



CSO Master Plan

Linden District Plan

August 2019

City of Winnipeg



CSO Master Plan

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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 ha¹ 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 Linden 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 Linden 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

CS to CS

- 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 AnnexCS 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.

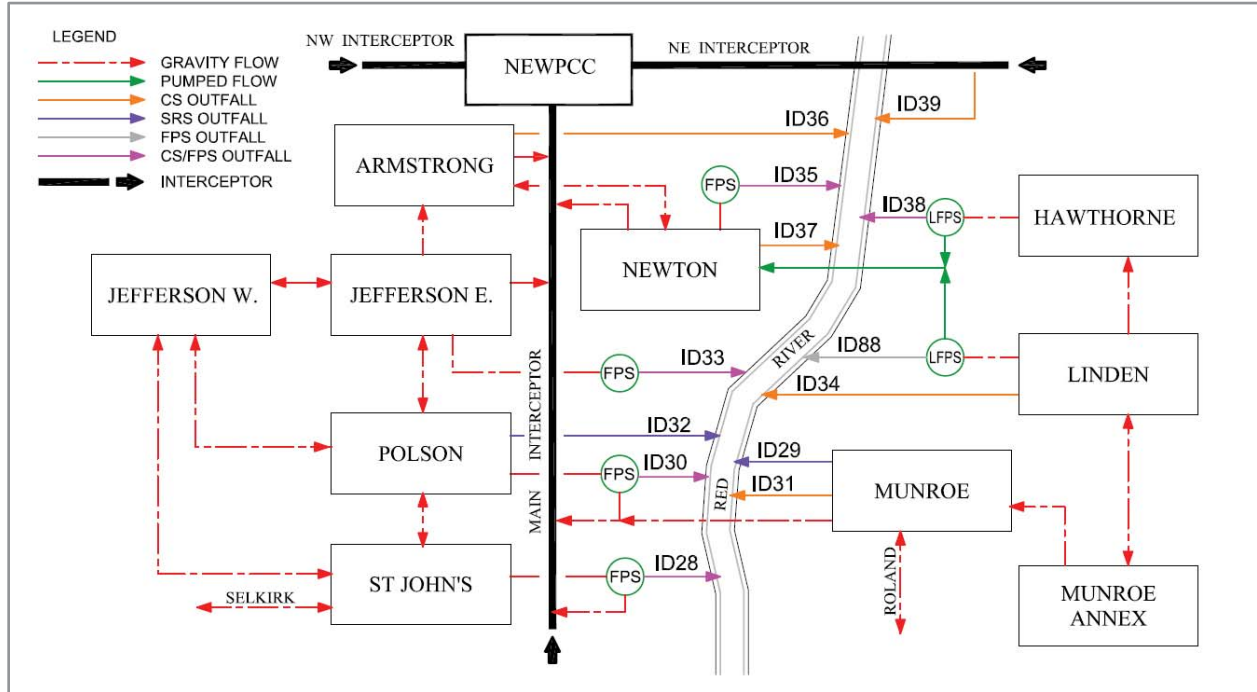


Figure 1-1. District Interconnection Schematic

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
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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 separate 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 conjunction 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 taken into consideration, and this associated 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 representative 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. The area 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. 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 (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	-	-	-

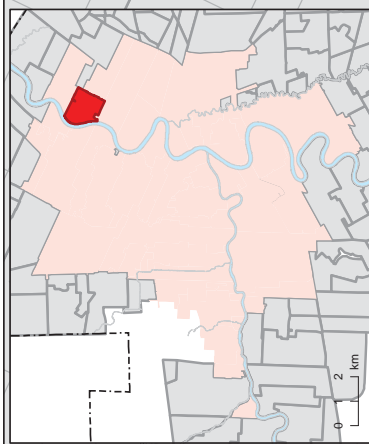
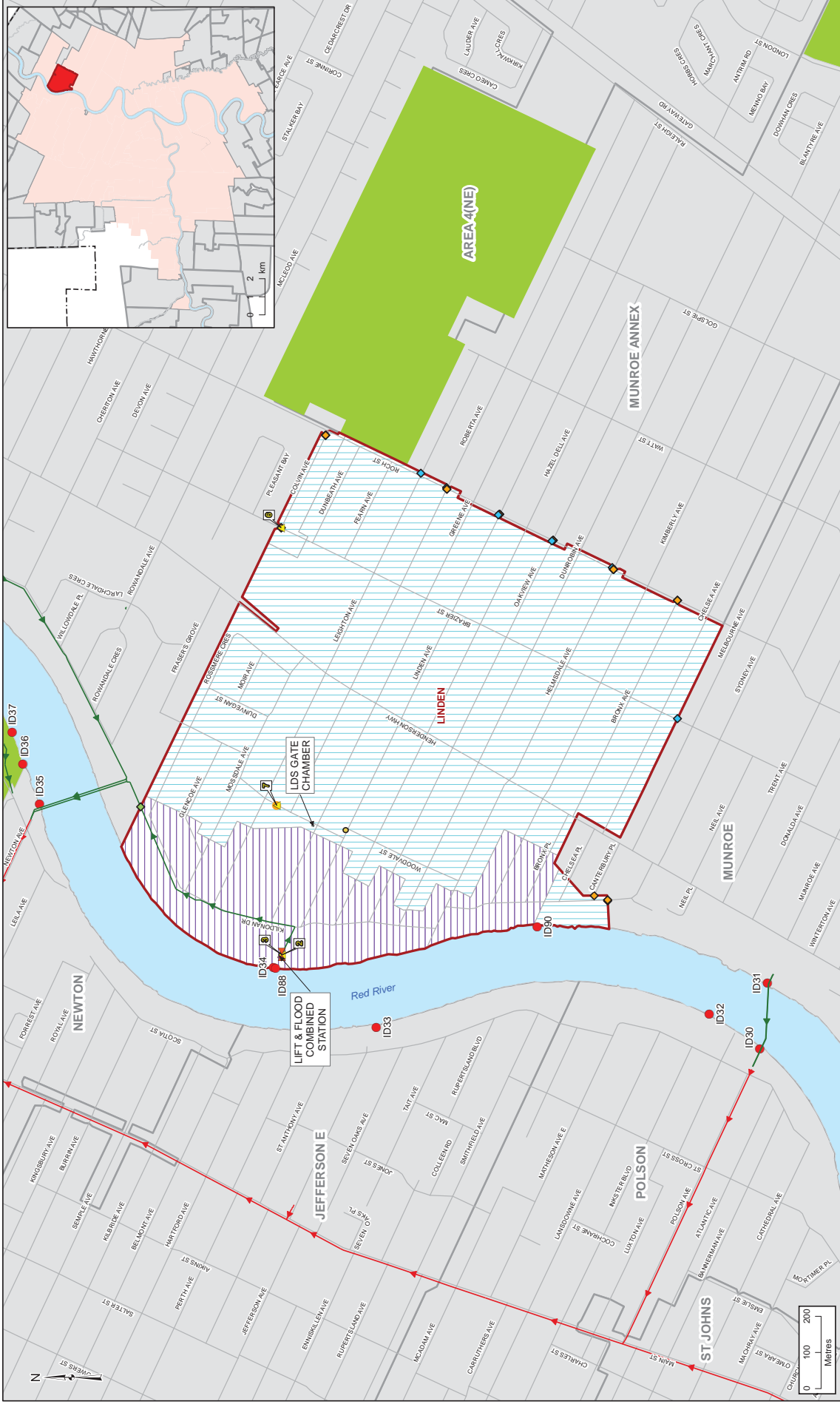
Table 1-9. Control Option 1 Significant Risks and Opportunities

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 Wef
- Critical Elevation
- CSO Outfall
- Low CS Manhole
- Interceptor Sewer
- District Boundary Crossing
- Force Main
- Street
- CS
- LDS
- CS - WWS
- WWS
- 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 23
District Overview Map
Sewer District: Linden
City of Winnipeg
Combined Sewer Overflow Master Plan