundary Crossing: WWS
- Interceptor Sewer
- Force Main
- Street
- District Boundary
- Watercourse
- Greenspace
- City Owned Land

CSO MASTER PLAN PROPOSED SOLUTIONS

- Proposed Control Gate
- Extent of In-line Storage
- Sewer Separation - Complete

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

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Notes:
1. Map data source - City of Winnipeg, 2013

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 43
District Overview Map
Sewer District: Woodhaven
City of Winnipeg
Combined Sewer Overflow Master Plan

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LEGEND

- Primary Weir
- Critical Elevation
- CSO Outfall
- Manhole
- Pump Location
- Force Main
- Sewer By Type
  - CS
  - WWS
- Pump Station Type
  - Lift Station
- Land Parcel

CSO MASTER PLAN PROPOSED SOLUTIONS

- Proposed Manhole
- Proposed CS Sewer
- Control Gate
- Screening

ALL PROPOSED SOLUTIONS SHOWN IN RED TEXT

JACOBS

Notes:
1. Map data source - City of Winnipeg, 2013

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

FIGURE 43-01
Control Gate and Screening
Sewer District: Woodhaven
City of Winnipeg
Combined Sewer Overflow Master Plan

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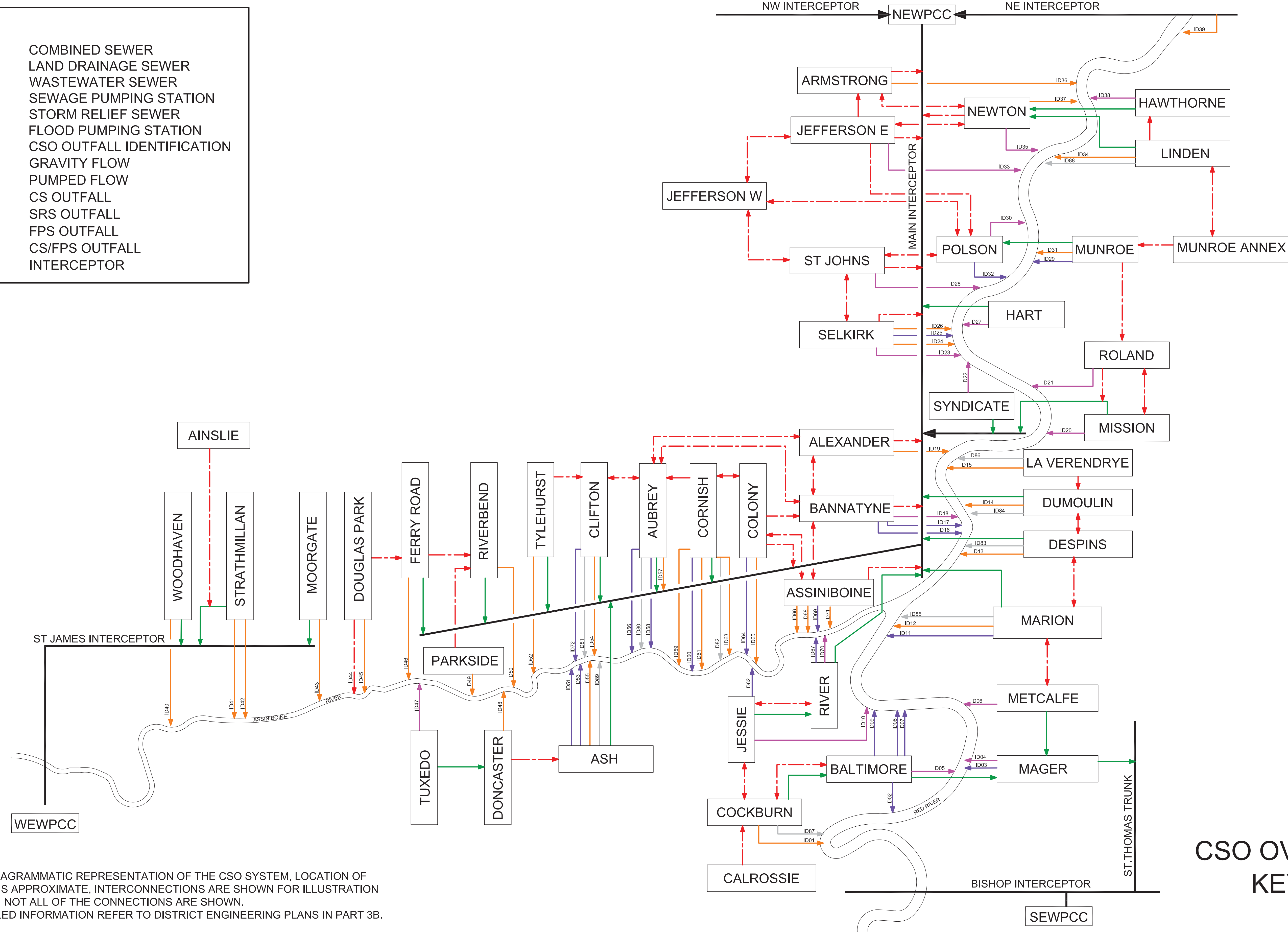
Appendix B
District Interconnection Overview Map

LEGEND

CS	COMBINED SEWER
LDS	LAND DRAINAGE SEWER
WWS	WASTEWATER SEWER
SPS	SEWAGE PUMPING STATION
SRS	STORM RELIEF SEWER
FPS	FLOOD PUMPING STATION
ILS	CSO OUTFALL IDENTIFICATION
	GRAVITY FLOW
	PUMPED FLOW
	CS OUTFALL
	SRS OUTFALL
	FPS OUTFALL
	CS/FPS OUTFALL
	INTERCEPTOR



NOTE:
THIS IS A DIAGRAMMATIC REPRESENTATION OF THE CSO SYSTEM, LOCATION OF DISTRICTS IS APPROXIMATE, INTERCONNECTIONS ARE SHOWN FOR ILLUSTRATION PURPOSES, NOT ALL OF THE CONNECTIONS ARE SHOWN.
FOR DETAILED INFORMATION REFER TO DISTRICT ENGINEERING PLANS IN PART 3B.

CSO OVERALL KEY PLAN

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470010

FILENAME: 470010_F001.dwg PLOT DATE: 8/8/2019

Appendix C. Cost Summary Table

This appendix provides a summary table of the estimated capital and operations and maintenance (O&M) costs associated with the CSO Master Plan recommended projects in each District Engineering Plan (DEP). The capital cost and O&M costs shown were developed as described in the Basis of Estimate Technical Memorandum which is included in Appendix C of the Part 2 Technical Report.

The two tables that follow show the capital and comparison based O&M costs of the CSO Master Plan. The capital costs estimates were derived using the methods described in the Basis of Estimate. The estimated capital costs associated with each proposed control option recommended for each specific district are then identified. Upgrades that are not specific to any one control option technology are lumped together under the 'additional' capital cost column. This additional capital cost may include off-take and weir height/location adjustments or additional interconnection construction work required to implement latent storage.

The O&M costs shown are reflective of the 35 year period which was used in the evaluations and comparisons of the different technologies. They are fictional representations of the O&M costs assuming each recommended control option is fully operational in 2019, then providing the cumulative O&M costs over the preceding 35 year period, in 2019 dollars. By providing this O&M estimate from the same project implementation timeframe, the impacts of inflation are not considered, and an O&M cost comparison between different recommended control options can be completed. This will be important as part of the future evaluation and business case approvals completed by the City of Winnipeg to evaluate each of the projects in the CSO Master Plan. Note that the O&M costs calculated in this manner are different from the O&M cost estimates produced as part of the program development of the CSO Master Plan, as documented in the Part 2 Technical Report, and Part 3A. The same 10% allowance applied for future green infrastructure projects in the capital cost estimates are applied to these total comparison based O&M costs.

The capital costs are shown for each proposed project within a sewer district. The costs are reported in terms of Present Value (PV) costs comprised of the following three components:

- 2019 CSO Master Plan Capital Cost – This represents the one-time, fixed expense to construct the sewer system control upgrades and is estimated in 2019 dollars.
- 2019 Total Operations And Maintenance Cost (Over 35-Year Period) – This represents the total required operations and maintenance (O&M) investment estimated in 2019 dollars over the 35 year period, under the assumption the project is complete and incurring O&M costs beginning in 2019.
- 2019 Total Lifecycle Costs – This is the sum of the 2019 CSO Master Plan Capital Cost and the 2019 Total Operations And Maintenance Cost (Over 35-Year Period). These values were used part of the project development process in determining projects to recommend for each specific district.

Appendix C
Cost Estimates

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District	2019 CSO Master Plan Capital Cost											
	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	Screen	Off-line Storage	Storage Tunnel	Sewer Separation	Additional	SUBTOTAL	Green Infrastructure Allowance	TOTAL
ALEXANDER	$0	$0	$1,280,000	$0	$2,680,000	$0	$0	$0	$0	$3,960,000	$400,000	$4,360,000
ARMSTRONG	$0	$0	$0	$0	$0	$0	$0	$61,080,000	$0	$61,080,000	$6,110,000	$67,190,000
ASH	$2,590,000	$2,340,000	$0	$5,100,000	$2,550,000	$0	$0	$29,100,000	$0	$41,680,000	$4,170,000	$45,850,000
ASSINIBOINE	$2,580,000	$0	$1,300,000	$0	$2,910,000	$0	$0	$0	$0	$6,790,000	$680,000	$7,470,000
AUBREY	$5,560,000	$0	$0	$2,920,000	$2,840,000	$0	$0	$0	$150,000	$11,470,000	$1,150,000	$12,620,000
BALTIMORE	$1,480,000	$0	$0	$2,360,000	$2,850,000	$0	$0	$0	$0	$6,690,000	$670,000	$7,360,000
BANNATYNE	$0	$0	$1,300,000	$0	$3,960,000	$0	$0	$0	$0	$5,260,000	$530,000	$5,790,000
CLIFTON	$2,410,000	$2,420,000	$0	$2,730,000	$2,730,000	$0	$0	$0	$0	$10,290,000	$1,030,000	$11,320,000
COCKBURN	$0	$0	$0	$2,650,000	$2,250,000	$0	$0	$56,280,000	$0	$61,180,000	$6,120,000	$67,300,000
COLONY	$2,340,000	$0	$1,280,000	$2,360,000	$2,790,000	$0	$0	$0	$0	$8,770,000	$880,000	$9,650,000
CORNISH	$2,440,000	$0	$0	$2,420,000	$2,350,000	$0	$0	$0	$0	$7,210,000	$720,000	$7,930,000
DESPINS	$0	$0	$0	$0	$0	$0	$0	$39,980,000	$0	$39,980,000	$4,000,000	$43,980,000
DONCASTER	$0	$0	$0	$0	$0	$0	$0	$49,890,000	$0	$49,890,000	$4,990,000	$54,880,000
DOUGLAS PARK	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
DUMOULIN	$0	$0	$0	$2,250,000	$1,920,000	$0	$0	$0	$0	$4,170,000	$420,000	$4,590,000
FERRY ROAD	$0	$0	$0	$0	$0	$0	$0	$129,360,000	$0	$129,360,000	$12,940,000	$142,300,000
HART	$0	$0	$0	$2,950,000	$2,330,000	$0	$0	$0	$0	$5,280,000	$530,000	$5,810,000
HAWTHORNE	$0	$0	$0	$2,650,000	$1,990,000	$0	$0	$0	$0	$4,640,000	$460,000	$5,100,000
JEFFERSON E	$0	$0	$1,280,000	$3,130,000	$2,890,000	$0	$0	$145,510,000	$0	$152,810,000	$15,280,000	$168,090,000
JEFFERSON W	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
JESSIE	$0	$0	$0	$2,540,000	$0	$0	$0	$25,900,000	$0	$28,440,000	$2,840,000	$31,280,000
LA VERENDRYE	$0	$0	$0	$0	$0	$0	$1,060,000	$2,080,000	$0	$3,140,000	$310,000	$3,450,000
LINDEN	$0	$0	$0	$0	$0	$0	$0	$10,900,000	$0	$10,900,000	$1,090,000	$11,990,000
MAGER	$0	$0	$0	$2,710,000	$1,590,000	$0	$0	$0	$0	$4,300,000	$430,000	$4,730,000
MARION	$2,170,000	$0	$0	$2,730,000	$0	$0	$0	$0	$0	$4,900,000	$490,000	$5,390,000
METCALFE	$0	$0	$0	$0	$0	$0	$0	$17,430,000	$0	$17,430,000	$1,740,000	$19,170,000
MISSION	$0	$0	$0	$0	$0	$0	$0	$130,320,000	$0	$130,320,000	$13,030,000	$143,350,000
MOORGATE	$0	$0	$0	$2,590,000	$2,450,000	$0	$0	$0	$0	$5,040,000	$500,000	$5,540,000
MUNROE	$0	$0	$1,280,000	$2,670,000	$3,340,000	$0	$0	$0	$0	$7,290,000	$730,000	$8,020,000
MUNROE ANNEX	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
NEWTON	$0	$0	$1,280,000	$2,550,000	$1,840,000	$0	$0	$0	$0	$5,670,000	$570,000	$6,240,000
PARKSIDE	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
POLSON	$0	$0	$1,290,000	$2,540,000	$0	$0	$0	$0	$0	$3,830,000	$380,000	$4,210,000
RIVER	$0	$0	$0	$0	$2,950,000	$0	$0	$0	$0	$2,950,000	$300,000	$3,250,000
RIVERBEND	$0	$0	$0	$0	$0	$0	$0	$76,590,000	$0	$76,590,000	$7,660,000	$84,250,000
ROLAND	$2,790,000	$0	$0	$2,540,000	$1,990,000	$0	$0	$0	$0	$7,320,000	$730,000	$8,050,000
SELKIRK	$1,830,000	$0	$1,280,000	$2,460,000	$3,030,000	$0	$0	$0	$0	$8,600,000	$860,000	$9,460,000
ST JOHNS	$3,140,000	$0	$1,350,000	$2,570,000	$3,220,000	$0	$0	$0	$0	$10,280,000	$1,030,000	$11,310,000
STRATHMILLAN	$0	$0	$0	$2,190,000	$2,360,000	$0	$0	$0	$30,000	$4,580,000	$460,000	$5,040,000
SYNDICATE	$0	$0	$0	$2,360,000	$1,870,000	$0	$0	$0	$0	$4,230,000	$420,000	$4,650,000
TUXEDO	$0	$0	$0	$0	$0	$0	$0	$8,790,000	$0	$8,790,000	$880,000	$9,670,000
TYLEHURST	$0	$0	$0	$0	$0	$0	$0	$86,670,000	$0	$86,670,000	$8,670,000	$95,340,000
WOODHAVEN	$0	$0	$0	$2,190,000	$1,840,000	$0	$0	$0	$0	$4,030,000	$400,000	$4,430,000
TOTAL	$29,330,000	$4,760,000	$12,920,000	$64,160,000	$63,520,000	$0	$1,060,000	$869,880,000	$180,000	$1,045,810,000	$104,600,000	$1,150,410,000

District	2019 Total Operations and Maintenance Cost (Over 35-year Period)												TOTAL LIFECYCLE COST
	Latent Storage	Flap Gate Control	Gravity Flow Control	Control Gate	Screen	Off-line Storage	Storage Tunnel	Sewer Separation	Additional	SUBTOTAL	Green Infrastructure Allowance	TOTAL	
ALEXANDER	$0	$0	$740,000	$0	$650,000	$0	$0	$0	$0	$1,390,000	$140,000	$1,530,000	$5,890,000
ARMSTRONG	$0	$0	$0	$0	$0	$0	$0	$1,220,000	$0	$1,220,000	$120,000	$1,340,000	$68,530,000
ASH	$1,550,000	$710,000	$0	$1,320,000	$1,190,000	$0	$0	$370,000	$0	$5,140,000	$510,000	$5,650,000	$51,500,000
ASSINIBOINE	$1,600,000	$0	$740,000	$0	$740,000	$0	$0	$0	$0	$3,080,000	$310,000	$3,390,000	$10,860,000
AUBREY	$3,690,000	$0	$0	$990,000	$1,100,000	$0	$0	$0	$20,000	$5,800,000	$580,000	$6,380,000	$19,000,000
BALTIMORE	$1,190,000	$0	$0	$900,000	$1,120,000	$0	$0	$0	$0	$3,210,000	$320,000	$3,530,000	$10,890,000
BANNATYNE	$0	$0	$740,000	$0	$1,080,000	$0	$0	$0	$0	$1,820,000	$180,000	$2,000,000	$7,790,000
CLIFTON	$1,860,000	$900,000	$0	$900,000	$1,040,000	$0	$0	$0	$0	$4,700,000	$470,000	$5,170,000	$16,490,000
COCKBURN	$0	$0	$0	$890,000	$730,000	$0	$0	$720,000	$0	$2,340,000	$230,000	$2,570,000	$69,870,000
COLONY	$1,640,000	$0	$740,000	$940,000	$1,170,000	$0	$0	$0	$0	$4,490,000	$450,000	$4,940,000	$14,590,000
CORNISH	$1,520,000	$0	$0	$950,000	$1,150,000	$0	$0	$0	$0	$3,620,000	$360,000	$3,980,000	$11,910,000
DESPINS	$0	$0	$0	$0	$0	$0	$0	$510,000	$0	$510,000	$50,000	$560,000	$44,540,000
DONCASTER	$0	$0	$0	$0	$0	$0	$0	$640,000	$0	$640,000	$60,000	$700,000	$55,580,000
DOUGLAS PARK	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
DUMOULIN	$0	$0	$0	$880,000	$970,000	$0	$0	$0	$0	$1,850,000	$190,000	$2,040,000	$6,630,000
FERRY ROAD	$0	$0	$0	$0	$0	$0	$0	$1,650,000	$0	$1,650,000	$170,000	$1,820,000	$144,120,000
HART	$0	$0	$0	$1,010,000	$1,150,000	$0	$0	$0	$0	$2,160,000	$220,000	$2,380,000	$8,190,000
HAWTHORNE	$0	$0	$0	$940,000	$1,080,000	$0	$0	$0	$0	$2,020,000	$200,000	$2,220,000	$7,320,000
JEFFERSON E	$0	$0	$740,000	$940,000	$710,000	$0	$0	$1,860,000	$0	$4,250,000	$430,000	$4,680,000	$172,770,000
JEFFERSON W	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
JESSIE	$0	$0	$0	$960,000	$0	$0	$0	$330,000	$0	$1,290,000	$130,000	$1,420,000	$32,700,000
LA VERENDRYE	$0	$0	$0	$0	$0	$0	$210,000	$30,000	$0	$240,000	$20,000	$260,000	$3,710,000
LINDEN	$0	$0	$0	$0	$0	$0	$0	$140,000	$0	$140,000	$10,000	$150,000	$12,140,000
MAGER	$0	$0	$0	$880,000	$640,000	$0	$0	$0	$0	$1,520,000	$150,000	$1,670,000	$6,400,000
MARION	$1,600,000	$0	$0	$1,010,000	$0	$0	$0	$0	$0	$2,610,000	$260,000	$2,870,000	$8,260,000
METCALFE	$0	$0	$0	$0	$0	$0	$0	$350,000	$0	$350,000	$40,000	$390,000	$19,560,000
MISSION	$0	$0	$0	$0	$0	$0	$0	$1,660,000	$0	$1,660,000	$170,000	$1,830,000	$145,180,000
MOORGATE	$0	$0	$0	$940,000	$1,100,000	$0	$0	$0	$0	$2,040,000	$200,000	$2,240,000	$7,780,000
MUNROE	$0	$0	$740,000	$990,000	$1,230,000	$0	$0	$0	$0	$2,960,000	$300,000	$3,260,000	$11,280,000
MUNROE ANNEX	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
NEWTON	$0	$0	$740,000	$860,000	$660,000	$0	$0	$0	$0	$2,260,000	$230,000	$2,490,000	$8,730,000
PARKSIDE	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
POLSON	$0	$0	$740,000	$860,000	$0	$0	$0	$0	$0	$1,600,000	$160,000	$1,760,000	$5,970,000
RIVER	$0	$0	$0	$0	$950,000	$0	$0	$0	$0	$950,000	$100,000	$1,050,000	$4,300,000
RIVERBEND	$0	$0	$0	$0	$0	$0	$0	$980,000	$0	$980,000	$100,000	$1,080,000	$85,330,000
ROLAND	$1,780,000	$0	$0	$850,000	$660,000	$0	$0	$0	$0	$3,290,000	$330,000	$3,620,000	$11,670,000
SELKIRK	$1,510,000	$0	$740,000	$930,000	$1,130,000	$0	$0	$0	$0	$4,310,000	$430,000	$4,740,000	$14,200,000
ST JOHNS	$1,890,000	$0	$740,000	$940,000	$1,040,000	$0	$0	$0	$0	$4,610,000	$460,000	$5,070,000	$16,380,000
STRATHMILLAN	$0	$0	$0	$840,000	$1,020,000	$0	$0	$0	$0	$1,860,000	$190,000	$2,050,000	$7,090,000
SYNDICATE	$0	$0	$0	$920,000	$1,120,000	$0	$0	$0	$0	$2,040,000	$200,000	$2,240,000	$6,890,000
TUXEDO	$0	$0	$0	$0	$0	$0	$0	$110,000	$0	$110,000	$10,000	$120,000	$9,790,000
TYLEHURST	$0	$0	$0	$0	$0	$0	$0	$1,110,000	$0	$1,110,000	$110,000	$1,220,000	$96,560,000
WOODHAVEN	$0	$0	$0	$840,000	$1,040,000	$0	$0	$0	$0	$1,880,000	$190,000	$2,070,000	$6,500,000
TOTAL	$19,830,000	$1,610,000	$7,400,000	$22,480,000	$24,470,000	$0	$210,000	$11,680,000	$20,000	$87,700,000	$8,780,000	$96,480,000	$1,246,890,000

Appendix D
Risk and Opportunity Matrix

Appendix D – Control Option Risk and Opportunity Matrix

The CSO Master Plan and implementation program are large and complex, with many risks having both negative and positive effects. The objective of the Risk and Opportunity Matrix is to further describe the significant risks and opportunities that apply for each type of solution used to develop the CSO Master Plan.

The two tables that follow relate to the Risk and Opportunity table included in each of the District Engineering Plans (DEPs). In the DEPs, the table includes an ‘R’ or ‘O’ under the solutions that are applicable within the district. The rows then relate to the various risk components. This appendix supplements the information provided in the DEPs by further describing the risk or opportunity associated with the specific solutions for the district.

		Latent Storage / Flap Gate Control		In-line Storage / Control Gate		Off-line Tank		Off-line Tunnel	
Risk Number	Risk Component	Risk	Opportunity	Risk	Opportunity	Risk	Opportunity	Risk	Opportunity
1	Basement Flooding Protection	Flap gate control introduces the potential for a flap gate to become stuck open or closed. Having a flap gate that does not open will increase the level within the system to the nearest alternate overflow point.	N/A	Control gate fails in upright position resulting in an increased level within the combined sewer system.	N/A	N/A	Off-line tanks provide increased conveyance of wastewater and storage capacity, reducing the risk of basement flooding.	N/A	Off-line tunnels provide increased conveyance of wastewater and storage capacity, reducing the risk of basement flooding.
2	Existing Lift Station	N/A	N/A	Pump modifications may be required to accommodate dewatering rate.	N/A	N/A	N/A	N/A	N/A
3	Flood Pumping Station	N/A	N/A	N/A	N/A	N/A	Existing pumps may be utilized to dewater off-line storage reducing the requirement for additional pumps.	N/A	Existing pumps may be utilized to dewater off-line storage reducing the requirement for additional pumps.
4	Construction Disruption	N/A	N/A	N/A	N/A	Off-line tanks are big, effecting large areas and causing significant impacts to the public upon construction.	N/A	N/A	N/A
5	Implementation Schedule	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	Sewer Condition	The increase use of a pipe for storage may increase pipe failure rate.	N/A	The increase use of a pipe for storage may increase pipe failure rate.	N/A	N/A	N/A	N/A	N/A
7	Sewer Conflicts	Any installation of wet wells and force mains can conflict with existing infrastructure.	N/A	The location of new chambers within the sewer system can conflict with existing infrastructure.	N/A	N/A	N/A	Off-line tunnels are typically large diameter and unless they are placed deep underground, there is a high potential for conflicts with other utilities and sewer infrastructure.	N/A
8	Program Cost	N/A	Capital costs are lowered as the storage arrangement maximizes the use of existing infrastructure.	N/A	Capital costs are lowered as the storage arrangement maximizes the use of existing infrastructure.	Off-line tanks result in a high cost for a marginal benefit.	N/A	N/A	Off-line tunnel storage is cheaper than other types of off-line storages resulting in cost savings.
9	Approvals and Permits	N/A	N/A	N/A	N/A	Projects affecting public / private land uses may not be approved.	N/A	N/A	N/A
10	Land Acquisition	N/A	N/A	N/A	N/A	Off-line tanks are big, covering large areas and appropriate space may be difficult to secure.	N/A	N/A	Can be installed within existing ROWs, which reduces the necessity for new sewer areas
11	Technology Assumptions	Flap gate control is a new technology and has not been used locally.	N/A	In-line storage is a new technology and has not been used locally.	N/A	N/A	N/A	N/A	Local experience is increasing with the growing applications of off-line tunnels.
12	Operations and Maintenance	The addition of flap gate control requires more controls and maintenance to the program.	N/A	The addition of a control gate requires more controls and maintenance to the program.	N/A	The addition of an off-line tank requires more controls and maintenance to the program.	N/A	The addition of an off-line tunnel requires more controls and maintenance to the program.	N/A
13	Volume Capture Performance	N/A	There is increased volume capture with the latent storage and dewatering process.	N/A	There is increased volume capture with the in-line storage and dewatering process.	N/A	There is increased volume capture with the off-line storage and dewatering process.	N/A	There is increased volume capture with the off-line tunnel storage and dewatering process.
14	Treatment	Increased storage causes an increase in solids and screenings that require management.	N/A	Increased storage causes an increase in solids and screenings that require management.	N/A	Increased storage causes an increase in solids and screenings that require management.	N/A	Increased storage causes an increase in solids and screenings that require management.	N/A

Risk Number	Risk Component	Sewer Separation		Green Infrastructure		Real Time Control		Floatable Management	
		Risk	Opportunity	Risk	Opportunity	Risk	Opportunity	Risk	Opportunity
1	Basement Flooding Protection	N/A	Reduces the risk of basement flooding by separating wastewater from stormwater sewers. Less flow in the sewer directly connected to homes reduces the potential for surcharging.	N/A	N/A	N/A	N/A	N/A	N/A
2	Existing Lift Station	N/A	N/A	N/A	N/A	Pump modifications may be required to meet dewatering rate.	N/A	N/A	N/A
3	Flood Pumping Station	N/A	Sewer flows are reduced from stormwater being removed / separated and the need for pumping stations may be reduced or eliminated.	N/A	N/A	N/A	N/A	N/A	N/A
4	Construction Disruption	Sewer separation occurs throughout the whole district with widespread construction impacts on the existing transportation network.	N/A	Green Infrastructure has the potential to impact large areas.	N/A	N/A	N/A	N/A	N/A
5	Implementation Schedule	Due to the magnitude and scope of this solution, design and construction to fully implement separation can take significant amount of time.	N/A	N/A	Green Infrastructure can be implemented over a short-term period.	A long term implementation plan may be required and planned for to incorporate a global RTC scheme.	N/A	N/A	N/A
6	Sewer Condition	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7	Sewer Conflicts	Installation may be difficult where a existing infrastructure is present.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8	Program Cost	Due to the magnitude of sewer separation, this solution results in a high initial capital cost.	N/A	N/A	Cost of Green Infrastructure may be much less than other types of infrastructure.	N/A	N/A	N/A	Alternative Floatable Management could eliminate screening and screen chambers, reducing the program costs.
9	Approvals and Permits	N/A	N/A	Projects affecting public / private land uses may not be approved	N/A	N/A	N/A	N/A	N/A
10	Land Acquisition	N/A	N/A	A large area of land is required for some technologies.	N/A	N/A	N/A	N/A	N/A
11	Technology Assumptions	N/A	Sewer separation implements common practices utilizing local experience. Challenges and approaches to sewer separation projects in Winnipeg well understood.	N/A	Green Infrastructure can utilize experiences in other metropolitan cities to draw upon.	Real Time Control is a new technology and has not been used locally.	System optimization provided by Real Time Control can improve operations of other technologies dramatically.	N/A	N/A
12	Operations and Maintenance	The additional pipe network may require an increase in maintenance.	Sewer separation can potentially eliminate requirement for use of flood pumping stations or lift stations. This removes the O&M requirements for this existing infrastructure.	Green Infrastructure implements various solutions as new infrastructure, which will require an increase in O&M requirements in order to perform as expected.	N/A	N/A		Floatable management implements screens which will require an increase in O&M requirements.	N/A
13	Volume Capture Performance	N/A	N/A	N/A	There is potential for a higher level of capture.	N/A	There is potential for a higher level of capture.	N/A	N/A
14	Treatment	N/A	Sewer separation causes a reduction of flow to WPCC, possibly increasing treatment capacity.	N/A	Flow is optimized to the WPCCs.	N/A	Flow is optimized to the WPCCs.	An increase in solids and screenings as a result of screen installation will require management for appropriate removal and treatment.	N/A

JACOBS

CSO Master Plan

Part 3C - Standard Details

Revision 02

July 18, 2019

City of Winnipeg

CSO Master Plan

Project No: 470010CH
Document Title: Part 3C - Standard Details
Revision: Revision 02
Date: July 18, 2019
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Contents

Appendixes

Tables

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Acronyms and Abbreviations

CS	combined sewer
CSO	combined sewer overflow
GI	Green Infrastructure
Inv	Invert
LDS	land drainage sewer
NWL	Normal Water Level
NSWL	Normal Summer Water Level
O&M	operations and maintenance
RTC	Real Time Control
SCADA	supervisory control and data acquisition
SRS	storm relief sewer
TBM	tunnel boring machine
WWF	wet weather flow
WWS	wastewater sewer

1. Introduction

1.1 Purpose

This document forms part of Phase 3 of the combined sewer overflow (CSO) Master Plan, to provide background information on CSO technologies including detailed descriptions of conceptual solutions, design rationale and considerations, and other rationale for their selection (such as operations and maintenance [O&M]) and, where appropriate, industry products with a history of use in these types of applications.

This is a supporting document to both the Part 3A – Master Plan Summary report and Part 3B – District Engineering Plans that all form part of Phase 3 of the Master Plan.

1.2 Approach to Product Selection

The approach to selecting products has given preference to ‘tried and true’ products. These are products that:

- Operators would be familiar with.
- Can be sourced readily from local suppliers.
- Have been used before in CSO control applications across North America.

Any specific manufacturer or product selection in this report is for reference use and example only. It is neither intended as an endorsement of the product specified, nor is it an exclusion of other manufacturers or suppliers. When applicable, other viable alternatives have also been documented for future consideration.

Design considerations presented in this report are conceptual and general in nature and should be revisited on a project-by-project basis during the preliminary and detailed design stages.

1.3 Organization of this Report

The six methods of CSO control and reduction considered in this report have been grouped in individual sections as follows:

- Section 2 Sewer Separation
- Section 3 Latent Storage
- Section 4 In-Line Storage
- Section 5 Screening
- Section 6 Gravity Flow Control
- Section 7 Off-Line Storage (i.e. Tank Storage and Tunnel Storage)

In each section listed above, there is a description of the CSO control option and a discussion of design and O&M considerations. Representative products and drawings describing typical details have also been included, where appropriate.

Appendix A is a Screen Sizing Calculation, which steps through the logic for mechanical screen sizing and gives an indicative size for the screen and screening chamber.

Appendix B presents the large format figures referenced in the report.

Appendix C presents a design table for the Latent Storage Option.

2. Sewer Separation

A short description of sewer separation is included here to facilitate discussion of design and O&M considerations. For a more detailed description of this solution, see Part 2, Section 3.3.1. For information on the City's approach to sewer separation to date, see Part 2, Section 2.4.

2.1 Facilities and Equipment

There are several types of separation that can be referred to when discussing sewer separation. Table 2-1 summarizes the typical types of sewer separation methodologies available.

Table 2-1. Types of Sewer Separation

Type of Separation	Features
Complete Separation	All wet weather flow is collected and conveyed by a LDS system. All wastewater flows are collected and conveyed by a WWS system. All road drainage is collected within the CS district by reconnecting all catch basins to the LDS system. Private foundation drains, sump pumps, and roof drain connections from older properties may remain connected to the CS system that is being used as part of the WWS system. A WWF response is likely to remain in this type of WWS system.
Partial Separation "Separation Ready"	Separation of selected regions within a sewer district is carried out to achieve a desired level of basement flooding protection or CSO relief. The entire CS district is not separated. Small separate areas within the district may be referred to as Separation Ready: typically, where the area can be connected to an existing LDS.
LDS Separation	A new LDS system is constructed and catch basins in the CS district are reconnected to the new LDS system. The existing CS system is then converted to a WWS system unless significant impermeable area (>4% of total area) is still connected from properties.
WWS Separation	A new wastewater system is installed to collect domestic sewage. The existing CS system is then converted to a LDS system.

Notes:
CS = combined sewer
LDS = land drainage sewer
WWF = wet weather flow
WWS = wastewater sewer

In a separate system, storm water is conveyed via the LDS system to a LDS outfall for discharge directly into the receiving water. This removal of storm water from the CS flow reduces the flow entering the CS system and reduces the amount of CSO occurring during WWF events. Figure 2-1 is a schematic representation of partial separation where a new LDS system is constructed, in which catch basins in the CS district are reconnected to the new LDS system and discharge directly to the receiving water.

2.2 Product Selection

There are no preferred products noted for sewer separation , as sewer infrastructure is generic and supplied by a wide range of suppliers.

2.3 Alternative Products

As discussed in Section 2.2, no alternative products are here listed, as there are many suppliers that stock the generic components of sewer infrastructure.

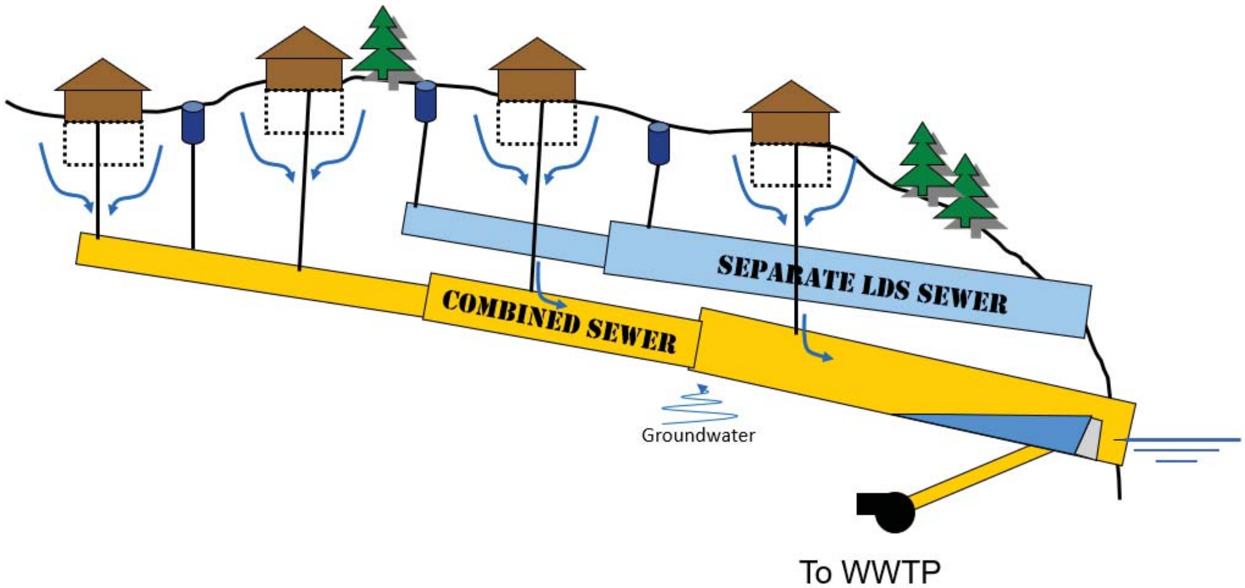


Figure 2-1. Partial Separation Schematic

2.4 Design Considerations

Sewer flow has been modelled assuming the 1992 representative year of rainfall with the Normal Summer Water Level (NSWL) assumed. For more information on flow and drainage modelling assumptions see Part 2, Section 3.5 of the Master Plan.

Sewer alignment considerations include:

- existing underground infrastructure;
- required cover for frost protection; and
- the level of the receiving waterbody.

Design considerations include:

- The City's Standard Construction Specifications, CW 2130 – Gravity sewers.
- Pipe sizing with Winnipeg's flat topography, river levels, clay soils, buildability, considering:
  - Minimum slopes
  - Minimum pipe cover
  - Pipe diameter and pipe type (i.e. Manning's value)
  - Minimum flushing/scouring velocities
  - Maximum allowable velocity
- Design events:
  - 1 in 5 year McLaren for CS and LDS
  - 1 in 10 year McLaren for WWS
  - Need for multi duration events (e.g. 30, 60, 120, 300, 600 and 1440 minutes)
- Other pipe sizing issues:
  - Lack of detailed GIS information
  - Permeable and impermeable areas within catchment area
  - Ten percent silt assumption
  - Consideration of adjacent water course(s)
- Manholes:
  - At every change of direction
  - At every change in slope
  - Maximum 185 metre spacing

- o At upper end of sewer run for maintenance purposes

A initial high-level assessment is completed to size the sewer. An area takeoff is required, and assumptions are made of the area that is going to be serviced by the new sewer. The rational method or other comparable method is then used to generate the estimated runoff flow based on the design event. A baseflow allowance is then calculated and added to this number using parameters such as per capita sewage flow rates, business, industrial, commercial and institutional flows. Flow rates should also consider land use zoning densities for future infill and densification areas.

These flows are calculated at different sections of the catchment area and then used to size the sewer through look-up tables or other such methods. Using the hydraulic model, boundary conditions (e.g. river level, ground level, alignment, roughness, silt, etc.) can be added and any changes made are documented with justification.

Changes that occur during either preliminary or detailed design (e.g. new asset, geotechnical, flow survey information) can be tracked, their impact assessed and made transparent to the City.

Post monitoring can validate performance and any significant differences can be used to update the process in the future.

2.5 Climate Change

Precipitation is expected to change over time because of the effects of greenhouse gases on the environment. Therefore, climate change could potentially have a worsening effect on the CSO program because of greater rates and volumes of runoff that must be managed by the CSO controls.

Long term precipitation records were reviewed to identify any climate change trends that may already be in progress. The rainfall categories used for the representative assessment are useful for this evaluation, since the assessment compares not only the total annual and event rainfalls, but the number of rainfalls of varying sizes. The review of long-term trends indicated the following:

- There was no increasing trend observed for annual rainfall accumulations.
- There was no increasing trend observed for any of the larger amounts of rainfall.
- The 0 to 5 mm amounts of rainfall showed an increased number in recent years, but this will not be significant in terms of the CSO program because the CSO control system will capture these smaller events.

However, there is a high degree of uncertainty in the long-term trends. As such, the CSO Master Plan includes a provision for a response to climate change through the use of Green Infrastructure (GI), rather than more complex and costly changes to the planned grey infrastructure. A 10 percent funding allowance is included in the budget for GI, which is over and above the Preliminary Proposal estimate.

Furthermore, the CSO Master Plan prioritizes sewer separation work upfront; this makes the system more resilient to climate change, as runoff will primarily be directed to LDSs.

2.6 Typical Drawings

The City's Standard Construction Specification, CW 2130 – Gravity sewers City has standard drawings showing generic gravity main components, accessible at https://www.winnipeg.ca/matmgt/spec/.

2.7 Operations and Maintenance

Maintenance schedules already in place for the existing CS can be duplicated for the newly installed LDS. The additional cost in O&M is a function of the increased number and length of sewers. This is discussed in Part 2 and budgeted at $4 per metre of sewer per year.

Physical inspections are performed to accomplish the following:

- Identify defects in the system that can contribute to or cause backups and overflows.
- Identify chronic problem areas, so maintenance can be planned and scheduled.
- Identify defects that, if not fixed, will result in a future failure.
- Determine the system needs for long-term replacement and rehabilitation.
- Develop a baseline for future comparison to determine rates of deterioration.

The City has construction work specifications for the commissioning and inspection of gravity mains using video surveillance equipment (CW 2145 – Sewer and Manhole Inspection) and for the cleaning of gravity mains using high pressure hoses and vacuum units (CW 2140 – Sewer and Manhole Cleaning).

3. Latent Storage

A short introductory description of latent storage is included here to facilitate discussion of design and O&M considerations. For a more detailed description of this option see Part 2, Section 3.3.2.

3.1 Facilities and Equipment

Latent storage refers to an available volume of storage in the storm relief sewer (SRS) system below the river level, which cannot dewater by gravity because of backpressure from the river on the flap gate, as shown on Figure 3-1. The available latent storage volume is based on the NSWL at the outfall and extends upstream through the SRS system.

A small SRS volume may not provide enough benefit to install a dewatering system. Flap gate control is a means to increase SRS available storage. The locking mechanism allows the level within the system to surpass the river level without opening the flap gate, thereby allowing for a higher volume of capture as compared to no flap gate control.

An off-line lift station located at the discharge end of the SRS empties the latent storage, readying the system for the next wet weather event. New level sensors, pump, and chamber are required near SRS outfalls suitable for latent storage. A force main from the new lift station connecting to the CS is also required. Where flap gate control is needed to increase SRS storage, a new latched flap gate and gate chamber are needed. Real time control (RTC) can be used to enhance this option and its operation in conjunction with other control options across districts. See Part 2, Section 7.3 for more information.

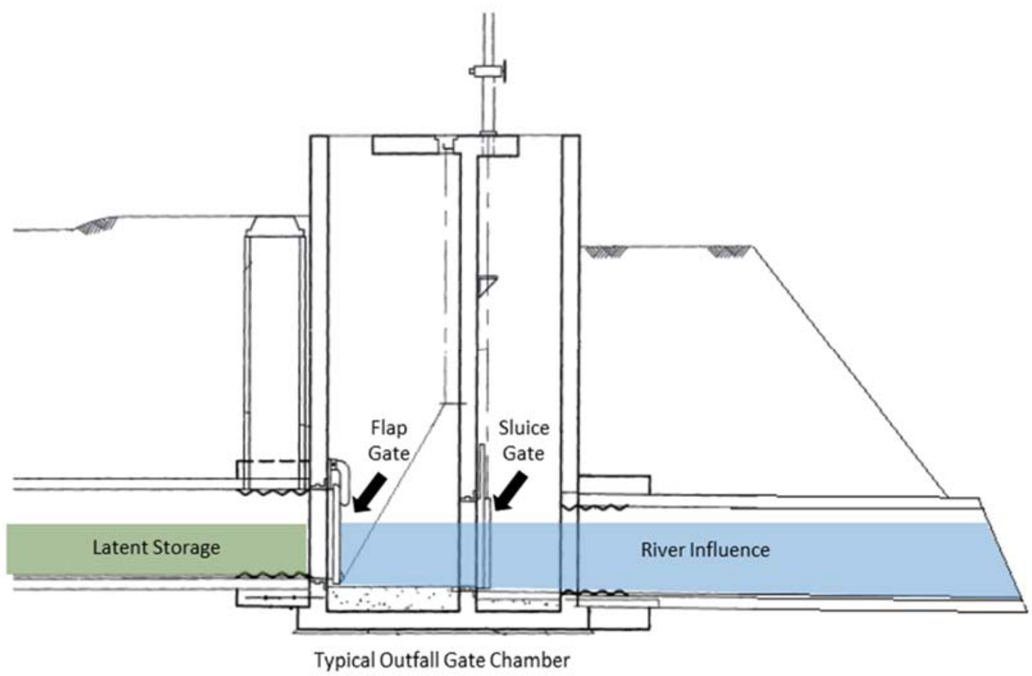


Figure 3-1. Latent Storage Schematic

3.2 Product Selection

3.2.1 Flap Gate (with control)

Where flap gate control is required, the ACU-GATE manufactured by Grande Water Management has been selected as the representative product for the CSO Master Plan. These gates have been used extensively in CSO projects in the past and have a proven track record.

The ACU-GATE is a latched gate, where the latching mechanism is hydraulically operated. Figure 3-2 shows an example installation.

Figure 3-2. Example ACU-GATE Installation
(Picture credit: courtesy of Grande, priv comm 9/11/2018)

Other features include the following:

- An entirely stainless steel construction, with gate latches protected from debris by the gate frame, thereby requiring little maintenance.
- A system of hydraulically operated latches, which rotate upwards when opening, so that additional clearance below the gate is not required.
- A design that is easy to retrofit into existing installations, with float or pneumatic operation available.

3.3 Alternative Products

Where flap gate control is required, an alternative arrangement would be to retrofit a winch and gear system that would secure the flap gate closed and would be set to fail open.

3.4 Design Considerations

Figure B-1 in Appendix B depicts the general arrangement of a sluice gate constructed 'in-line' with the CS. It includes a flap gate, the sluice gate with operator in its own structure and an off-take line to a sewage lift station. The lift station will provide a method of emptying the latent storage, readying the system for the next wet weather event. Critical design parameters for the gate chambers and lift station are below.

3.4.1 Gate Design

Design parameters and calculations for the latent storage option are set out in a table in Appendix C. These include:

- Storm Relief Sewer Dimensions
  - Horizontal inside and outside dimensions of the sewer main (d1 and d2);
  - Vertical inside and outside dimensions of the sewer main, if not a round pipe (v1 and v2);
  - Maximum SRS storage required;
  - Invert elevation at diversion weir (Inv); and,
  - River normal summer elevation (NWL).
- Gate Chamber Design Information
  - Chamber height;
  - Chamber length;
  - Chamber width; and,
  - Elevation and size of off-take to pump station.

3.4.2 Lift Station Design

Because lift stations are expensive facilities to operate and maintain, in the conceptual design stage a cost benefit analysis should be undertaken. There are a variety of different issues to consider during the cost benefit analysis, and the subsequent conceptual and detailed design, including:

- contributing per capita rates with respect to flow;
- critical infrastructure such as hospitals and schools serviced by the lift station (e.g. use of in-situ standby power versus maintenance crews hauling in a portable standby power unit);
- minimum pass forward flows;
- impact on downstream CSO service areas and trunk lines;
- minimum storage volume where the lift station is more cost effective than constructing storage;
- pump start stop settings and how they interact with either the gate or weir controls;
- integration with RTC; and,
- merits of a prefabricated lift station versus one constructed in place.

A minimum of two pumps is required for each pumping station, although three is preferred. These pumps should be identical and interchangeable. If two pumps are used, each unit should be capable of pumping at the peak design capacity flow rate for the station under service conditions. If three pumps area used, the two smallest pumps operating in parallel should be capable of pumping at the design capacity flow.

Another important consideration is redundancy in the power supply. Each lift station must continue operation when its primary power source is not available. The source of temporary power could be a natural gas, propane or diesel powered generator set, or a hook-up point that a mobile generator source can be brought in by field crews. The latter is less desirable, as emergency storage must be provided to allow time for a field crews to mobilize and hook up the temporary external power source.

The feasibility of a gravity overflow in the event of the failure of all lift station pumps should be evaluated and emergency storage provided if gravity discharge in not available. Emergency storage should be sized on peak flows and the response time for emergency crews to bring in a back-up power generator and pumps. Sizing should be on a case-by-case basis, and a cost benefit analysis undertaken to determine the appropriate sizing based on criticality of the lift station, the presence of back-up power and the response time of field crews.

The feasibility of installing an oversize pipe upstream of the lift station to store excess flow if the lift station pumps fail is also to be evaluated. The pipe is to be sized as indicated above.

Alarms must be relayed back via a phone line or cellular service to the operations centre responsible for sending a crew to investigate the reason for the alarm.

Pump start and stop level configurations should not exceed six starts per hour for dry well pumps and 12 starts per hour for wet well or submersible pumps. Normal lift station operation of pump starts and stops subject the force mains to cyclic pressure loading, which may reduce the allowable maximum pressure or the pipe life, or both, particularly for flexible pipe materials such as PVC. Existing and future forcemains should be checked to verify that cyclic loading does not introduce design limitations for the selected pipe. Maximum pump discharge pressures should also be checked to confirm they are suitable for existing forcemains.

Velocities need to be kept within a maximum range to avoid excessive head loss and vibration problems from turbulence in fittings and valves. Conversely, minimum velocities in the wet well will cause sediment to deposit in the base of the wet well, reducing storage capacity and increasing pump starts. Increasing pump starts increases wear and tear on the pumps and lowers the pumps' efficiency. Reducing the number of starts could cause the sewage to become septic, so a balance is required. Whether the lift station has a dry or wet well will also affect the frequency of the pump starts. The wet well will allow more starts than the dry well because of the cooler pump motors. Lift station wet well capacity should be maintained by regular inspection and proactive maintenance to remove silt. Wet wells should be designed so dead spots are not created in the sump where the silt can settle out.

Other design considerations include:

- Solids handling capacity of the pumps and their ability to handle floatables such as natural debris, grease and scum, plastics and paper products.
- Hydraulic considerations such as suction levels and total system head (i.e. pump basics).
- Pump efficiency and energy efficiency requirements.
- Valves, piping and fittings.
- Interior linings for corrosion resistance.
- Design of any concrete structures should be in accordance with the City's Construction Work Specification CW 2160 – Concrete underground structures and works, which gives guidance on the preferred process for concrete formwork.
- Access for maintenance personnel and confined space entry. Physical access can be provided using manhole covers and ladders. However, the infrastructure should be designed to permit as much inspection from the surface as possible, so that entry into the structures is not required unless correctable problems are identified. This may be as simple as equipping crews with sewer inspection cameras mounted on poles. If possible, entry into structures should be located outside of roadways to avoid the need for traffic control measures.
- Access for replacement of pumps and controls.
- Vehicle access and parking for maintenance vehicles. If possible, entry into structures should be located outside of roadways to avoid the need for traffic control measures.
- Odour control.

3.5 Typical Drawings

Figure B-1 in Appendix B presents the general configuration, plan and section drawings for a SRS chamber with flap gate, sluice gate, and off-take.

3.6 Operations and Maintenance

General O&M should include regular inspection of facilities. O&M manuals are available from suppliers, but details such as frequency of inspection and maintenance activities should be flexible and tailored to each district, as debris will differ from catchment to catchment area. If required, high pressure hoses can be used to dislodge stringy materials or other debris interfering with the proper working of the either the flap gate or sluice gate. The ACU-GATE representative product includes a flushing mechanism that will be used to flush debris settled downstream of the gate and near the gate frame.

Initial operation should include inspection of gate chambers and lift stations following every WWF event to develop an understanding for the type of debris and amount of sedimentation encountered during each high flow event. Access to the gate control chamber and the lift station will be required for inspection and cleaning. As such, secure access manhole covers and ladders will be provided for these chambers. However, the infrastructure should be designed to permit as much inspection from the surface as possible, so that entry into the structures is not required unless correctable problems are identified. This may be as simple as equipping crews with sewer inspection cameras mounted on poles. If possible, entry into structures should be located outside of roadways to avoid the need for traffic control measures.

The maintenance schedule for flap gate controls should be broken down as follows: after a WWF event, weekly operations, and monthly operations.

After a WWF event, the following should be completed:

- The gate, upstream and downstream piping, and diversion pipe to lift station should be inspected and cleaned if necessary to confirm that no build-up of sediment, debris, grease, or malodorous materials has occurred.
- The gate control mechanism (disc or flap, seating face, guides and hinges, operating stem, latches, and motorized and manual operators) should be inspected. Obstructions in the seating surfaces and paths of gate travel should be removed.
- All moving parts should be lubricated and adjusted as recommended by the manufacturer.

Weekly inspections are similar to a WWF event, if no such event has occurred in the past week.

Monthly inspections are similar to weekly inspections plus the following: if the flap gate is hydraulically controlled, the hydraulic system should be cycled and checked for proper operation, and the system should be checked for hydraulic leaks. The function of gate position indicators should also be checked and adjusted if necessary. The working condition of back-up power should be checked, if so equipped.

Lift stations should be visited daily, or at least every other day with remote monitoring, to verify that the system is functioning properly. Any alarms recognized by the telemetry or supervisory control and data acquisition (SCADA) system should be responded to and addressed during these daily visits. Regular maintenance intervals should be broken down as follows: after a WWF event, weekly, monthly, and every six months.

After a WWF event, the following should be completed:

- Visually inspect pumps, piping, and fittings and clean if necessary.
- Remove any trash, debris, or malodourous materials from the sump and screen (if so equipped).
- Record run-time hours for each pump.
- Run pumps using manual control to verify proper operation. Leave pumps in automatic mode.

Weekly inspections are similar to a WWF event, plus the following:

- Confirm working condition of back-up power, if so equipped.
- Confirm that check valves are seating properly and are not plugged with debris.
- Check pump seal failure lights (if so equipped).
- Confirm that ventilation system is operating properly.
- Test all control panel operations and lights.
- Inspect the station for vandalism or damage, and clean station grounds.

Monthly inspections usually add the following tasks:

- Clean floats and level controller, if needed.
- Blow out lines on bubbler system, if so equipped.
- Visually inspect wet well for grease build-up, and clean if needed.
- Wash wet well down, if needed.
- Confirm operation of any gate or plug valves.
- Confirm operation of flushing valve, if so equipped.
- Confirm proper cycling of lead-lag pumps.
- Test alarm system.

The inspections every six months should also include the following:

- Remove grit and grease from wet well (usually by vacuum truck).
- Operate automatic transfer switch and back-up power under load (if so equipped) by manually tripping line power.

Annual calibration services include the following:

- Confirm accuracy of flow meter (if so equipped) by performing a draw-down test.
- Assess operating set points (on / off) for pumps and adjust as necessary to improve system performance.

Each gate should be taken out of service for maintenance on a routine basis. Units should be cleaned, and the components checked for such potential issues as leakage when closed, corrosion, removal of obstructions, flushing of closure areas, and adjustment or repacking of seals if so equipped. If not used frequently, gate controls should be cycled at least once every six months.

Common problems that arise in flap or sluice gates are summarized in Table 3-1.

Table 3-1. Typical Operational Problems with Gates

Operational Problem	Cause	Solution
Seat leakage	Gate not seating properly	Check for obstruction between gate and seat or obstruction in path of travel. Check for bent operating mechanism and functioning of hydraulic system (if so equipped).
Gate difficult to operate	Operating mechanism not lubricated often enough	Lubricate. Check function of hydraulic system (if so equipped).
Jammed mechanism	Obstruction Moment / torque setting for mechanism set too low.	Remove obstruction. Consult manufacturer for setting adjustment.
Gate will not operate	Broken mechanism Defective controls	Inspect mechanism and repair. Check control circuits and hydraulic system (if so equipped), and repair or replace.

4. In-Line Storage

A short description of in-line storage is included here to facilitate discussion of design and O&M considerations. For a more detailed description of this option see Part 2, Section 3.3.3.

4.1 Facilities and Equipment

In-line control gates allow for the effective use of the excess upstream storage capacity, reducing the frequency and severity of CSOs without reducing the level of basement flood protection. The main objective for in-line storage is to temporarily contain a volume of CSO in the system until sufficient capacity exists in the interceptor system to convey flows to a wastewater treatment plant.

The infrastructure required for the option include a new in-line gate and chamber, which will also include housing for the mechanism that lifts and lowers the in-line gate. Level sensors and RTC can be used to enhance this option and its operation in conjunction with other control options across other districts. See Part 2, Section 7.3 for more information.

4.2 Product Selection

The TRU-BEND weir, manufactured by Grande Water Management, has been selected as the representative product for the CSO Master Plan. These overflow gates have been used extensively in in-line storage projects in the past and have a proven track record. Recent installations have been completed in New York City, NY; Ottawa, ON, Quebec City, QC and Columbus, OH to name a few. Figure 4-1 shows example installations of this product.

Features of the TRU-BEND weir include the following:

- A non-powered self-adjusting counterweight allows just enough water to overflow, while maintaining the desired constant upstream water level. Once a predetermined inflow is exceeded, the gate fully opens.
- The weir has all stainless steel construction, for easy operation and low maintenance.

Figure 4-1. Examples of TRU-BEND Installations
(Picture credit: http://grandeinc.com/product/overflow-control/tru-bend/)

4.3 Alternative Products

The product listed below has been selected as an alternative, as it has a negligible weir sill that can be installed almost flush with the pipe floor.

4.3.1 Downward Opening Weir Gate, Manufactured by Instream

Figure 4-2 shows an example installation of the Instream Water Control Projects Ltd. downward opening weir gate. This type of gate is similar to the example given previously, but rather than being controlled by a counterweight, the Instream downward opening gate is lowered or raised by a winched cable system, with cables connected to the far edges of the gates. The gate has specially designed side rub plates that keep the cables outside the flow, preventing debris from getting hung up on them, ensuring a smooth uninterrupted flow channel.

Instream's downward opening weir gate can also open flat with minimal flow restrictions, so that the capacity of the conveyance system is maintained during high flows. Controls can be programmed so a loss of power or system error code will cause the gate to open, eliminating the added risk of flow restriction and basement flooding. Several of these gates have been used in the City of Lethbridge, Alberta's wastewater treatment plant to control upstream water levels in various treatment basins. They are available in 304, 316 and 316L stainless steel for corrosive environments.

Figure 4-2. Example of Instream's Downward Opening Gate Installation
(Picture credit: Instream Water Control Projects Ltd.

4.4 Design Considerations

An in-line gate chamber may be stand-alone or combined with a screening chamber. The design of an in-line gate chamber as a proposed solution for the CSO Master Plan has been conservatively designed to include a side overflow weir (for screening). As such, the design for the in-line gate chamber is combined with the design for the overflow screening. See Section 5.4 for the combined design considerations of in-line gate chambers and off-line screening chambers. In addition, designers need to verify that screens are not drowned out by high tailwater levels, as this undermines their self-cleaning system.

4.5 Typical Drawings

Figure B-6 in Appendix B shows the general layout for in-line gate chambers and screening chambers.

4.6 Operations and Maintenance

Initial operation should include inspection of weir stations following every WWF event to develop an understanding for the type of debris and amount of sedimentation encountered during each high flow event. The maintenance schedule for control gates (weirs) should be broken down as follows: after a WWF event, weekly, and monthly.

After a WWF event, operation should include the following:

- The weir and upstream and downstream piping should be inspected and cleaned if necessary to confirm that there is no build-up of sediment, debris, grease, or malodorous materials.
- Document any movement of the overflow detection device and reset if necessary. It is recommended that the City install overflow detection devices to identify CSOs that may have occurred between inspections. These devices usually consist of a small wooden block positioned on the weir and tethered to the chamber wall. Movement of the device is indicative of an overflow.
- Document any instances of backflow from the river; the water level should be below the crest of the weir, so that it prevents river water from entering the sewer.
- Inspect the weir control mechanism for proper operation (weir plates, counter weight, guides and hinges, latches, and motorized and manual operators).
- All moving parts should be lubricated and adjusted as recommended by the manufacturer.

Weekly inspections are similar to a WWF event, if no such event has occurred in the past week.

Monthly inspections are similar to weekly inspections plus the following:

- If the weir is hydraulically controlled, the hydraulic system should be cycled and checked for proper operation, and the system should be checked for hydraulic leaks.
- If the weir is controlled by a winch and cable system, the system should be cycled and checked for proper operation and the cables should be checked for any debris and cleaned if necessary.
- The function of any weir position indicators should also be checked and adjusted if necessary. The working condition of back-up power should be checked, if so equipped.
- Weir controls should be checked for fail-safe open operation.

Each weir should be taken out of service for maintenance on a routine basis. Units should be cleaned, and the components checked for such potential issues as leakage around seals when closed, corrosion, removal of obstructions, and flushing of closure areas. If not used frequently, weir controls should be cycled at least once every six months.

General O&M should also include regular inspection of facilities. O&M manuals are available from suppliers, but details such as frequency of inspection and maintenance activities should be flexible and tailored to each district. If required, high pressure hoses can be used to dislodge stringy materials or other debris interfering with the proper working of the weir.

Access to the weir chamber will be required for inspection and cleaning. This is addressed in Section 5.4.

Common problems that arise in weirs are summarized in Table 4-1.

Table 4-1. Typical Operational Problems with Weirs

Operational Problem	Cause	Solution
Weir leakage	Weir not seating properly	Check for obstruction between weir and seat or obstruction in path of travel. Check for bent operating mechanism and functioning of hydraulic system (if so equipped). Check for misaligned or missing counterweight.
Weir difficult to operate	Operating mechanism not lubricated often enough	Lubricate.
Jammed mechanism	Obstruction Weir and counterweight not balanced	Remove obstruction. Consult manufacturer for setting adjustment.
Weir will not operate	Broken mechanism Defective controls	Inspect mechanism and repair. Check control circuits and hydraulic system (if so equipped), and repair or replace.

5. Screening

5.1 Facilities and Equipment

Screening operation typically requires the installation of an in-line control gate to generate sufficient hydraulic head differential for screening operation to function. The control gate would capture all sewage, including floatables, up to the design capacity, and screening would only take place beyond that point. Excess flow beyond the design capacity is diverted through a side-diversion weir to the screening chamber. The screening chamber returns screened material back to the interceptor downstream of the control gate for final routing to the sewage treatment plant.

Screening operations require hydraulic head, which varies by district location. In cases of minimal hydraulic grade, screenings will be pumped back to the interceptor sewer.

The screening operation takes place to a predetermined rate, after which the control gate would open restoring the full system hydraulic capacity to avoid impacting the level of basement flooding protection.

A powered kiosk for electronic components of the mechanical screens is required. The kiosk houses an interface display, the screen system Central Processing Unit, and other controls for screen operation. If in-line storage is required, the screening system can be incorporated into the in-line gate RTC, such that screening is automatically initiated once a water level threshold is reached or can be manually or remoted engaged. As such, RTC with a SCADA system or incorporated level sensors is also required.

5.2 Product Selection

There are number of screen systems that can be used to control CSO floatables. An overview of the more common options is provided in the following subsections.

5.2.1 Static Screens

Static screens have no moving parts or electrical requirements. Static screens are comprised of a bar rack or perforated mesh that may be mounted vertically in the wastewater flow or horizontally above it. Static screens may be designed with self-cleaning features that direct collected material out of the wastewater flow, but they require manual cleaning after each event. Because static screens are susceptible to blinding, they are typically used for locations with fewer CSOs or for those with smaller peak flow rates in the order of 100 L/s or less.

5.2.2 Non-mechanical Self-cleaning Screens

Self-cleaning screens are like static screens, in that there are no moving parts or electrical requirements. Self-cleaning screens comprise a bar rack or perforated mesh that is mounted horizontally above the wastewater flow. During a WWF event, levels in the screening chamber rise, and the combined sewage flows over a weir onto and then through the screens, such that screenings are captured on top of the screen. A siphon is included, which is used to induce a “scouring backwash” that lifts debris from the mesh and flushes it down the screenings return channel. Self-cleaning screens are less susceptible to blinding than static screens, but they require greater head differential and a larger construction footprint to house the siphons and screening return channels. Self-cleaning screens are typically used for CSOs with peak flow rates in the order of 200 L/s or less.

5.2.3 Mechanically Cleaned Screens

Mechanically cleaned screens are stationary fine screens that are cleaned with a brush driven by a motor or hydraulic pack. They are arranged in either a horizontal or vertical position to the CSO flow. The screen consists of modules of horizontal or vertical fixed bar racks and cleaning assemblies mounted along a weir wall. Each module is made of stainless steel bars with pre-determined spacing or a stainless steel perforated mesh. Spacing or mesh size typically ranges from 4 to 6 mm, with 4 mm being most commonly used for CSO floatables control when flows are directed to receiving waters.

During a CSO event, the water level rises, and the comb or brush begins its raking operation based on a signal from a level sensor. In the horizontal configuration, the flow is upward through the bars / mesh to the receiving body of water, while the solids and floatables are brushed to the edges of the screen and into storage areas reserved for screened material. When the water level drops below the weir, the sensor signals the rake assembly to stop, and screened material is discharged to the dry weather sewer. Though the screens are brushed during operation, they require periodic cleaning with a high-pressure hose by the facility operators to dislodge accumulated stringy materials.

5.2.4 Representative Product

The ACU-SCREEN mechanical screen, manufactured by Grande Water Management, has been selected as the representative product for the CSO Master Plan. These screens have been used extensively in CSO screening projects in the past and have a proven track record. Figure 5-1 shows example installations of this product.

The ACU-SCREEN design is based on a special stainless steel screening surface, with slotted screen openings of 5 mm by 25 mm and a total free area of 50 percent, achieving a high degree of solids retention while minimizing the head loss. Other features include the following:

- Stainless steel 316 construction.
- Self-adjusting brush which provides automatic cleaning of the screening surface in both directions.
- A cleaning system that may be driven by a water wheel (requiring no external energy) or by an electrohydraulic drive, depending on site constraints.
- A slotted screening surface which retains solids greater than 5 mm.
- A design that verifies that moving parts are never submerged.
- A modular screen design that allows for installation over virtually any overflow weir type and size.
- An assembly that is easy to retrofit into existing structures.
- An assembly that may be installed in the vertical or diagonal position, when the preferred horizontal arrangement is not possible due to site constraints.

Figure 5-1. Examples of ACU-SCREEN Installations
(Picture credit http://grandeinc.com/product/overflow-screening/acu-screen/)

5.2.5 Screenings Removal

Screened material is pushed and retained in storage areas adjacent to the mechanical screen. Where there is available head and space, screenings can be returned to the main interceptor under gravity after the overflow event. Where there are space or head constraints, a pumping system is required to remove screenings and return them to the main interceptor for final routing to the sewage treatment plant. There are several suppliers in the market that can provide entire lift station packages with the wet well or provide the pumping, piping, and operational components independently of a wet well.

5.3 Alternative Products

Products listed in the following subsections have been selected as alternative products, as they do not have electrical or moving mechanical components, which is advantageous from a maintenance and occupational health and safety perspective.

5.3.1 Hydro-Static Screen

This static screen is manufactured by Hydro International. It features no moving parts, is self-activating, and has flow-modifying baffles incorporated into the design that provide partial self-cleaning. Material greater than 4 mm or 6 mm is retained by coated screen panels that resist grease build-up. Figure 5-2 shows an example installation of this product.

Hydro-Static screens will be appropriate for sites that have smaller peak flows and less frequent spills, as these screens need to be manually cleaned after each overflow event.

Figure 5-2. Example Installation of a Hydro-Static Screen
(Picture credit: https://www.hydro-int.com/sites/default/files/hydro-static-screen-brochure-en-gb.pdf)

5.3.2 Hydro-Jet Screen

This self-cleaning screen is manufactured by Hydro International. Hydro-Jet screens also feature no moving parts. They are self-activating and self-cleaning, removing material greater than 4 mm in two directions. Compared to the Hydro-Static screen, Hydro-Jet screens require minimal maintenance but do have a larger construction footprint and require greater head loss. Figure 5-3 shows an example installation of this product.

Hydro-Jet screens will be appropriate for sites where a larger construction footprint could be accommodated and where there is greater differential head loss available for screening.

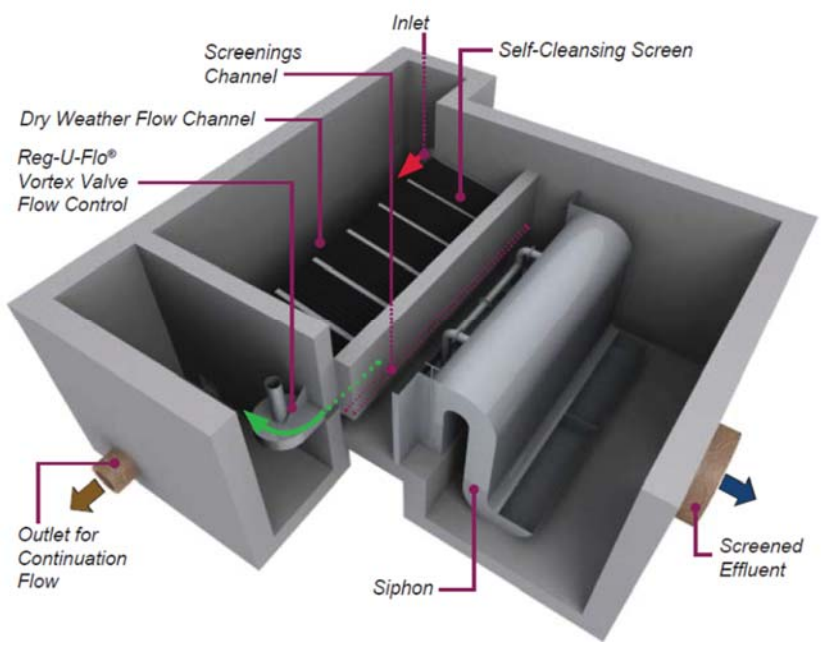


Figure 5-3. Example Installation of Hydro-Jet Screen
(Picture credit: Hydro International UK Ltd.)

5.4 Design Considerations

Figure B-6 in Appendix B depicts the screening chamber as a side addition to the control gate chamber, and includes a side overflow weir, screens, and a discharge channel. Where there is sufficient hydraulic grade, screenings will be returned to the interceptor sewer by gravity. In cases of minimal hydraulic grade, screenings will be pumped back to the interceptor sewer and flow to the wastewater treatment plant.

A cost benefit analysis should be undertaken. There are a variety of issues to consider during the cost benefit analysis, and the subsequent conceptual and detailed design including:

- Ability to retrofit an existing chamber versus construction of a new chamber.
- Ability to construct a new chamber ‘off-line’ to reduce flow interruption.
- Peak flow to be captured by screen.
- Level of screen blinding assumed.
- Risk of basement flooding should screen be 100 percent blinded.
- Fail safe mechanisms.
- Access for maintenance personnel and confined space entry. Secure access manhole covers and ladders must be provided for these chambers. However, the infrastructure should be designed to permit as much inspection from the surface as possible, so that entry into the structures is not required unless correctable problems are identified. This may be as simple as equipping crews with sewer inspection cameras mounted on poles.
- Access for replacement of control weir / gate and screen.
- Screen cleaning mechanism.
- Odour control.

- Design of any concrete structures should be in accordance with the City's Construction Work Specification CW 2160 – Concrete underground structures and works, which gives guidance on the preferred process for concrete formwork.
- Vehicle access and parking for maintenance vehicles. If possible, entry into structures should be located outside of roadways to avoid the need for traffic control measures.
- Is a new outfall required?
- Power requirements and redundancy.

Design parameters and calculations for sizing of the screen are set out in a table in Appendix A. These include:

- Storm Relief Sewer Dimensions
  - Horizontal inside and outside dimensions of the sewer main (d1 and d2);
  - Vertical inside and outside dimensions of the sewer main, if not a round pipe (v1 and v2);
  - Invert elevation at diversion weir (Inv); and,
  - River normal summer elevation (NWL).
- Gate Chamber Design Information
  - Chamber height (GH);
  - Chamber width (GW) [usually default to d1];
  - Control gate top elevation (GTE) [usually Inv + GH];
  - Side weir crest elevation (SWCE) [usually Inv + (GH x 0.50)]; and,
  - Side weir length (SWL).
- Screen Chamber Design information
  - Peak Screen Rate [input parameter in cu.m. per second]; and
  - Screen Chamber Maximum Head (Head) [function of screen selection].

An example screen sizing calculation is included in Appendix A.

5.4.1 Screen

Screen sizing will be determined by the peak discharge over the weir and available head for each outfall, per Table A-1 of Appendix A. The maximum head available for screening is the side overflow weir crest elevation minus the NWL in the receiving river. A 100 mm vertical allowance for end of screens discharge to river level is assumed. Figure B-6 in Appendix B shows the general arrangement of the screening chamber. Head losses labelled in this drawing are the design parameters set out in Table A-2 of Appendix A.

An example screen sizing calculation is included in Appendix A.

Design of screens should be such that the velocity through the screen will be sufficient for matter to attach itself to the screen without producing excessive loss of head or complete clogging of the bars or mesh. At the same time, velocities in the upstream piping network should be sufficient to avoid deposition of solids.

Screen piping and channels should be designed for approach velocities between 0.6 and 1.0 m/s. If velocities drop below 0.6 m/s, grit and screenings might accumulate upstream of the screen. Accumulated debris might lead to functional problems once a WWF event flushes that debris to the screens within a short time period. If velocities are higher than 1.0 m/s, debris might bypass the screen and end up downstream.

5.4.2 Control Weir / Gate

Design considerations for the control weir are outlined in Section 4.4 and for gate design are outlined in Section 3.4.1.

5.4.3 Lift Station

In cases of minimal hydraulic grade, screenings may need to be pumped back to the interceptor sewer. This will be done via a sewage lift station constructed adjacent to the screening chamber. As a minimum, a duplex pump-style lift station with one pump meeting 100 percent of design flow is recommended. Design considerations for the lift station are outlined in Section 3.4.2.

5.5 Typical Drawings

Figure B-6 in Appendix B shows the general layout for in-line gate chambers and screening chambers.

5.6 Operations and Maintenance

Initial operation should include the inspection of screens following every WWF event to develop an understanding for the type of floatables and amount of sedimentation encountered during each high flow event. The maintenance schedule for screening facilities should be broken down as follows: after a WWF event, weekly, monthly, and every six months.

After a WWF event, operation should include the following:

- Remove remaining screenings to avoid odour and vermin nuisance. Screenings removed should be disposed of as soon as possible, and the storage area should be regularly washed and cleaned.

  Manually cleaned screens require little or no equipment maintenance and provide a good alternative for smaller flows with few floatables. However, manually cleaned screens require frequent raking to prevent clogging. Cleaning frequency primarily depends upon the amount and composition of floatables in the wastewater flow. Static screens may be designed with self-cleaning features that direct collected material into the wastewater flow to be treated. After a spill event, screens should be relatively clear of debris; if excessive debris is observed, an upstream surcharge condition likely occurred.

  Mechanically cleaned screens usually require less labour for operation than do manually cleaned screens, because screenings are raked or brushed with a mechanical device rather than by operations personnel. However, they still require periodic cleaning with a high-pressure hose to dislodge accumulated stringy material, and the brush or rake teeth on mechanically cleaned screens must be routinely inspected because of their susceptibility to breakage and bending.

- The upstream and downstream piping and the overflow weir should be inspected and cleaned if necessary to confirm that no build-up of sediment or malodorous materials has occurred. It should be noted that screening areas are one area where odours are difficult to avoid.
- The screen raking mechanism (raking chain, sprockets, teeth, brushes, and other moving parts) should be inspected after every WWF event to prevent fouling due to grease, grit, stringy material and rags. All moving parts should be lubricated and adjusted as recommended by the manufacturer.

Weekly inspections are similar to a WWF event, if no such event has occurred in the past week.

Monthly inspections usually add the following task:

- Confirm operation of screen raking mechanism.

Every six months, screens should be taken out of service and the following completed:

- Obstructions should be removed.

- Units should be cleaned.
- Components should be checked for such potential conditions as corrosion, frayed cables, worn chains, teeth or brush replacement, and straightening of bent bars or mesh.

O&M manuals are available from suppliers, but details such as frequency of inspection and maintenance activities should be flexible and tailored to each district.

Access to chambers is required for inspection and cleaning of screens. This is addressed in Section 6.4.

Operators should maintain records of the quantities of screenings observed. They should also note any problems with screening equipment or problems associated with particularly heavy screenings loads. The occurrence of unusual or excessive quantities of screenings should prompt investigation of potential sources both to alleviate the problem at the screening works and to avoid potential problems in the upstream sewer network.

The floatables component of the **2002 CSO Management Study**1 documented the results of a pilot screening study, which captured floatables in booms installed at outfalls in four districts in Winnipeg. A wide variation in floatable types and weights between the study catchments was found. In general, the debris primarily consisted of the following (in order from high to low loading rates): natural debris, grease and scum, plastics, paper products, and hygienic products.

Common problems that arise in the screening facilities are summarized in Table 5-1.

Table 5-1. Typical Operational Problems with Screens

Operational Problem	Cause	Solution
Odours or vermin	Improper or prolonged storage of screenings Screenings are not being returned to the trunk sewer	Provide proper storage and increase removal and disposal. Confirm that return pipe to trunk sewer is not plugged.
Excessive clogging	Unusual amount of debris in wastewater flow Velocity through screen too low Screen not cleaned often enough	Identify source of debris and implement corrective measures. Increase screen opening size. Increase frequency of screen cleaning.
Excessive grit accumulation	Low velocities in piping network	Remove irregularities in floor, weir, or channel. Flush screening chamber regularly.
Jammed raking or brush mechanism	Obstruction Moment setting for mechanism set too low	Remove obstruction. Consult manufacturer for setting adjustment.
Rake or brush will not operate	Broken mechanism Defective controls	Inspect mechanism and repair. Check control circuits, repair or replace.

[1] 'Combined Sewer Overflow Management Study' by Wardrop Engineering Inc., TetreES Consultants Inc., CH2M HILL Canada, and EMA Services Inc., prepared for the City of Winnipeg, Water and Waste Department

6. Gravity Flow Control

A short description of gravity flow control is included here to facilitate discussion of design and O&M considerations. For a more detailed description of this option see Part 2, Section 3.3.5. Orifice control was considered during the modeling exercise but is not the preferred option. Static optimization such as the raising of weirs or pipe reductions, was outside the scope of this exercise but should be evaluated during preliminary design.

6.1 Facilities and Equipment

Districts that discharge to the main interceptor via gravity have no mechanism to modulate flow. These districts would require installation of a flow meter and flow regulating system to allow for integrated system control. This would enable optimal and equitable discharge to the main interceptor across all districts and will give the system the ability to react to local storms, giving one district greater share of the main interceptor capacity when required.

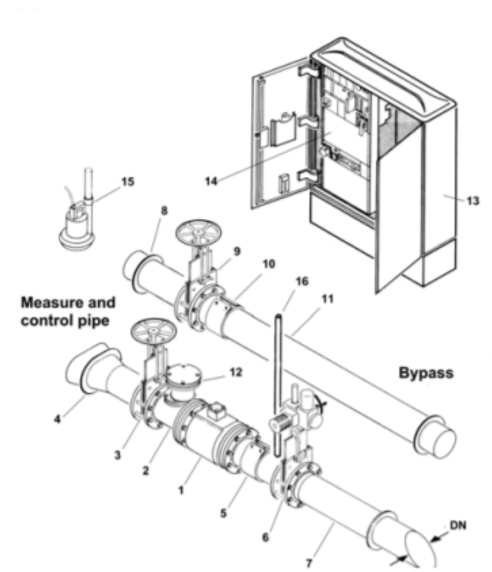
Individual components for this option are shown on Figure 6-2 including a flow meter, flow modulator and other required instrumentation. An aboveground kiosk, housing a control panel and interface, is also required. RTC can be used to enhance this option and its operation in conjunction with other control options across districts. See Part 2, Section 7.3 for more information.

6.2 Product Selection

The HYDROVEX *Fluid*MIDu, manufactured by Veolia Water Technologies, has been selected as the representative product for gravity flow control for the CSO Master Plan. This product has been used extensively in CSO management projects in the past and has a proven track record. Figure 6-1 shows an example installation of this product. Figure 6-2 is a labelled schematic of the components in a typical flow monitoring and regulating station.

Figure 6-1. Example of HYDROVEX® *Fluid*MIDu Installation

(Picture credit courtesy of Veolia, priv comm 9/11/18)



Measuring tube with motorized valve and pumps:

1 Magnetic Flowmeter
2 Tube, stilling length
3 Isolation manual knife gate valve
4 Incoming mouthpiece
5 Self adjusting collar for unit dismantling
6 Motor piloted valve to regulate the flow
7 Outlet tube
8 Bypass pipe and wall thimble
9 Bypass manual valve
10 Self adjusting collar for bypass dismantling
11 Bypass outlet tube
12 Pressure head recorder (optional) or cleaning orifice
13 Above ground or inside building main control panel
14 PLC system, monitoring, recording and instrument adjustments
15 Sump pump
16 Aeration vent

Figure 6-2. Typical Flow Monitoring and Regulating Station
(Picture credit Veolia Water Technologies)

6.3 Alternative Products

6.3.1 Vortex Style Flow Control Valve

A vortex-style flow control valve regulates flow by hydraulic effect. It controls the rate of discharge by creating an air-filled vortex in the valve outlet. These valves rely on upstream hydraulic head, and the flow rate can be customized for a wide range of applications. During low flows, these valves operate like an oversized orifice. During high flows, the valves create a vortex that limits the flow rate.

The advantages of vortex-style flow control valves are their stainless steel construction, which resists corrosion; their ability to maintain constant flow rate without operator intervention; their design, which reduces clogging and maintenance; and a bypass, which allows access for cleaning.

A vortex-style flow control valve could be combined with a RTC-operated gate valve to control flow rate from a catchment area to either ‘On with a set flow rate’ or to ‘Off’. The disadvantage of this type of valve is that, once installed, the flow rate is not adjustable: it only provides one set flow rate restriction. This limitation needs to be considered in design if this type of control valve is to be installed, so that the threshold for throttled flow is correctly set.

6.4 Design Considerations

Consideration of available upstream storage is necessary when deciding if gravity flow control is applicable. If there is little to no upstream storage, there would be little to no benefit controlling flows. One practical application of this approach could be to only install gravity flow control in locations where there are more than two hours of dry weather flow storage upstream.

A cost benefit analysis should be undertaken. There are a variety of issues to consider during the cost benefit analysis, and the subsequent conceptual and detailed design, including:

- Ability to retrofit an existing chamber versus construction of a new station.
- Ability to construct a new station ‘off-line’ to reduce flow interruptions.

- Minimum and maximum flow rates to be controlled.
- Hydraulic head available.
- Fail safe mechanism should flow control valve fail closed (i.e. bypass line).
- Materials of construction for valves, piping and fittings, including linings and coatings for corrosion protection.
- Physical location of station with respect to adjacent utilities and surface structures.
- Design of any concrete structures should be in accordance with the City's Construction Work Specification CW 2160 – Concrete underground structures and works, which gives guidance on the preferred process for concrete formwork.
- Access for maintenance personnel and confined space entry. The infrastructure should be designed to permit as much inspection from the surface as possible, so that entry into the structures is not required unless correctable problems are identified . This may be as simple as equipping crews with sewer inspection cameras mounted on poles.
- Access for replacement of flow meter and control valve.
- Vehicle access and parking for maintenance vehicles. If possible, entry into structures should be located outside of roadways to avoid the need for traffic control measures.
- Power requirements and redundancy.

Sizing of the HYDROVEX *Fluid*MIDu is dependent on the minimum and maximum flow range required. Table 6-1 shows indicative ranges achievable for various nominal diameters

Table 6-1. Indicative Sizing of Flow Monitoring and Regulating HYDROVEX *Fluid*MIDu

Nominal Diameter (Nominal Pipe Size)	Q minimum (L/s)	Q maximum (L/s)
200 mm	10	66
250 mm	17	115
300 mm	28	182
350 mm	43	267
400 mm	61	373
500 mm	109	652
600 mm	176	1,029

6.5 Typical Drawings

Figure 6-3 provides an isometric drawing of a typical flow monitoring and regulating installation.

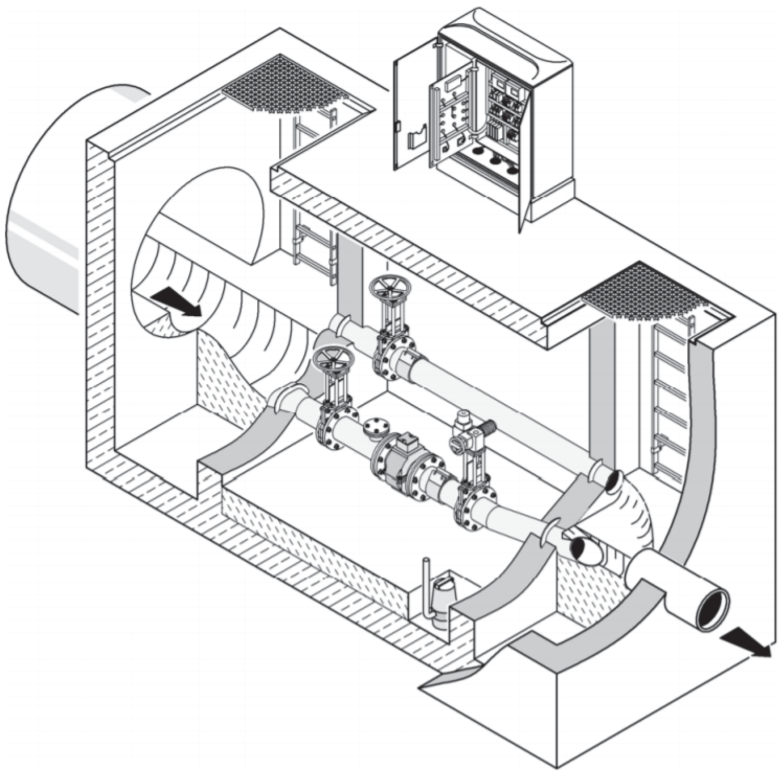


Figure 6-3. Typical Flow Monitoring and Regulating Station Chamber
(Picture credit Veolia Water Technologies)

6.6 Operations and Maintenance

O&M manuals are available from suppliers, but details such as frequency of inspection and maintenance activities should be flexible and tailored to each district, as debris will differ from catchment to catchment area. If required, high pressure hoses can be used to dislodge stringy materials or other debris interfering with the proper working of the flow monitoring and regulating station.

Initial operation should include inspection of the flow control chamber and the piping and controls contained within it following every WWF event to develop an understanding for the type of debris and amount of sedimentation encountered during each high flow event. Access to the flow control chamber will be required for inspection and cleaning. As such, secure access manhole covers and ladders will be provided for these chambers.

The maintenance schedule for gravity flow controls should be broken down as follows: after a WWF event, weekly, and monthly operations.

After a WWF event, the following should be completed:

- The flow meter, flow control valve, piping and fittings should be inspected and cleaned if necessary to confirm that there is no build-up of sediment, grease, or malodorous materials.
- Moving parts should be lubricated and adjusted as recommended by the manufacturer.
- The bypass line should be checked for blockages, sediment, and grease.

Weekly inspections are similar to a WWF event, if no such event has occurred in the past week.

Monthly inspections are similar to weekly inspections, plus the sump pump should be checked (if so equipped) to confirm that it functions and keeps the chamber dry.

Each station should be taken out of service for maintenance on a routine basis. Stations should be cleaned, and the components checked for potential issues such as corrosion, removal of obstructions, and flushing of piping. If not used frequently, both the valve operator and sump pump should be cycled at least once every six months.

Common problems that arise in flow monitoring and regulating stations are summarized in Table 6-2.

Table 6-2. Typical Operational Problems with Flow Monitoring and Regulating Stations

Operational Problem	Cause	Solution
Seat leakage	Flow control valve (usually a knife gate) not seating properly	Check for obstruction between gate and seat. Check for bent operating mechanism.
Valve difficult to operate	Operating mechanism not lubricated often enough	Lubricate.
Jammed mechanism	Obstruction Moment / torque setting for operator set too low	Remove obstruction. Consult manufacturer for setting adjustment.
Valve not operating	Broken mechanism Defective controls	Inspect mechanism and repair. Check control circuits, and repair or replace.
Excessive grit or clogging of piping	Unusual amount of debris in wastewater flow Velocity through piping too low	Identify source of debris and implement corrective measures. Flush piping regularly. Increase slope on piping.
Improper flow measurement	Magnetic flow meter not measuring properly. Mouthpiece on entrance piping missing or damaged.	Clean flow meter electrodes of grease and grit. Consult manufacturer for calibration. Repair or replace mouthpiece.

7. Off-Line Storage

A CSO volume can be stored off-line in either near surface or deeper underground facilities during the peak of a WWF event. Tanks, shafts, or pipes are all types of potential underground storage. Once flow subsides and sufficient capacity is available in the interceptor to convey flows to the wastewater treatment plant, the facilities are then drained into the CS.

Two types of off-line storage are presented below, tank storage and tunnel storage.

7.1 Tank Storage

7.1.1 Facilities and Equipment

The infrastructure required for this option includes concrete or high density polyethylene storage tanks, shafts, or pipes; lift stations to either fill the storage tank and or dewater it depending on the elevation differences between the storage tank and sewer infrastructure; and level sensors, which will also allow for future RTC. Gravity flow control and odour control may also be required.

Figure B-2 in Appendix B shows a schematic representation where a high water level side weir is constructed in the main trunk, which allows overflow into an off-line deep tank via gravity. After the WWF event, the tank is drained by pumping the stored CSO volume back to the main interceptor and on to further treatment (Figure B-3 in Appendix B).

Figure B-4 in Appendix B shows a schematic representation of near surface storage. During the peak of the WWF event, flow will spill from the main trunk through a high level side weir to a pump well chamber, where it is lifted to storage at a higher elevation. After the event, dewatering can occur via gravity or by a second dewatering pump (Figure B-5 in Appendix B).

7.1.2 Product Selection

Most underground CSO storage tanks are constructed from either precast or cast-in-place concrete. StormTrap by LaFarge (Figure 7-1) is a precast concrete tank system. Although traditionally used for storm water detention, StormTraps has also been used in CSO projects.

Figure 7-1. StormTrap Detention Tank
(Picture credit: LaFarge)

7.1.3 Alternative Products

Alternative products would include cast-in-place reinforced concrete tanks, deep storage shafts and pipe storage.

7.1.4 Design Considerations

Off-line CSO storage can be either gravity fed or pumped to storage. In gravity fed storage the volume is pumped back to the sewer after the storm event. In pumped storage the volume is pumped from the sewer main to storage then released back to the sewer after the storm event at a controlled flow rate.

A cost benefit analysis should be undertaken. There are a variety of issues to consider during the cost benefit analysis, and the subsequent conceptual and detailed design, including:

- Deep storage versus near surface storage. Deep storage tanks, shafts, or pipes are costly to construct and maintain, posing a greater health and safety risk than near surface storage. In built-up urban areas, deep storage can be easier to locate away from existing underground services.
- Forcemain length and return connection length back into the interceptor. Storage tanks, shafts, or pipes should be located reasonably close to the interceptor network.
- Location of storage facility with respect to adjacent utilities and surface structures.
- Pumps and gravity flow controllers should be sized to dewater tanks within 24 hours of the WWF event.
- Design of any concrete structures should be in accordance with the City's Construction Work Specification CW 2160 – Concrete underground structures and works, which gives guidance on the preferred process for concrete formwork.

- Off-line storage tank floors should be designed with adequate slope to promote self-cleaning and adequate flushing velocities, which help to reduce the maintenance burden. Consideration should be made to installing flushing pipes along the ceiling of any storage facility to facilitate cleaning.
- Consideration should be made for mixing storage contents to help reduce accumulated solids.
- Large storage facilities should be divided into multiple compartments that can be filled sequentially to enhance flexibility and reduce clean-up time after a small wet weather event.
- Access for maintenance personnel and confined space entry. Physical access can be provided using manhole covers and ladders. However, the infrastructure should be designed to permit as much inspection from the surface as possible, so that entry into the structures is not required unless correctable problems are identified. This may be as simple as equipping crews with sewer inspection cameras mounted on poles. I f possible, entry into structures should be located outside of roadways to avoid the need for traffic control measures.
- Vehicle access and parking for maintenance vehicles. Off-line storage systems require regular pumping and servicing. Secure service accesses must be provided into each compartment, tank, or storage pipe; and pumping access ports should be brought to or above the ground surface for emergency pumping access.
- Large off-line storage facilities should have multiple pumping ports and service accesses. All covers should be leak-proof to prevent both infiltration and exfiltration. The area around these access points should be graded, so that any spillage can be washed back into the tank.
- Power requirements and redundancy.
- Odour control.

7.1.5 Typical Drawings

Figures B-2 and B-3 in Appendix B are schematic representations of an off-line deep storage tank.

Figures B-4 and B-5 in Appendix B are schematic representations of an off-line near surface storage tank.

7.1.6 Operations and Maintenance

Operators should maintain records of the quantities of sludge, grit, and floatables found in any off-line storage system. They should also note any problems associated with particularly heavy rainfall events.

The maintenance schedule for off-line storage facilities should be broken down as follows: after a WWF event, weekly, monthly, and every six months.

After a WWF event, operation should include the following:

- Inspect the storage facility for significant quantities of sludge, grit, or floatables remaining in the bottom of the tank or stuck to the level controls.
- Both the tank and pumping station should be inspected and cleaned if necessary to confirm that no build-up of sediment or malodorous materials has occurred. It should be noted that holding tanks are one of the areas where odours are difficult to avoid.
- All rotating or moving parts in the pumping station should be lubricated as recommended by the manufacturer. Confirm that the float controls are operational.

Weekly inspections are similar to a WWF event, if no such event has occurred in the past week.

Monthly inspections usually add the following tasks:

- Clean floats and level controller, if needed.
- Blow out lines on bubbler system, if so equipped.

- Visually inspect storage tank for grease build-up, and clean if needed.

Every six months, storage tanks should be taken out of service and the following completed:

- Inspect components for corrosion.
- Flush tanks.

O&M requirements for storage tank pumping systems are similar to lift stations. These requirements are outlined in Section 3.6.

7.2 Tunnel Storage

7.2.1 Facilities and Equipment

Tunnel storage is a variant of off-line storage, where large tunnels or pipes are used for storage instead of tanks. Unlike storage tanks, which relieve the system at a specific location, storage tunnels have multiple connections to the sewer system at strategic locations for relief at the broader system level. Tunnels have several advantages, including the following:

- Storage tunnels can convey as well as capture CSO volumes, acting as secondary interceptor sewers crossing catchment areas to utilize excess capacity in adjacent areas or transport wastewater to the treatment facility.
- Tunnels are cost competitive with storage tanks and are easier to locate in CS areas.
- Construction techniques make it possible to design tunnels at nearly any depth and alignment, allowing the tunnel to be filled from CS by gravity drainage rather than high-rate pumping.

Tunnel storage usually involves large diameter and deep pipes, often located alongside rivers to intercept the CSO volume that would otherwise be discharged to the receiving waters. Due to the difficult alluvial ground conditions, large pipe diameters, and built-up urban settings, tunnel storage is often constructed using tunnel boring machines (TBMs). TBMs are used in these situations, as they limit the disturbance to the surrounding ground, excavating at the face of the machine while concurrently building the tunnel wall around it. The CSO Master Plan considered construction of tunnels ranging up to 5,000 mm in diameter and located throughout the CS area.

An example of a TBM is shown on Figure 7-2. Figure 7-3 shows a TBM just starting operation, after it has been lowered into a deep shaft to begin tunneling underground toward the terminal shaft.

Tunnel storage projects often include RTC components to control both the flow into storage and the dewatering process after the WWF event. Given that tunnel storage is often at depth, tunnel dewatering usually involves pumps, which also require RTC and an integrated network of level sensors and flow meters.

One of the biggest examples of a storage and transport tunnel being constructed at the time of writing is the Thames Tideway project. To be completed by 2023, the Tideway tunnel will be 25 km long, up to 7 m in diameter, and up to 66 m deep. The tunnel intercepts 34 CSO outfalls, and it will capture, store, and convey over 39 million cubic metres of untreated raw sewage that would otherwise discharge to the Thames River in the heart of London. The captured CSO volume will be conveyed to a wastewater treatment plant, which is to be upgraded and sized for the new tunnel sewer.

Figure 7-2. Two TBMs Currently Being Used in the Thames Tideway Project in London, UK
(Picture credit: https://www.tideway.london/the-tunnel/the-engineering/)

Figure 7-3. A TBM Beginning Boring Operation in London for the Thames Tideway Project
(Picture credit: https://www.tideway.london/the-tunnel/the-engineering/)

Other recent and North American examples of storage and transport tunnels are the W12 tunnel in Edmonton, Alberta; the West Side CSO Tunnel in Portland, Oregon; and the Deep Tunnel in Chicago, Illinois.

- The Edmonton W12 tunnel is a 2.5 m diameter, 1.2 km long tunnel that conveys combined sewage flows under the North Saskatchewan River to the Gold Bar Wastewater Treatment Plant during WWF events and times of high flow.
- The West Side CSO Tunnel in Portland is 4.3 m in diameter and 5.6 km long and connects to dozens of smaller sewer overflow interceptors along the western side of the Willamette River, conveying

combined sewage flows to the Swan Island Pump Station. Figure 7-4 shows the inside of a completed section of the tunnel during the construction phase and prior to commissioning.

Figure 7-4. West Side CSO Tunnel Under Construction in Portland, Oregon
(Picture credit: https://en.wikipedia.org/wiki/West_Side_CSO_Tunnel)

While tunnels are a viable option for CSO control, they require a major investment and have inherent constructions risks, such as variations in geology and hydrogeology and the contractor's interpretation of these conditions.

The cost of tunnel storage was found to be comparable with off-line tank storage during the cost comparison updates. As such, each district was assessed for both tunnel storage and off-line storage during development of the Phase 2, 85 percent capture option.

7.2.2 Design Considerations

Tunnels are typically constructed using precast concrete, segmental lined panels. Tunnel lining design is a specialized discipline that not only looks at strength, but also at variable loadings such as ground movement and the lining's interaction and flexural behavior, joint reaction, and seismic stability. Panels need to be coated to prevent corrosion from sulphide generation, sewage, and groundwater infiltration. Technologies should also be evaluated to prevent hydrogen sulphide gas collection in the headspace and drop shafts and the resulting odour releases.

Considerations for design of CSO tunnel storage are tunnel dimensions and alignment. The CSO volume to be stored and the location of the wastewater treatment plant are parameters that will dictate the diameter and length of the tunnel. The alignment and depth of the tunnel will be influenced by the location of the CSO outfalls or interceptor mains to be relieved, and other existing underground infrastructure.

Tunnel depth can be significant if the tunnel is to cross under a river, as was the case with the W12 syphon.

For tunnel storage, the requirement for a 4-lane road to allow construction and contractor activities is necessary to provide adequate traffic movement and minimize disruptions, as shaft chamber dimensions could be potentially restrictive for a local road location. This issue led to the proposed offline tunnel locations as defined in Part 3B of the CSO Master Plan.

7.2.3 Operations and Maintenance

Secure service access must be provided into the tunnel storage pipe at regular intervals. Large off-line storage facilities should have multiple service accesses. All covers should be leak-proof to prevent both infiltration and exfiltration. The area around these access points should be graded, so that any spillage can be washed back into the tank.

Physical access can be provided using manhole covers and ladders. However, the infrastructure should be designed to permit as much inspection from the surface as possible, so that entry into the structures is not required unless correctable problems are identified. This may be as simple as equipping crews with sewer inspection cameras mounted on poles. If possible, entry into structures should be located outside of roadways to avoid the need for traffic control measures.

Generally, tunnel storage is self-flushing with the next storm event. Regardless, operators should maintain records of the quantities of sludge, grit, and floatables found in the tunnels. They should also note any problems associated with particularly heavy rainfall events.

The maintenance schedule for tunnel storage facilities should be broken down as follows: after a WWF event, weekly, monthly, and every six months.

After a WWF event, operation should include the following:

- Inspect for significant quantities of sludge, grit, or floatables remaining in the bottom of the tunnel.
- The tunnel, diversion structure, and RTC chambers should be inspected and cleaned if necessary to confirm that no build-up of sediment or malodorous materials has occurred.
- If equipped with a pumping station, all rotating or moving parts should be lubricated as recommended by the manufacturer. Confirm that the float controls are operational and not covered with grease or sludge.

Weekly inspections are similar to a WWF event, if no such event has occurred in the past week.

Monthly inspections usually add the following tasks:

- Visually inspect the storage tunnel for grease build-up, and clean if needed.

Every six months, storage tanks should be taken out of service and the following completed:

- Inspect components for corrosion.
- Flush tanks and clean them of debris.

O&M requirements for pumping systems are similar to lift stations. These requirements are outlined in Section 3.6.

APPENDIX A
EXAMPLE SCREEN SIZING CALCULATION

Design Tables

Table A-1. Design Table for In-line Gate and Screening Option

Description		Calculations	Notes
Station information			
Trunk Horizontal ID	d1		To Be Entered During Preliminary Design Typical for egg-shape d1 < v1
Trunk Horizontal OD	d2		To Be Entered During Preliminary Design
Trunk Vertical ID	v1		To Be Entered During Preliminary Design
Trunk Vertical OD	v2		To Be Entered During Preliminary Design
Invert Elevation at Diversion Weir	Inv		To Be Entered During Preliminary Design
River Normal Summer Elevation	NWL		To Be Entered During Preliminary Design
Gate Chamber Design Information			
Control Gate Height	GH		To Be Entered During Preliminary Design
Control Gate Width	GW		Default to d1
Control Gate Top Elevation	GTE		Invert + gate height
Side Weir Crest Elevation	SWCE		Default Invert + (GH x 0.50)
Side Weir Length	SWL		Default 50 percent of pipe width
Screen Chamber Design Information			
Peak Screen Rate			To Be Entered During Preliminary Design
Screen Chamber Maximum Head	Head		To Be Entered During Preliminary Design
Screen Channel Head Loss	hl_SC	0.100 m	Default value
Outfall Head Loss	hl_Out	0.100 m	Default value
Maximum Screen Loss	hl_max		Maximum head available minus hl_SC minus hl_Out
Mechanical Screen Design			
Design Screen Flow			Normally designed for peak
Design Screen Head Loss			Must not exceed maximum
Number of Rows			Maximum of 2
Screen Width	SW		Either 0.800 or 1.600 m
Design Screen Length			Based on manufacturer's information, selected from Table A-2
Screen Length	SL		Calculated
Screening Area			Normally designed for peak
Screen Chamber Design Information			
Screen Chamber Width	SCW		SW + default 0.500 m
Screen Chamber Length	SCL		SL + SWL + default 1.000 m
Gate Chamber Dimensions			

Table A-1. Design Table for In-line Gate and Screening Option

Description		Calculations	Notes
Gate Chamber Length	GCL		GH + default 4.500 m
Gate Chamber Width			d2 + default 1.000 m
Counter Weight Chamber	GCW		Manufacturer's recommendations

Table A-2. Screen Sizing Table, based on ACU-SCREEN

(Assuming 2 rows of 0.8 m wide linear screen and horizontal screens)

Linear Screen Length (m) for Peak flow (m^3/s) and Head (m)					
	Head (m)				
Flow (m^3/s)	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**
0.2	2.67	1.04	0.65	0.47	0.37
0.4	5.33	2.09	1.30	0.94	0.74
0.6	8.00	3.13	1.95	1.41	1.11
0.8	10.67	4.17	2.59	1.88	1.48
1.0	13.33	5.22	3.24	2.35	1.85
1.2	16.00	6.26	3.89	2.82	2.22
1.4	18.67	7.30	4.54	3.29	2.58
1.6	21.33	8.35	5.19	3.76	2.95
1.8	24.00	9.39	5.84	4.24	3.32
2.0	26.67	10.43	6.49	4.71	3.69
2.2	29.33	11.48	7.13	5.18	4.06
2.4	32.00	12.52	7.78	5.65	4.43
2.8	37.33	14.61	9.08	6.59	5.17
3.0	40.00	15.65	9.73	7.06	5.54
3.2	42.66	16.70	10.38	7.53	5.91
3.4	45.33	17.74	11.03	8.00	6.28
3.6	48.00	18.78	11.68	8.47	6.65
3.8	50.66	19.83	12.32	8.94	7.02
4.0	53.33	20.87	12.97	9.41	7.38

Example Screen Sizing Calculation

Design Parameters – Cockburn:

- Q_{peak} = 0.520 m^3/second
- H_{max} = 0.650 m
- Inside Pipe Dimensions = 2.700 m wide x 2.075 m high
- Outside Pipe Dimensions = 3.000 m wide x 2.375 m high (assumed 0.15 m wall thickness)
- Invert Elevation = 223.070 m
- Normal Summer River Level = 223.750 m
- Control Gate Height = 1.35 m

Use Tables A-1 and A-2 and the following figures to calculate screening chamber size.

Yellow highlights are input data.

Blue highlights are calculated.

Example Screen Sizing Calculation

Description		Calculations	Notes
Station Information			
Trunk Horizontal ID	d1	2.700 m	Typical for egg-shaped, d1 < v1
Trunk Horizontal OD	d2	3.000 m	
Trunk Vertical ID	v1	2.075 m	
Trunk Vertical OD	v2	2.375 m	
Invert Elevation at Diversion Weir	Inv	223.070 m	
River Normal Summer Elevation	NWL	223.750 m	
Gate Chamber Design Information			
Control Gate Height	GH	1.350 m	
Control Gate Width	GW	2.700 m	Default to d1
Control Gate Top Elevation	GTE	223.070 + 1.350 = 224.420 m	Invert + gate height
Side Weir Crest Elevation	SWCE	223.070 + (1.350 x 0.50) = 223.745 m	Default Invert + (GH x 0.50)
Side Weir Length	SWL	2.700 / 2 = 1.350 m	Default 50 percent of pipe width
Screen Chamber Design Information			
Peak Screen Rate		0.520 m^3/second	
Screen Chamber Maximum Head	Head	0.650 m	
Screen Channel Head Loss	hl_SC	0.100 m	Default value
Outfall Head Loss	hl_Out	0.100 m	Default value
Maximum Screen Loss	hl_max	0.650 – 0.100 – 0.100 = 0.450 m	Maximum head available minus hl_SC minus hl_Out

Example Screen Sizing Calculation

Description		Calculations	Notes
Mechanical Screen Design			
Design Screen Flow		0.520 m^3/second	Normally designed for peak
Design Screen Head Loss		0.200 m	Must not exceed maximum
Number of Rows		2	Maximum of 2
Screen Width	SW	1.600 m	Either 0.800 or 1.600 m
Design Screen Length		3.13 m	Based on manufacturer's information – **From Table 4**
Screen Length	SL	3.500 m	
Screening Area		1.600 m x 3.500 m = 5.600 m^2	Based on horizontal screens
Screen Chamber Design Information			
Screen Chamber Width	SCW	1.600 + 0.500 = 2.100 m	SW + default 0.500 m
Screen Chamber Length	SCL	3.500 m + 1.350 m + 1.000 m = 5.850 m	SL + SWL + default 1.000 m
Gate Chamber Dimensions			
Gate Chamber Length	GCL	1.350 - 4.500 = 5.350 m	GH + default 4.500 m
Gate Chamber Width	GCW	3.000 + 1.000 = 4.000 m	d2 + default 1.000 m
Counter Weight Chamber		Not applicable in this example	Manufacturer's recommendation

Example Screen Sizing Table, based on ACU-SCREEN

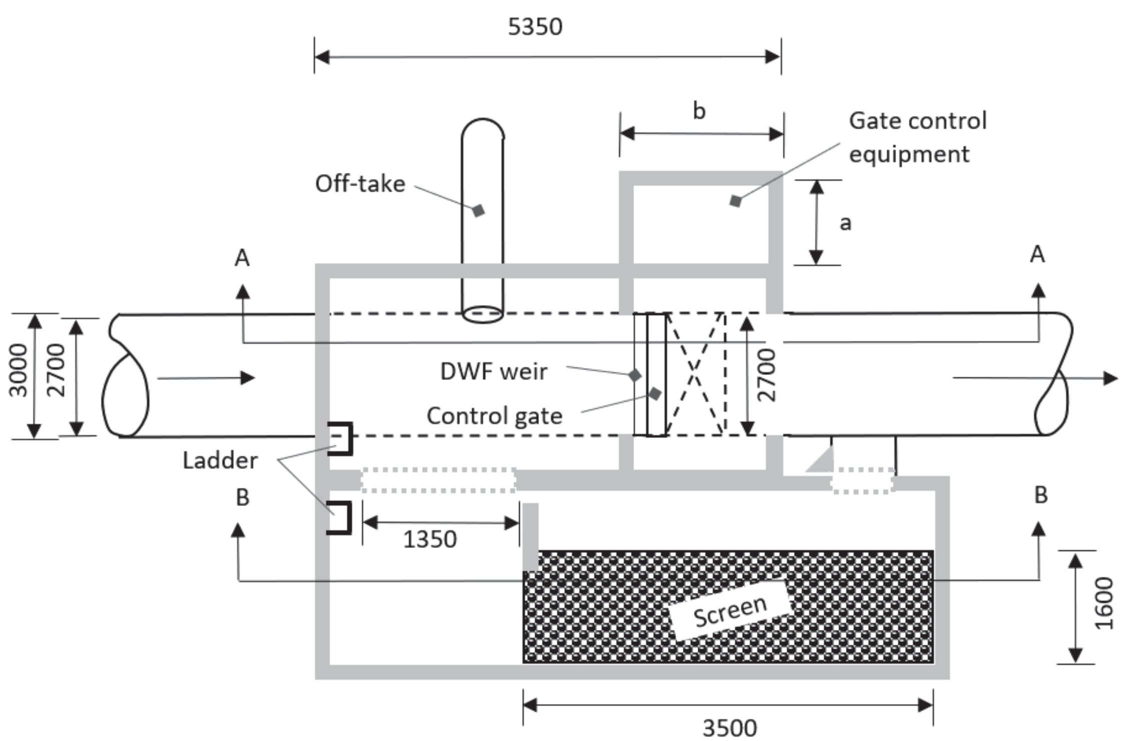
(Assuming 2 rows of 0.8 m wide linear screen and horizontal screens)

Linear Screen Length (m) for Peak flow (m^3/s) and Head (m)					
	Head (m)				
Flow (m^3/s)	0.1	0.2	0.3	0.4	0.5
0.2	2.67	1.04	0.65	0.47	0.37
0.4	5.33	2.09	1.30	0.94	0.74
0.6	8.00	3.13	1.95	1.41	1.11
0.8	10.67	4.17	2.59	1.88	1.48
1.0	13.33	5.22	3.24	2.35	1.85
1.2	16.00	6.26	3.89	2.82	2.22
1.4	18.67	7.30	4.54	3.29	2.58
1.6	21.33	8.35	5.19	3.76	2.95
1.8	24.00	9.39	5.84	4.24	3.32
2.0	26.67	10.43	6.49	4.71	3.69
2.2	29.33	11.48	7.13	5.18	4.06
2.4	32.00	12.52	7.78	5.65	4.43

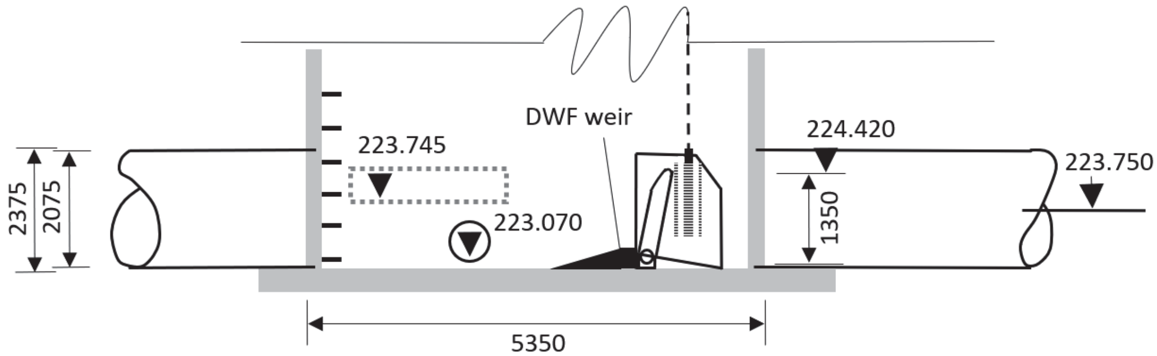
Example Screen Sizing Table, based on ACU-SCREEN

(Assuming 2 rows of 0.8 m wide linear screen and horizontal screens)

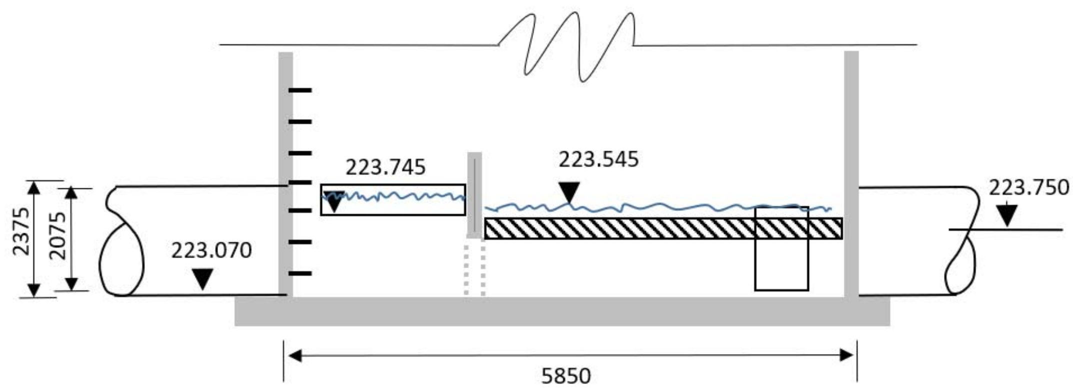
Linear Screen Length (m) for Peak flow (m^3/s) and Head (m)					
	Head (m)				
Flow (m^3/s)	0.1	0.2	0.3	0.4	0.5
2.8	37.33	14.61	9.08	6.59	5.17
3.0	40.00	15.65	9.73	7.06	5.54
3.2	42.66	16.70	10.38	7.53	5.91
3.4	45.33	17.74	11.03	8.00	6.28
3.6	48.00	18.78	11.68	8.47	6.65
3.8	50.66	19.83	12.32	8.94	7.02
4.0	53.33	20.87	12.97	9.41	7.38



Plan View

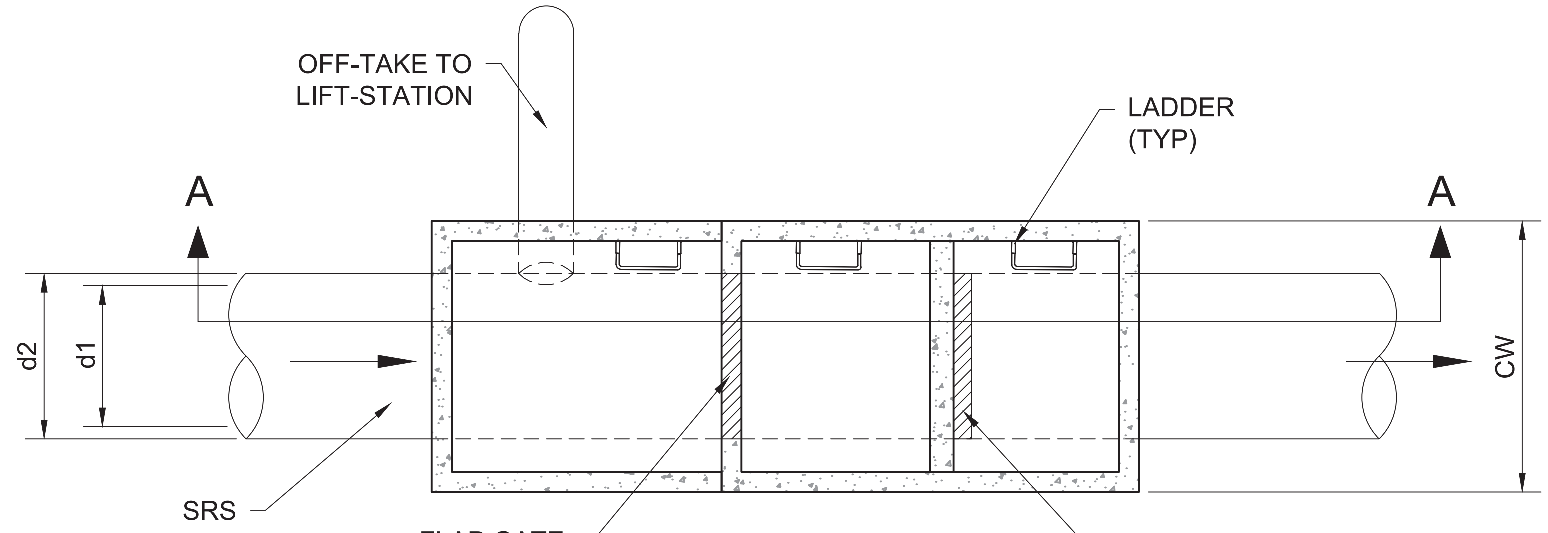


Section A - A

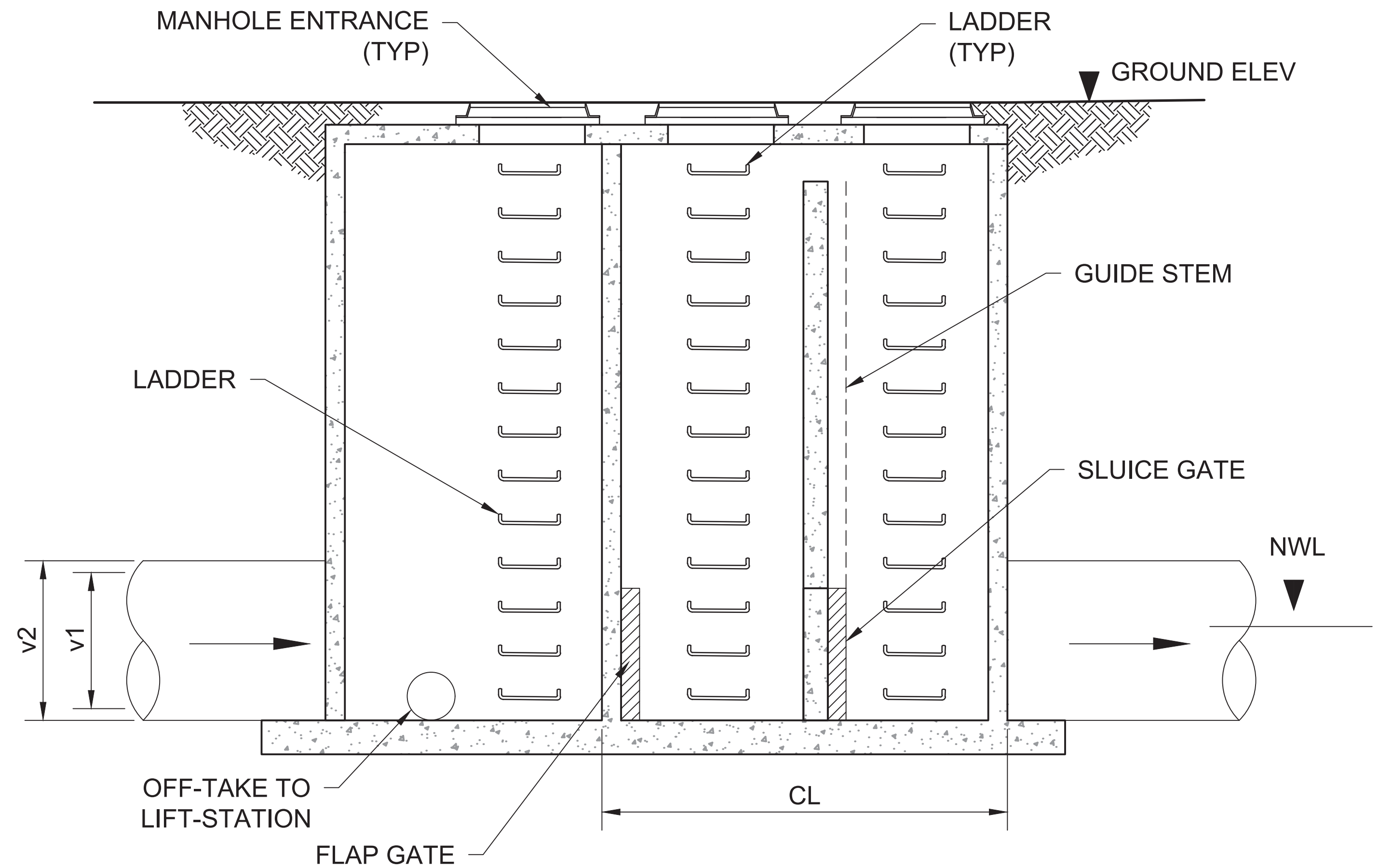


Section B - B

APPENDIX B
FIGURES



PLAN VIEW



SECTION A-A

Winnipeg

CITY OF WINNIPEG

CSO MASTER PLAN

FIGURE B–1 : SRS CHAMBER WITH FLAP GATE AND OFF–TAKE

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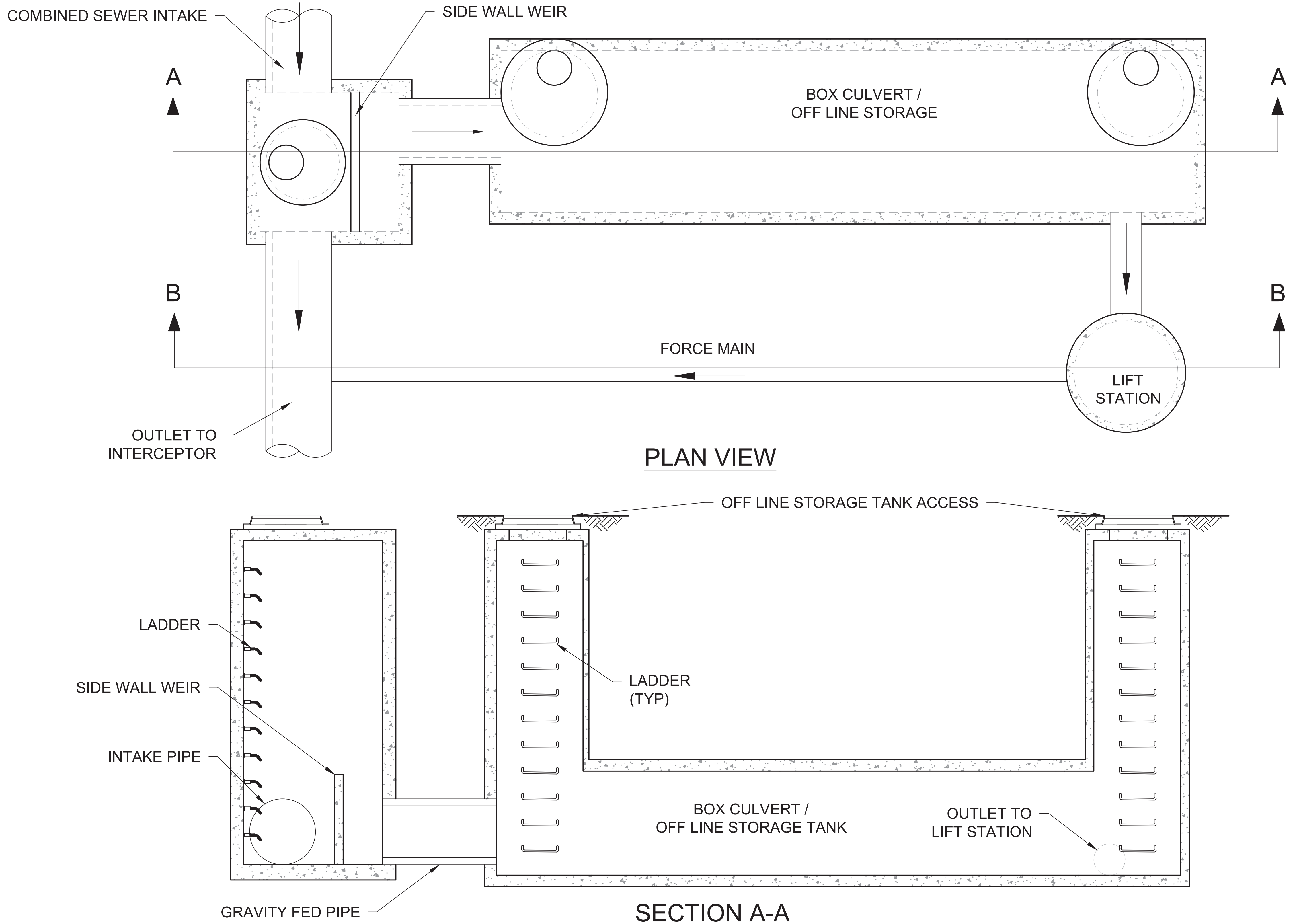

Winnipeg

CITY OF WINNIPEG
CSO MASTER PLAN
FIGURE B–2 : OFFLINE DEEP STORAGE TANK
1 of 2

470010CH

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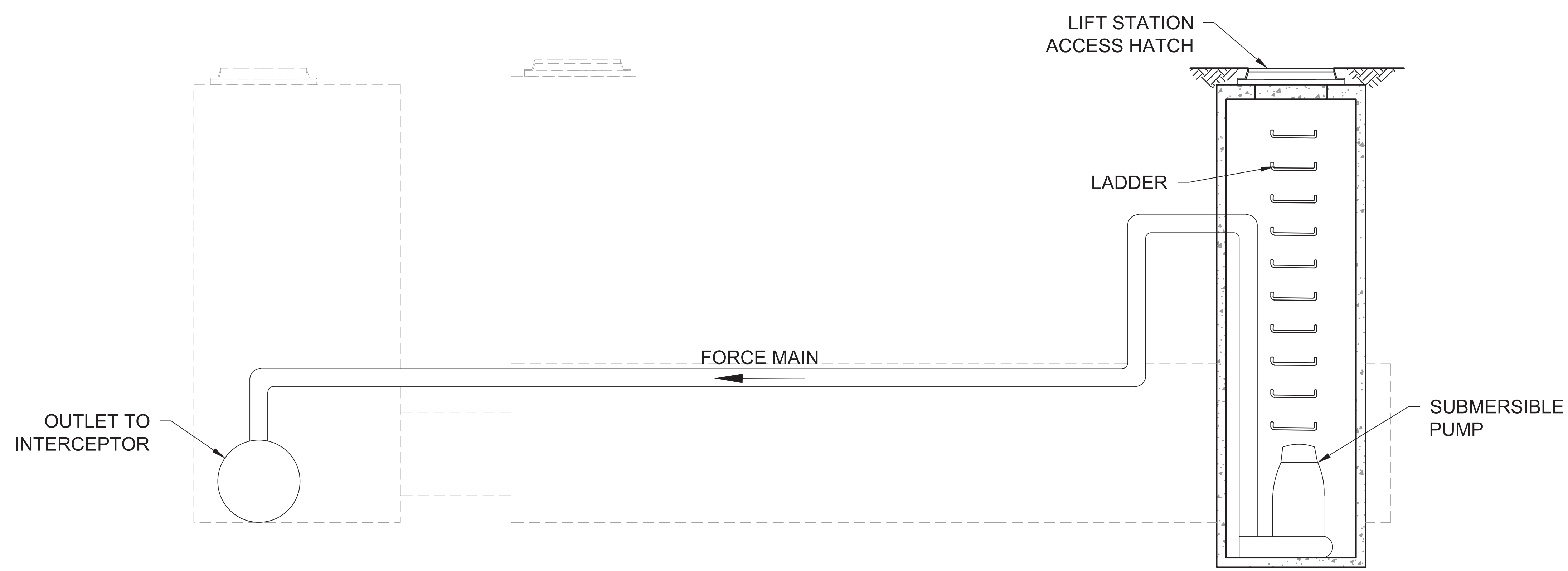

SECTION B-B

CITY OF WINNIPEG

CSO MASTER PLAN

FIGURE B–3 : OFFLINE DEEP STORAGE TANK

2 of 2

Winnipeg

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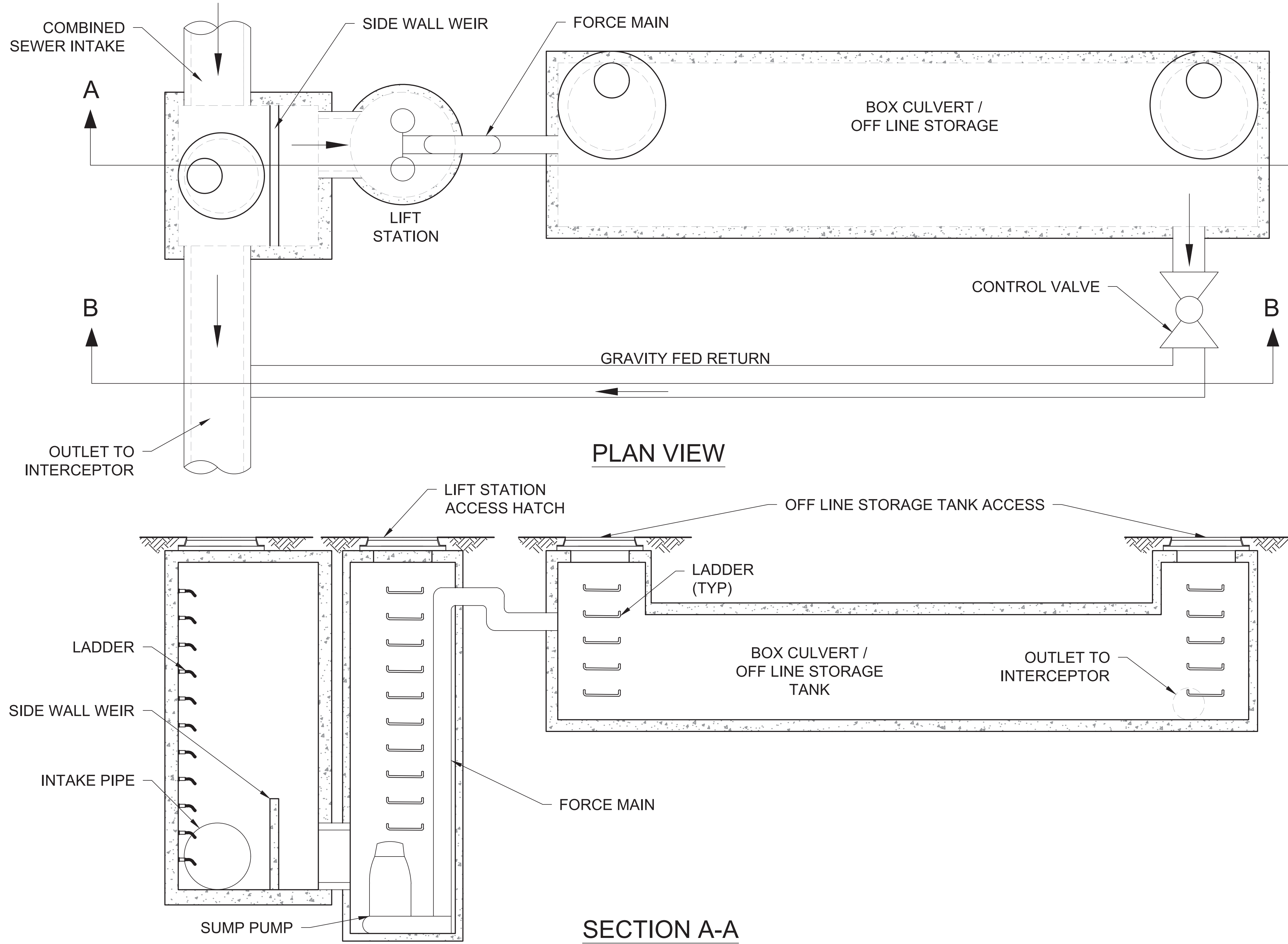

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CITY OF WINNIPEG

CSO MASTER PLAN

FIGURE B–4 : OFFLINE NEAR SURFACE STORAGE TANK

1 of 2

470010CH

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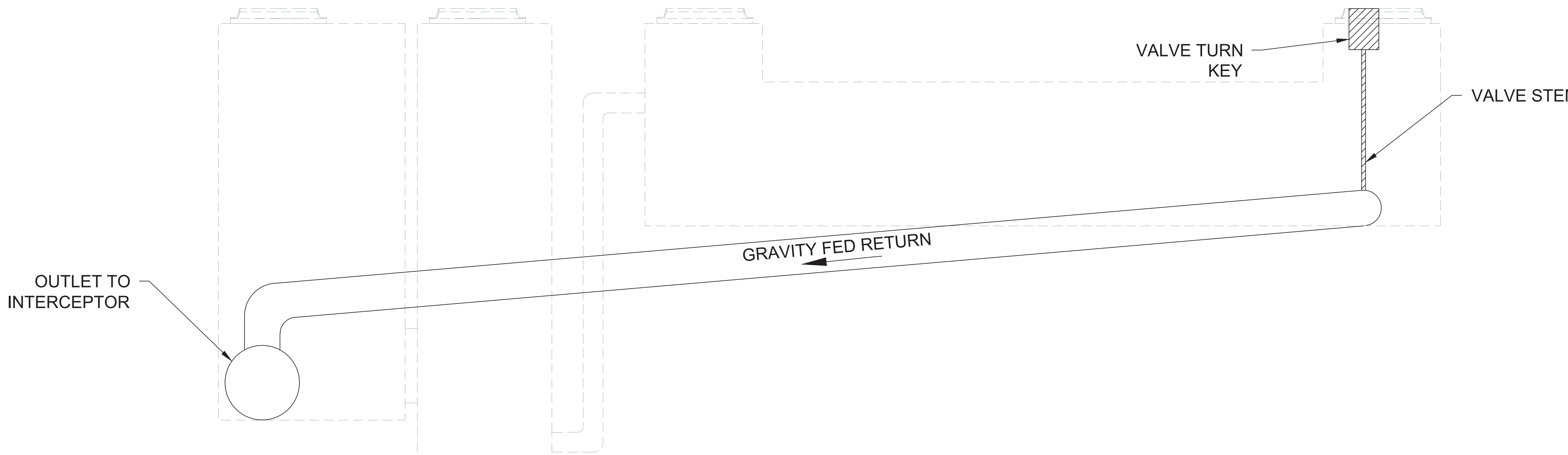

SECTION B-B

CITY OF WINNIPEG

CSO MASTER PLAN

FIGURE B-5 : OFFLINE NEAR SURFACE STORAGE TANK

2 of 2

Winnipeg

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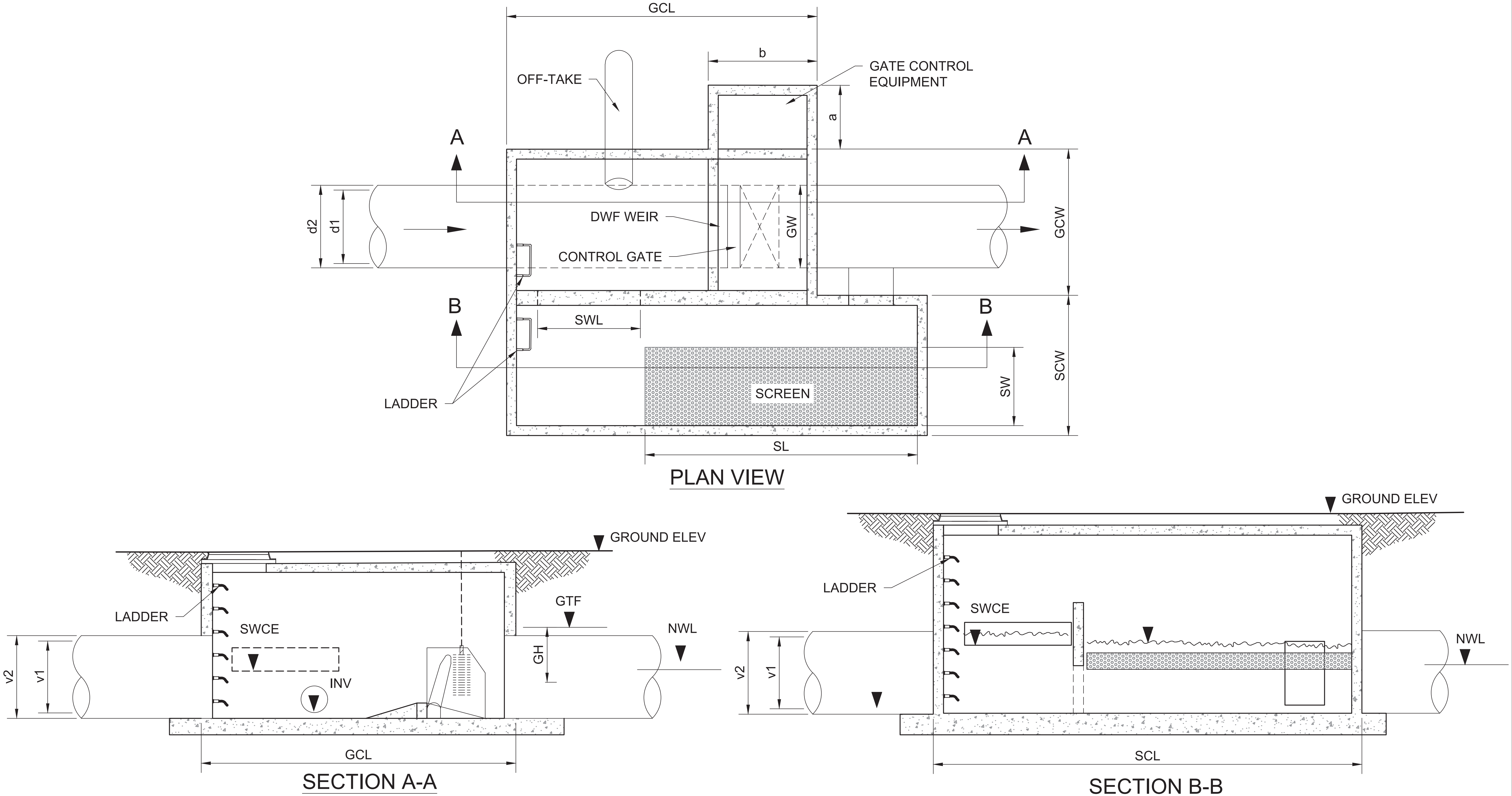

CITY OF WINNIPEG

CSO MASTER PLAN

FIGURE B–6 : IN LINE GATE CHAMBER WITH SIDE ADDITION OF SCREENING CHAMBER

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APPENDIX C
DESIGN TABLE FOR LATENT STORAGE OPTION

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Design Table for Latent Storage Option

Table C-1. Design Table for Latent Storage Option

Description		Calculations	Notes
SRS Dimensions			
SRS Horizontal ID	d1		To Be Entered During Preliminary Design
SRS Horizontal OD	d2		To Be Entered During Preliminary Design
SRS Vertical ID	v1		To Be Entered During Preliminary Design
SRS Vertical OD	v2		To Be Entered During Preliminary Design
SRS Maximum Storage			To Be Entered During Preliminary Design
Invert Elevation at Diversion Weir	Inv		To Be Entered During Preliminary Design
River Normal Summer Elevation	NWL		To Be Entered During Preliminary Design
Gate Chamber Design Information			
Chamber Height			To Be Entered During Preliminary Design
Chamber Length			To Be Entered During Preliminary Design
Chamber Width			To Be Entered During Preliminary Design
Off-Take to Pump Well ID			To Be Entered During Preliminary Design
Gate Design Information			
Flap Gate Height			ACU-GATE available in 2 sizes: 41 cm high by 51 cm wide 41 cm high by 508 cm wide
Flap Gate Width			Calculated, usually matching chamber width.
Sluice Gate Height			Calculated
Sluice Gate Width			Calculated
Pump Design Information			
Dewatering Rate			From storm water modelling
Wet Well Depth			To Be Entered During Preliminary Design
ON Level			Calculated, based upon sump capacity and dimensions
OFF Level			Calculated, based upon sump capacity and dimensions
No. Pumps			Minimum design capacity with one pump out of service
Force Main Design Information			
Force Main ID			To Be Entered During Preliminary Design
Force Main Length			To Be Entered During Preliminary Design

Notes:
ID = inside diameter
Inv = Invert
NWL = Normal Water Level
OD = outside diameter