Winnipeg | Water and Waste
Eaux et déchets

Environment and Climate Change
Environmental Stewardship Division
Environmental Compliance and Enforcement Branch
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December 13, 2024
Client File No.: 3205.10
Our File Nos.: S-734, EMS
020-17-08-11-00
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Attention: Yvonne Hawryliuk, MSc, Acting Director

RE: ENVIRONMENT ACT LICENCE NO. 3042

The City of Winnipeg is pleased to submit the enclosed *2024 River, Stream, and Combined Sewer Overflow Discharge Water Quality Monitoring Report*, in response to the requirements within the CSO Master Plan approval letter dated November 13, 2019, issued under the Environment Act Licence No. 3042.

This submission fulfills the 2024 requirements specified in Clause E of the 2019 CSO Master Plan approval letter and the related *City of Winnipeg Water Quality Monitoring Plan*, dated January 6, 2023.

The water quality monitoring was completed in 2023 and 2024, with results compared to those from the 2014/15 Interim Water Quality Monitoring. Notably, the comparison indicates some degradation in average river and stream water quality during dry weather flow, an unexpected result that the City will investigate further. An improvement in river and stream water quality during wet weather is also noted.

Additional data collected over time will offer deeper insights into trends and the sensitivity of the data to various influencing factors. As you review this report, please consider the many variables that can affect sample results, such as weather conditions, river dynamics, sampling and testing methods, changes within the city's catchment area and upstream and downstream influences. These considerations are particularly important when comparing data across different events, years, and monitoring campaigns.

Should you have any questions on this submission, please contact Mr. Jon Goodbrandson, P. Eng., at 204-952-7258 or by email at jgoodbrandson@winnipeg.ca.

Sincerely,

[redacted]

Cynthia Wiebe, P.Eng., CAMP
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Attachment

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THE CITY OF WINNIPEG

River, Stream, and Combined Sewer Overflow Discharge Water Quality Monitoring Report

Revision:
Final/Rev 3

Date:
December 6, 2024

KGS Group Project:
23-0107-004

Client Project:
949-2022 / S-1259

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3205.10

Environment Act Licence:
3042

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EXECUTIVE SUMMARY

Kontzamanis Graumann Smith MacMillan Inc. (KGS Group) was retained by the City of Winnipeg to conduct river, stream and combined sewer overflow (CSO) discharge water quality monitoring in accordance with Environment Act Licence No. 3042 and the CSO Master Plan Approval Letter. This report was developed to meet the licence requirements in the 2023 Approved Water Quality Monitoring Plan (Appendix A) [10].

Water quality monitoring was undertaken in 2023 and 2024. The 2023/24 program results as compared to the 2014/15 Interim Water Quality Monitoring are:

- During dry weather, river and stream water quality performance degraded, particularly in streams.
- During wet weather, river and stream water quality performance improved.
- Discharge quality remained within the expected range.

River and stream water quality is influenced by numerous sources, in addition to CSOs. The degraded water quality performance during dry weather is an unexpected result and will be investigated further by the City. Dry weather Flow Event 1 in 2023 had 23.50 mm of total precipitation that occurred in the five days prior to sampling; therefore, it may not reflect dry weather flow conditions (Section 3.5.1).

The improved water quality performance during wet weather is also an unexpected result relative to the number of sewer network changes that have occurred since 2014/15. The apparent improvement in water quality performance may be due to a data anomaly identified in the 2014/15 data set. When the data anomaly is removed, the 2014/15 and 2023/24 performance are similar which would be an expected result.

Discharge quality remained within the expected range based on past monitoring, literature values and the dilution factors of the outfalls monitored.

Several continuous improvement initiatives were implemented in 2023/24 including:

- Site risk assessments to increase sampling safety.
- Manhole sampling method to eliminate confined space entry and meet intrinsic safety requirements.
- Alerts and instrumentation connections to capture wet weather and discharge events.

To establish data trends, additional monitoring campaigns are required such as the next monitoring campaign and report which occurs every 5 years, in accordance with Environment Act Licence No. 3042. This data will also assist with identifying any correlations between sampling results and the environmental context in which they are taken (precipitation, river levels, ambient temperature, etc.).

Recommendations for future programs include:

- Consider adding an additional Red River sampling point at Kildonan Settler's Bridge to provide additional data on the river reach north of the confluence.
- Consider adding one or two days to wet weather sampling events to capture the point at which bacteria levels in rivers return to or below dry weather and/or criteria levels.
- Remove total nitrogen as a priority pollutant of concern, given the lack of exceedances on average across both campaigns. Total nitrogen should continue to be monitored as part of the program.

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ACRONYMS AND ABBREVIATIONS

AVG	Average
BOD_5	five-day biochemical oxygen demand
CALA	Canadian Association for Laboratory Accreditation
CFU	colony forming units
CSO	combined sewer overflow
DL	detection limit
DO	dissolved oxygen
DWF	dry weather flow
EAL	Environment Act Licence
E. coli	*Escherichia coli*
ICM	Integrated Catchment Modelling
MECC	Manitoba Environment and Climate Change
MPN	most probable number
MWQSOG	Manitoba Water Quality Standards Objectives and Guidelines
POC	pollutant of concern
SALD	St. Andrew's Lock and Dam
QA/QC	quality assurance/quality control
RPD	relative percent difference
SCADA	supervisory control and data acquisition
TKN	total Kjeldahl nitrogen
TN	total nitrogen

TP	total phosphorus
TSS	total suspended solids
WQG	Water Quality Guideline (MWQSOGs Tier III)
WQO	Water Quality Objective (MWQSOGs Tier II)
WWF	wet weather flow

1.0 INTRODUCTION

Kontzamanis Graumann Smith MacMillan Inc. (KGS Group) has prepared this monitoring report on behalf of the City of Winnipeg (City). The purpose of the monitoring program was to collect river, stream and combined sewer overflow (CSO) discharge samples in 2023 and 2024, analyze the results and prepare this report. This report compares current river water quality and CSO discharge results to previous performance. In accordance with the conditions in Environment Act Licence (EAL) No. 3042 and the CSO Master Plan Approval Letter, this report is required for submission to Manitoba Environment and Climate Change (MECC).

This monitoring program was undertaken in accordance with the City of Winnipeg Water Quality Monitoring Plan, January 2023 (Appendix A) that was submitted to and approved by MECC (the "2023 Approved Water Quality Monitoring Plan"). The approved plan targeted collecting and analyzing two dry weather and three wet weather river and stream sample sets, as well as three CSO discharge samples at two outfall locations.

The main purpose of this program, per previous conversations between the City and the Province, is to provide a representation of the water quality of Winnipeg's rivers and streams at a point in time and to collect additional CSO discharge data.

For detailed monitoring program design information, including parameters, criteria, locations and methods, see the 2023 Approved Water Quality Monitoring Plan (Appendix A). [10]

1.1 Background

The City has been testing and studying river water quality and CSO discharge quality for decades, through a biweekly river water quality monitoring program, the 2002 CSO Management Study [1] and Interim Monitoring undertaken in 2014/15. [2] Detailed descriptions of these programs and studies, which informed the CSO Master Plan (2015) [3], are included in the 2023 Approved Water Quality Monitoring Plan (Appendix A).

1.2 Public Communications

Scatliff + Miller + Murray (SMM), KGS Group, and the City worked together to identify the appropriate approach and level of public participation for the monitoring program relative to the International Association of Public Participation's public participation spectrum. The monitoring program consisted of executing prescribed regulatory compliance and there were no opportunities for the public to influence the program design. Therefore, the monitoring program was identified to be an Inform level of public participation, with the intent to inform the public-at-large about the program.

The Communications Report, which includes a copy of the project fact card/public notice posted for all wards on the City's Water and Waste Notices webpage and provided to interested public during sampling, is provided in Appendix B.

2.0 ENVIRONMENTAL INFLUENCES

Water quality can be influenced by environmental factors at the time of sampling such as:

- Precipitation
- River levels
- Ambient temperature

Water quality is also influenced by numerous point and non-point sources within and upstream of the city limits.

Precipitation
Larger precipitation (i.e., rainfall) events can result in more dilute discharges and can influence river and stream flows and subsequent dilution of pollutants. Conversely, smaller precipitation events and/or lower river levels can result in higher parameter concentrations.

River Levels

Higher river levels are associated with a greater volume of water in rivers, streams and creeks and greater flows which can provide dilution and mixing of parameters. Discharges during low river levels and/or flows can cause more detriment than discharges during high river levels and/or flows because there is less water volume in the rivers, streams or creeks and typically lower flows.

Ambient Temperature

Warmer ambient temperature can lead to warmer waterbody temperatures which can increase the rate of bacteria decay. Lower ambient temperature can lead to cooler water temperatures which can slow the rate of bacteria decay.

Summary

When monitoring water quality performance over time, the context of the precipitation events and river conditions receiving the discharges need to be taken into consideration along with the sewer network and other watershed and land use changes that may have occurred between monitoring events. Environmental influences that can affect each type of program are discussed in greater detail in each section.

3.0 RIVERS AND STREAMS MONITORING

The monitoring objective was to assess the current river and stream water quality performance during both dry weather and wet weather. The following sections describe the 2023/24 river and stream water quality monitoring program, followed by results and discussion. For more information on parameters and monitoring frequency see the 2023 Approved Water Quality Monitoring Plan (Appendix A).

3.1 Parameters and Criteria

River and stream samples collected in 2023/24 were analyzed for the following nine parameters:

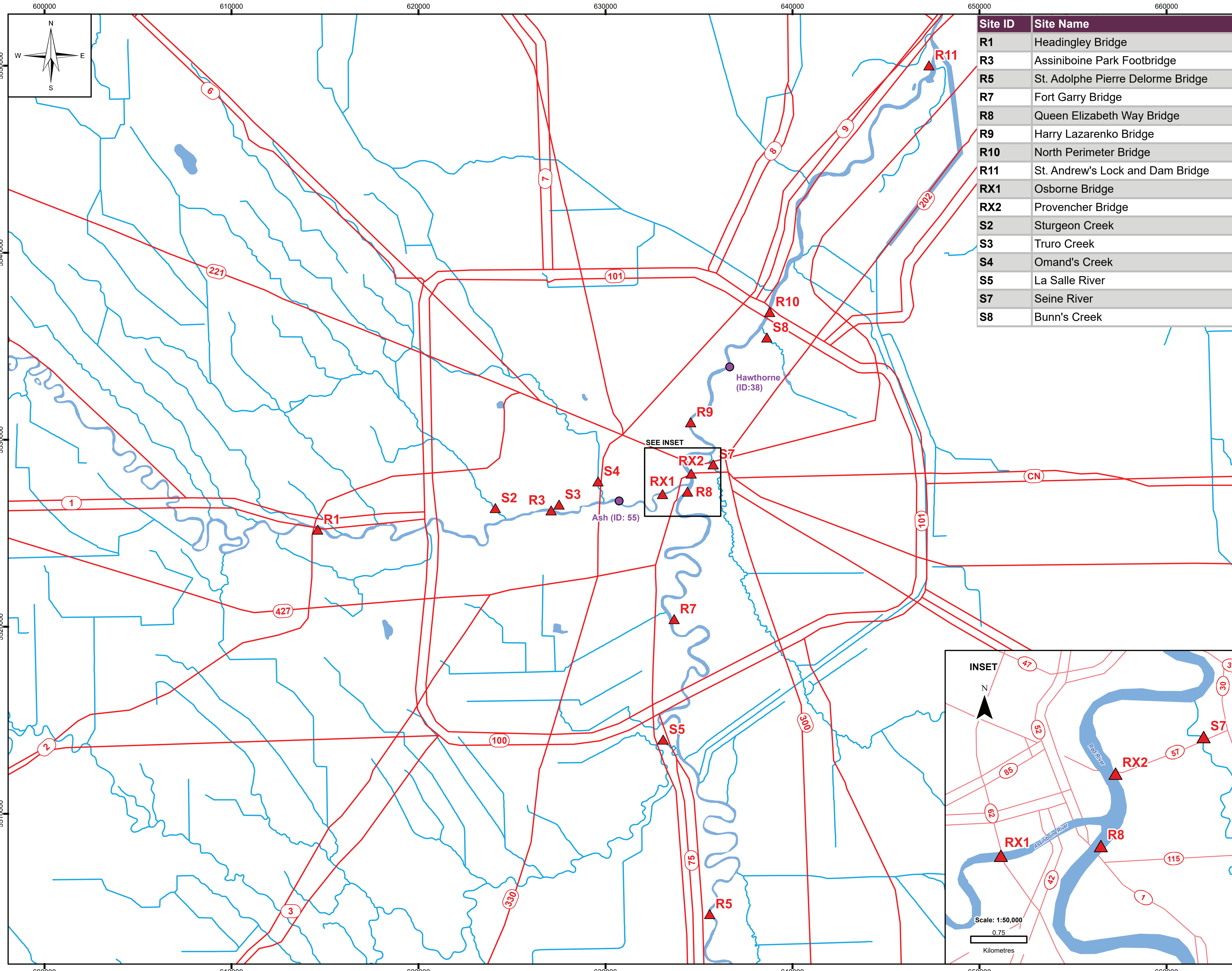
- *Escherichia coli* (*E. coli*)
- Total phosphorus (TP)
- Total nitrogen (TN)
- Five-day biochemical oxygen demand (BOD_5)
- Ammonia
- Total suspended solids (TSS)
- Temperature
- pH
- Dissolved oxygen (DO)

Temperature, pH, and DO were measured on-site. The pH and DO meters were maintained and stored in accordance with manufacturer recommendations and calibrated daily during sampling.

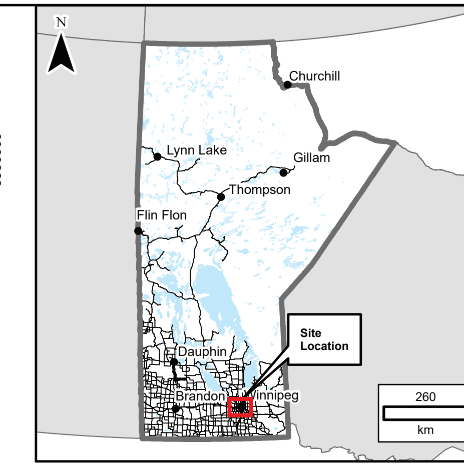
River and stream water quality data was compared to Manitoba Water Quality Standards Objectives and Guidelines (MWQSOG) Tier II Water Quality Objectives (WQO) and Tier III Water Quality Guidelines (WQG), where present, for performance assessment.

3.2 Monitoring Locations

The 2023/24 monitoring locations for rivers and streams are shown in Figure 1. Discharge monitoring locations are also shown. See Section 4.0 for more information on CSO discharge monitoring. The St. Adolphe Bridge (R5) and Harry Lazarenko Bridge (R9) monitoring locations were added to the program in 2023/24, relative to 2014/15.



Site ID	Site Name
R1	Headingley Bridge
R3	Assiniboine Park Footbridge
R5	St. Adolphe Pierre Delorme Bridge
R7	Fort Garry Bridge
R8	Queen Elizabeth Way Bridge
R9	Harry Lazarenko Bridge
R10	North Perimeter Bridge
R11	St. Andrew's Lock and Dam Bridge
RX1	Osborne Bridge
RX2	Provencher Bridge
S2	Sturgeon Creek
S3	Truro Creek
S4	Omand's Creek
S5	La Salle River
S7	Seine River
S8	Bunn's Creek



LEGEND:

- River and Stream Monitoring Locations
- CSO Monitoring Locations
- Primary Road
- Waterway Network
- Manitoba Waterbody

NOTES:

1. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983 CSRS, Zone 14. Elevations are in metres above sea level (MSL).

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REVISIONS / ISSUE

KGS GROUP

Winnipeg

CSO DISCHARGE WQ MONITORING

RIVER, STREAM AND CSO MONITORING LOCATIONS

OCTOBER 2024 | FIGURE 01 | REV: 1

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3.3 Sampling Event Types and Triggers

There were two sample event types for the monitoring program described below: dry weather flow (DWF) and wet weather flow (WWF). For each event type, sampling was carried out for three consecutive days after being triggered.

3.3.1 DWF SAMPLING EVENT

A DWF sampling event occurs during a period of dry weather in the absence of wet weather overflows. To be triggered, a DWF event required:

- three antecedent dry/minimal rainfall (<1mm/day) days; and,
- three subsequent dry days forecasted.

The DWF water quality data indicates natural state river and stream performance, with sewage treatment plant effluents and upstream sources as inputs.

3.3.2 WWF SAMPLING EVENT

A WWF sampling event occurs after a large rainfall event that is sufficient in size to cause city-wide CSOs. To be triggered, a WWF sampling event required:

- three antecedent limited rainfall (<1mm/day) days;
- followed by a rainfall with a depth of ≥5 mm at ≥10 City rain gauge sites;
- ≥20 CSOs; and,
- three subsequent days of limited rainfall (<1mm/day) forecasted.

A WWF event represents discharges from land drainage sewers, CSOs, sewage treatment plants, and direct runoff as inputs on the rivers as they flow through Winnipeg.

3.4 Sample Collection and Analysis

Samples were collected from rivers and streams with a bridge sampling device at each monitoring location from pedestrian walkways on bridges or bridge-sized culverts. At river locations, three subsamples were collected in transect, except for at the St. Andrews Lock and Dam (SALD; R11) site in Lockport, where only one sample was collected due to access limitations. At the stream locations, one sample was collected from the stream midpoint, except at Bunns Creek (S8) where it was collected from the side due to access. Duplicate samples were collected at a 10% frequency for river and stream sampling.

The water samples were stored in coolers with ice, maintained at approximately 4 degrees Celsius and delivered by sampling staff under chain of custody to the City's Environmental Standards Division Lab at the North End Sewage Treatment Plant. Bacteria samples were subsequently delivered under chain of custody by sampling staff to ALS Environmental for analysis within sample hold times. Laboratory hold times and/or drop off temperatures were exceeded for some samples transferred by City staff and/or received by ALS Environmental.

In 2023, MECC approved a change in the collection method, whereby the three subsamples collected in transect for river samples were combined in equal volumes by the City's Environmental Standards Division Lab to generate one composite sample per sampling site for general water quality parameter analysis. The City's Environmental Standards Division Lab subsequently split the composite sample into aliquots. Individual (i.e., non-composite) bacteria samples were collected at each sub-location and analyzed individually due to preservatives in the sampling containers.

General parameters were analyzed by the City's Environmental Standards Division Lab. Bacteria samples were analyzed by ALS Environmental. Both labs are accredited by the Canadian Association for Laboratory Accreditation (CALA) and follow the methods prescribed in the "Standard Methods for the Examination of Water and Wastewater" per Clause 3(a) of EAL No. 3042.

3.5 Dry Weather Flow Monitoring

3.5.1 DRY WEATHER FLOW MONITORING RESULTS

The dry weather flow monitoring results are summarized in Table 1 and in the sections below. E. coli and total phosphorus are discussed in detail as the primary pollutants of concern (POCs). Total nitrogen is discussed at a high level, as no exceedances on average were observed. The full data set, including comparison to 2014/15 is available in Appendix C.

TABLE 1: DRY WEATHER FLOW SAMPLING CONTEXT AND RESULTS

Environmental Factor		Sep 15-19, 2014	Jul 2-4, 2015	*14/15 AVG*	Jul 29-31, 2023	Sep 11-13, 2023	*23/24 AVG**	Current vs. Past Context
River Level (geodetic m)		223.49	223.79	*223.64*	223.82	223.70	*223.76*	Higher River Levels
Total Rainfall (mm)		0.5	43.3	*21.9*	23.5	0.1	*11.8*	Lower Precipitation
Temperature (Deg. C)		9	21	*15*	18	12	*15*	Similar Temperatures
Waterbody	**Parameter**	**2014 DWF 1**	**2015 DWF 2**	***14/15 AVG***	**2023 DWF 1**	**2023 DWF 2**	***23/24 AVG****	**Current vs. Past Performance**
Assiniboine	*E.coli* (MPN/100 mL)	26	42	*33*	39	**222**	*130*	Poorer
	TP (mg/L)	**0.26**	**0.16**	***0.22***	**0.18**	**0.17**	***0.17***	Better
	TN (mg/L)	1.68	1.31	*1.54*	0.81	0.36	*0.59*	Better
Red	*E.coli* (MPN/100 mL)	103	73	*91*	100	76	*88*	Better
	TP (mg/L)	**0.20**	**0.21**	***0.21***	**0.23**	**0.21**	***0.22***	Poorer
	TN (mg/L)	1.34	1.63	*1.45*	0.89	0.85	*0.88*	Better
Streams	*E.coli* (MPN/100 mL)	87	**298**	*167*	**434**	78	***281***	Poorer
	TP (mg/L)	**0.19**	**0.29**	***0.22***	**0.35**	**0.28**	***0.31***	Poorer
	TN (mg/L)	1.04	1.08	*1.06*	0.53	0.74	*0.64*	Better
Overall	*E.coli* (MPN/100 mL)		90			133		Poorer
	TP (mg/L)		**0.21**			**0.25**		Poorer
	TN (mg/L)		1.40			0.72		Better

*** Sample results that were less than or greater than laboratory detection limits (</> DL) were included as absolute values in data average calculations to allow for direct comparison to 2014/15 averages.**

3.5.1.1 *E.coli*

The 2023/24 *E.coli* dry weather flow results are summarized below:

- On average, *E.coli* was below the MWQSOG Tier II Water Quality Objective (WQO;200 CFU/100 mL[1]).
- *E.coli* ranged from <10 MPN/100 mL to 1,620 MPN/100 mL, with an average of 133 MPN/100 mL.
- The individual locations with *E.coli* exceedances, on average, in 2023/24 is presented in Table 2.
- In comparison to 2014/15, the dry weather exceedances in 2023/24 are all at new locations, except for:
  - Omand's Creek which had a 2014/15 exceedance of 300 MPN/100 mL (1.5x the WQO).
- In comparison, dry weather *E.coli* exceedances on average in 2014/15 occurred at:
  - SALD (R11; 346 MPN/100 mL; 1.73x the WQO).
  - Omand's Creek (S4; 300 MPN/100 mL; 1.5x the WQO).
- Figure 2 presents the 2023/24 *E.coli* performance relative to 2014/15, which is summarized as:
  - Better, yet relatively similar in the Red River on average (88 MPN/100 mL vs. 91 MPN/100 mL).
  - Poorer in the Assiniboine River on average (130 MPN/100 mL vs. 33 MPN/100 mL).
  - Poorer in streams on average (281 MPN/100 mL vs. 167 MPN/100 mL).

TABLE 2: DRY WEATHER *E.COLI* EXCEEDANCES, 2023/24

Location	AVG (MPN/100 mL)	MWQSOGs Tier II Exceedance (AVG)	Max (MPN/100 mL)
Harry Lazarenko Bridge (R9)	231	1.2x	1,620
Assiniboine Park Bridge (R3)	206	1.0x	550
Truro Creek (S3)	490	2.5x	1,280
Omand's Creek (S4)	320	1.6x	830
Seine River (S7)	218	1.1x	460
Bunn's Creek (S8)	593	3.0x	1,450

AVG=Average; MWQSOGs = Manitoba Water Quality Standards, Objectives and Guidelines; MPN=Most Probable Number; Tier II WQO for *E.coli* = 200 Colony Forming Units (CFU)/100 mL; CFU and MPN are considered equivalent.

[1] For the purposes of this report, Colony Forming Units (CFU) and Most Probable Number (MPN) estimates for *E.coli* are considered equivalent.

FIGURE 2: *E.COLI* MULTIYEAR DWF PERFORMANCE

3.5.1.2 Total P

The 2023/24 total P dry weather flow results are summarized as follows:

- The MWQSOG Tier III narrative WQG (0.05 mg/L), intended to prevent eutrophication, was exceeded by all dry weather samples, including upstream boundary samples.
- Total P ranged from 0.13 mg/L to 0.62 mg/L in all waterway types, with an average value of 0.25 mg/L.
- In comparison to 2014/15, total P ranged from 0.051 mg/L to 0.952 mg/L[2], with an average value of 0.21 mg/L.
- Figure 3 presents the 2023/24 Total P performance relative to 2014/15, which is summarized as:
  - Poorer but relatively similar in the Red River (0.22 mg/L vs. 0.21 mg/L on average).
  - Better in the Assiniboine River (0.17 mg/L vs. 0.22 mg/L on average).
  - Poorer in streams (0.31 mg/L vs. 0.22 mg/L on average).

3.5.1.3 Total N

The 2023/24 total N dry weather flow results are summarized as follows:

- There were no exceedances of the MWQSOGs Tier II WQO for total N (10 mg/L).
- Total N ranged from <0.20 mg/L to 1.95 mg/L, with an average value of 0.72 mg/L.
- In comparison to 2014/15, total N ranged from 0.48 mg/L to 2.96 mg/L, with an average value of 1.40 mg/L.
- The 2023/24 total N performance relative to 2014/15 is summarized as:
  - Better in the Red River (0.88 mg/L vs. 1.45 mg/L on average).
  - Better in the Assiniboine River (0.59 mg/L vs. 1.54 mg/L on average).
  - Better in streams (0.64 mg/L vs. 1.06 mg/L on average).

3.5.1.4 Non-POC Parameters

The results for non-POC parameters, including ammonia, BOD_5, TSS, temperature, pH, and DO are outlined in Appendix D. Of note, the average TSS values exceeded the MWQSOG criteria (varies) on the Assiniboine River during DWF events in 2023/24, but average TSS concentrations in the Assiniboine improved relative to 2014/15 (45 mg/L vs. 251 mg/L).

[2] 0.952 mg/L is the second highest value in the 2014/15 dataset; the highest value appears to be a data entry error.

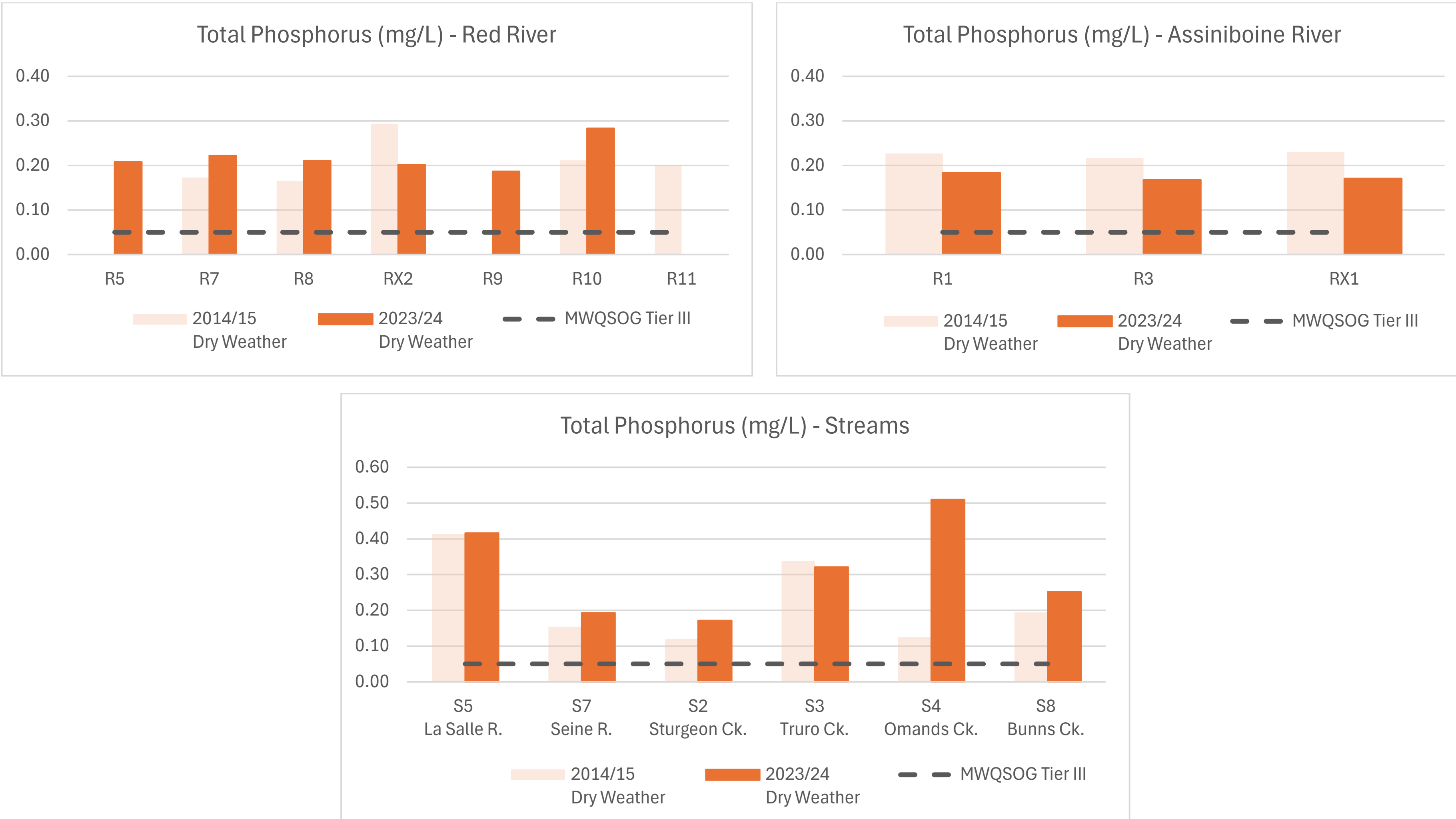

FIGURE 3: TOTAL P MULTIYEAR DWF PERFORMANCE

3.5.2 WATER QUALITY INFLUENCES – DRY WEATHER

Water quality during dry weather flow can be influenced by factors such as:

- Environmental context (antecedent precipitation, river water levels and associated flows, ambient temperature)
- Sampling methods
- Analysis methods

3.5.2.1 Environmental Context

A summary of the environmental context for the dry weather flow events is presented alongside the results in Table 1. In comparison to 2014/15, the environmental context during the 2023 dry weather events were:

- Higher river levels
- Lower antecedent precipitation
- Similar ambient temperatures

3.5.2.2 Sampling Methods

The following river and stream sampling method changes were made in 2023/24:

- **Compositing River Sub Samples:** the three sub samples collected in transect at each river location were composited in equal volumes in the lab prior to being divided into aliquots for analysis. Previously each subsample was submitted individually for analysis and the results were averaged.
- **On-site pH Measurement:** pH was collected on site for river and stream samples using a calibrated and maintained pH probe to provide a more accurate reading than being measured later in the lab.
- **New Locations:** the St. Adolphe Bridge (R5) and Harry Lazarenko Bridge (R9) monitoring locations were added to the program in 2023/24.
- **Shifted Locations:** S2, S3 and S4 were shifted to safer locations nearby on the same stream to match the City's bi-weekly river and stream sampling program locations.

The above sampling method changes are not anticipated to have negatively affected water quality data.

3.5.2.3 Data Analysis Methods

In 2014/15, sample results that were less than or greater than laboratory detection limits (</> DL) were included as absolute values in data average calculations (e.g., <10 mg/L = 10 mg/L; >24,200 MPN/100 mL = 24,200 MPN/100 mL). In 2023/24, sample results that were < / > DL were excluded from data average calculations. The rationale for this change in data average calculation approach was to avoid potentially skewing results. However, to allow for comparison of data, the 2023/24 average results presented in Table 1 above were calculated in the same manner as 2014/15. The 2023/24 average results presented in Appendix C have been calculated using the new approach.

3.5.3 DRY WEATHER FLOW DISCUSSION

E.coli and Total P results were higher in 2023/24 than 2014/15, while Total N results were lower.

Dry weather flow exceedances of *E.coli* on creek-type waterways (Truro, Omand's and Bunn's creeks) were higher (1.6-3.0 x the WQO) than on river-type waterways (Red River, Assiniboine River and Seine River) which were slight (1.0-1.2 x the WQO). The Bunn's Creek and Truro Creek exceedances are marked compared to 2014/15 (14x and 3x higher, respectively). The marked values are primarily associated with Day 3 of DWF Event 1 (i.e., July 31, 2023 results). DWF Event 2 results for Bunn's Creek and Truro Creek were within the *E.coli* WQO.

Total P levels were 1.2x higher than 2014/15 (0.25 mg/L vs. 0.21 mg/L) and exceeded the MWQSOGs Tier III narrative guideline for all samples, including upstream boundary samples, meaning water quality exceeds total P guidelines (by up to 4x) entering the city. Conversely, Total N levels results were nearly halved relative to 2014/15 (0.75 mg/L vs. 1.40 mg/L) and were within guidelines.

The 2023/24 dry weather sample results do not align with expectations based on the environmental context during sampling. For example, river levels were higher in 2023/24 than 2014/15, which would typically be anticipated increase dilution of parameters within the rivers. It is noted that DWF Event 1 had 23.5 mm of total rainfall five days antecedent to the event; therefore, the water quality results may not reflect dry weather conditions. Removal of this event with five-day antecedent rainfall would result in similar or better performance to 2014/15 DWF for most parameters, except *E.coli* in the Assiniboine River.

In addition, river levels presented in Table 1 are based on James Avenue Pumping Station Datum (JASPD) on the Red River and may not reflect river levels on the Assiniboine River, streams and creeks. In general *E.coli* levels were the highest, on average, in the Assiniboine River and streams which typically have lower water levels than the Red River and may have contributed to less dilute results.

Considering the MWQSOGs exceedances observed for *E.coli* and Total P in 2023/24 compared to 2014/15, the City will investigate further. Locations with notable exceedances will be reviewed for possible causes. At this time, according to the City, there are no known sewer system deficiencies that would account for the detriment. It is also possible the observed detriment is due to a difference in environmental influences between the monitoring programs (Section 3.5.2).

3.6 Wet Weather Flow Monitoring

3.6.1 WET WEATHER FLOW MONITORING RESULTS

The wet weather flow results are summarized in Table 3 and summarized in the sections below. The full data set, including comparison to 2014/15 is available in Appendix C.

TABLE 3: WET WEATHER FLOW SAMPLING CONTEXT AND RESULTS

Environmental Factor		Jun 7-9, 2015	Jun 28-30, 2015	Jul 5-7, 2015	*14/15 AVG*	Sep 5-7, 2023	May 4-6, 2024	May 25-27, 2024	*23/24 AVG**	Current vs. Past Context
River Level (geodetic m)		225.01	223.89	223.90	*224.27*	223.67	223.90	224.40	*223.99*	Lower River Levels
Total Rainfall (mm)		20.60	19.90	23.40	*21.30*	10.70	17.20	30.90	*19.60*	Lower Precipitation
Temperature (Deg. C)		19	19	15	*17.53*	14	10	11	*11.43*	Lower Temperatures
Elapsed Time Trigger to Sampling (hr)		N/A	N/A	N/A	-	12	21	24	-	Not Available
Waterbody	**Parameter**	**2015 WWF 1**	**2015 WWF 2**	**2015 WWF 3**	***14/15 AVG***	**2023 WWF 1**	**2024 WWF 2**	**2024 WWF 3**	***23/24 AVG****	**Current vs. Past Performance**
Assiniboine	*E.coli* (MPN/100 mL)	**3,379**	99	197	***1,225***	**2,160**	7.37	**219**	***796***	Better
	TP (mg/L)	**0.14**	**0.16**	**0.23**	***0.18***	**0.14**	**0.31**	**0.21**	***0.22***	Poorer
	TN (mg/L)	1.32	1.40	1.52	*1.41*	0.23	1.10	0.98	*0.77*	Better
Red	*E.coli* (MPN/100 mL)	**3,650**	196	**369**	***1,405***	**2,267**	64	**1,022**	***1,114***	Better
	TP (mg/L)	**0.18**	**0.21**	**0.28**	***0.22***	**0.18**	**0.19**	**0.39**	***0.26***	Poorer
	TN (mg/L)	1.96	1.70	1.90	*1.85*	0.64	1.36	2.90	*1.70*	Better
Streams	*E.coli* (MPN/100 mL)	**4,029**	**2,025**	**3,237**	***3,097***	**1,842**	**588**	**619**	***1,017***	Better
	TP (mg/L)	**0.22**	**0.27**	**0.32**	***0.27***	**0.26**	**0.23**	**0.31**	***0.27***	Similar
	TN (mg/L)	2.00	1.11	1.25	*1.45*	0.90	1.45	2.07	*1.47*	Poorer
Overall	*E.coli* (MPN/100 mL)	**1,672**				**1,012**				Better
	TP (mg/L)	**0.22**				**0.26**				Poorer
	TN (mg/L)	1.65				1.43				Better

* Sample results that were less than or greater than laboratory detection limits (</> DL) were included as absolute values in data average calculations to allow for direct comparison to 2014/15 averages.

3.6.1.1 *E.coli*

The 2023/24 *E.coli* wet weather flow results are presented in Table 3 and summarized below:

- *E.coli* exceedances of the MWQSOG Tier II WQO (200 CFU/100 mL[3]) occurred:
  - On the Red River, downstream of the confluence with the Assiniboine River.
  - On the Assiniboine River, as the river enters the downtown core at Osborne Street Bridge (RX1).
  - In all streams, except for the La Salle River (S5).
- Individual locations with *E.coli* exceedances, on average, in 2023/24 are presented in Table 4.
- *E.coli* ranged from 1 MPN/100 mL to >24,200 MPN/100 mL on all waterway types, with an average of 1,012 MPN/100 mL.
  - On the Red River *E.coli* levels ranged from 2 to 24,200 MPN/100 mL, with an average of 1,114 MPN/100 mL or 5.6x the WQO on average. Notable exceedances in the Red River occurred at:
    - North Perimeter Bridge (R10): 4,668 MPN/100 mL (avg).
    - Provencher Bridge (RX2): 1,065 MPN/100 mL (avg).
    - SALD (R11): 933 MPN/100 mL (avg).
    - Harry Lazarenko Bridge (R9): 675 MPN/100 mL (avg).
  - On the Assiniboine River, *E.coli* levels in exceedance ranged from 1 to 19,900 MPN/100 mL with an average of 796 MPN/100 mL or 4x the WQO on average. The exceedance on the Assiniboine River was:
    - Osborne Street Bridge (RX1): 2,162 MPN/100 mL (avg).
  - In streams, *E.coli* levels ranged from <1 MPN/100 mL to 10,500 MPN/100 mL with an average of 1,017 MPN/100 mL or 5x the WQO. Notable exceedances in streams occurred at:
    - Omand's Creek (S4) with an average of 2,608 MPN/100 mL (13x the WQO).
    - Seine River (S7) with an average of 1,746 MPN/100 mL (8.7x the WQO).

Return to Within Objective

River sites with *E.coli* exceedances returned to within the WQO by sampling Day 3 on average, except for:

- North Perimeter Bridge (R10; 600 MPN/100 mL) during WWF Event 1.
- Osborne Street Bridge (RX1; 325 MPN/100 mL) during WWF Event 1.

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[3] For the purposes of this report, Colony Forming Units (CFU) and Most Probable Number (MPN) estimates for *E.coli* are considered equivalent.

TABLE 4: WET WEATHER *E.COLI* EXCEEDANCES, 2023/24

Location	AVG (MPN/100 mL)	MWQSOGs Tier II Exceedance (on AVG)	Max (MPN/ 100 mL)	DWF Level by Day 3 (on AVG)	Below WQO by Day 3 (on AVG)
Provencher Bridge (RX2)	1,106	5.5x	14,100	No	Yes
Harry Lazarenko Bridge (R9)	675	3.4x	3,080	Yes	Yes
North Perimeter Bridge (R10)	4,668	23.3x	>24,200	No	No
SALD (R11)	933	4.7x	3,650	No	Yes
Osborne Street Bridge (RX1)	2,245	11.2x	19,900	No	No
Sturgeon Creek (S2)	659	3.3x	2,650	No	Yes
Truro Creek (S3)	678	3.4x	3,650	Yes	Yes
Omand's Creek (S4)	2,608	13.0x	10,500	No	No
Seine River (S7)	1,746	8.7x	3,790	No	No
Bunn's Creek (S8)	374	1.9x	500	Yes	No

Notes:
AVG=Average; MWQSOGs = Manitoba Water Quality Standards, Objectives and Guidelines; MPN=Most Probable Number; DWF=Dry Weather Flow; WQO = Water Quality Objective Tier II WQO for *E.coli* = 200 Colony Forming Units (CFU)/100 mL; CFU and MPN are considered equivalent.

Comparison to Previous Years

- *E.coli* performance was better on all waterways in 2023/24 vs. 2014/15, as presented in Figure 4.
- On the Red River in 2014/15, unlike 2023/24, *E. coli* levels were consistently high throughout the city, with notable peaks at:
  - Queen Elizabeth Way (R8) (avg. 1,602 MPN/100 mL) before the confluence.
  - SALD (R11) (1,811 MPN/100 mL) downstream of the city.
- On the Assiniboine River in 2014/15, unlike 2023/24, E. coli levels were above the WQO entering the city at Headingley Bridge (R1) (avg. 1,171 MPN/100 mL) and were consistently high within the city (avg. 1,234-1,270 MPN/100 mL).
- In the streams in 2014/15, the average *E. coli* level was 3.0x higher than in 2023/24 (3,097 MPN/100 mL vs. 1,017 MPN/100 mL). The *E. coli* levels improved by an order of magnitude for streams in 2023/24 on average, except for:
  - Omand's Creek (S4).
  - Seine River (S7).
- In comparison, in 2014/15 Sturgeon Creek (S2) and Omand's Creek (S4) had the highest *E. coli* levels at 6,336 MPN/100 mL (avg.) and 5,578 MPN/100 mL (avg.), respectively. While the Seine River (S7) had the third highest *E. coli* levels in 2014/15 at 2,307 MPN/100 mL.
- Despite remaining relatively high, the *E. coli* levels in Omand's Creek (S4) during wet weather more than halved in 2023/24 as compared to 2014/15 (2,608 MPN/100 mL vs. 5,578 MPN/100 mL).
- The most improved stream performance was Sturgeon Creek (S2), with the 2023/24 wet weather performance for *E. coli* being nearly one tenth of the levels in 2014/15 (659 MPN/100 mL vs 6,336 MPN/100 mL).
- While the La Salle River (S5) had high levels during wet weather in 2014/15 (1,224 MPN/100 mL), the same high trend was not observed in 2023/24 (75 MPN/100 mL).

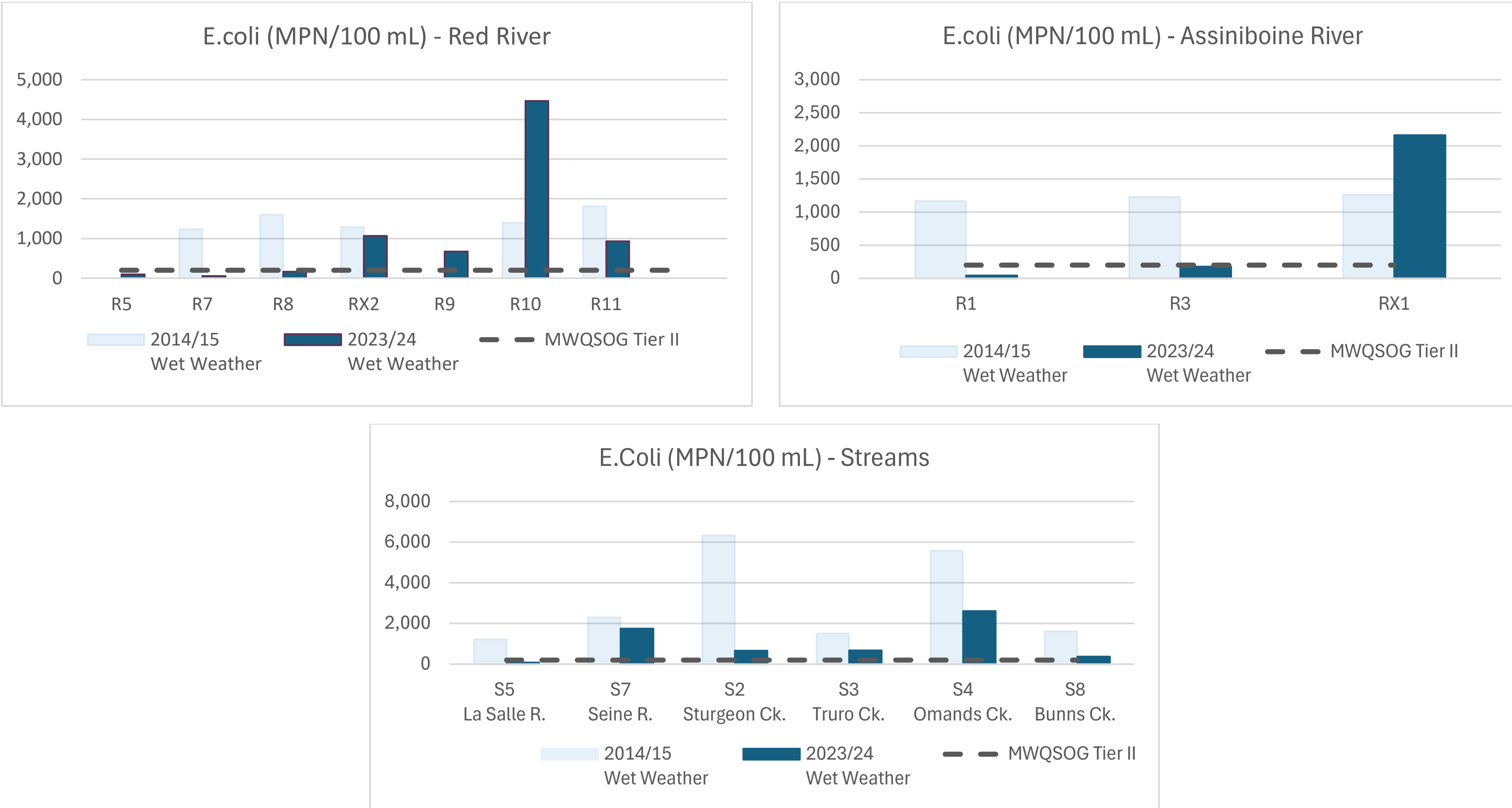

FIGURE 4. E.COLI MULTI YEAR WWF PERFORMANCE

3.6.1.2 Total P

The 2023/24 total P wet weather flow results are summarized below:

- The total P MWQSOG Tier III WQG (0.05 mg/L) was met or exceeded by all wet weather samples, including upstream boundary samples.
- Total P ranged from 0.05 mg/L to 0.85 mg/L, with an average of 0.26 mg/L.
  - On the Red River, total P was higher in 2023/24 as compared to 2014/15 (0.26 mg/L vs. 0.22 mg/L, on average).
  - On the Assiniboine River, total P was higher than 2014/15 (0.22 mg/L vs. 0.18 mg/L, on average).
- Figure 5 presents the 2023/24 Total P performance relative to 2014/15, which is summarized as:
  - Poorer in the Red River (0.26 mg/L vs. 0.22 mg/L on average).
  - Poorer in the Assiniboine River (0.22 mg/L vs. 0.18 mg/L on average)
  - The same in streams (0.27 mg/L on average).

3.6.1.3 Total N

The 2023/24 total N wet weather flow results are summarized below:

- There were no exceedances of the MWQSOGs Tier II WQO for total N (10 mg/L).
- Total N ranged from <0.20mg/L to 5.38 mg/L, with an average of 1.43 mg/L.
- The Red and Assiniboine rivers performed better for total N than in 2014/15:
  - Red River: 1.70 mg/L vs. 1.85 mg/L, on average.
  - Assiniboine River: 0.77 mg/L vs. 1.41 mg/L, on average.
- Streams performed slightly poorer for total N than in 2014/15 (1.47 mg/L vs. 1.45 mg/L, on average).
- In the rivers, the highest average total N concentration in 2023/24 occurred at SALD (R11) downstream of the city in wet weather at 2.49 mg/L; whereas, in 2014/15 the highest was at Queen Elizabeth Way (R8) at 1.96 mg/L.
- In the streams, total N was highest in Sturgeon Creek (S2) at 2.11 mg/L on average in wet weather, followed by the La Salle River (S5) at 1.96 mg/L. In 2014/15, the La Salle River had the highest total N concentrations at 3.44 mg/L.
- Similar to 2014/15, Truro Creek (S3) had the lowest total N concentration of the streams in wet weather at 1.19 mg/L in 2023/24.

3.6.1.4 Non-POC Parameters

The results for non-POC parameters, including ammonia, BOD_5, TSS, temperature, pH, and DO are outlined in Appendix D. Of note, the average TSS values exceeded the MWQSOG criteria (varies) in the Assiniboine River and in the Red River during WWF events. In comparison to 2014/15 results, TSS concentrations improved in the Assiniboine (164 mg/L vs. 194 mg/L) and in the Red River (216 mg/L vs. 242 mg/L) during WWF events.

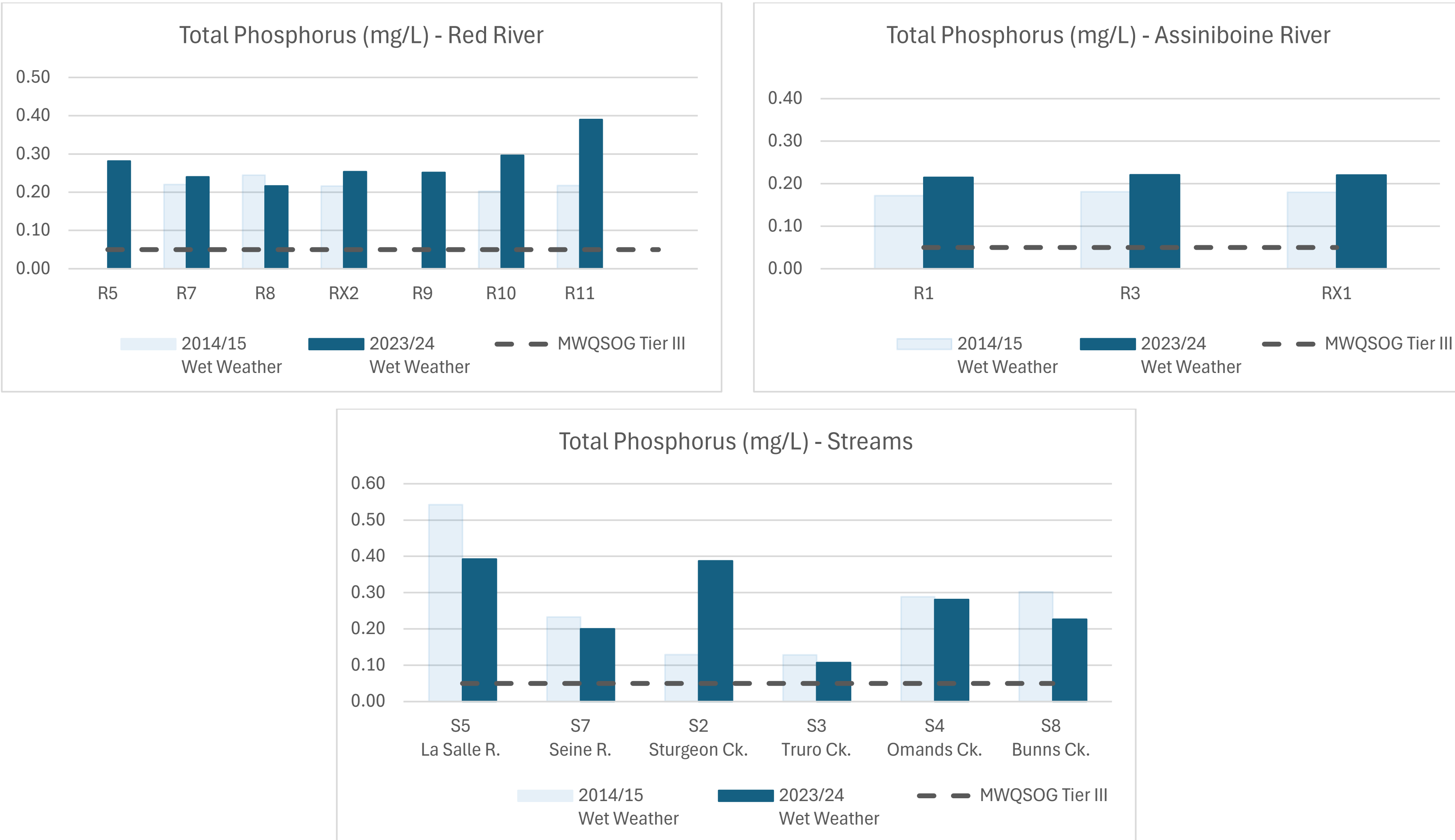

FIGURE 5: TOTAL P MULTIYEAR WWF PERFORMANCE

3.6.2 WATER QUALITY INFLUENCES – WET WEATHER

Water quality during wet weather flow can be influenced by factors such as:

- Precipitation
- River water levels and associated flows
- Ambient temperature
- Nutrient-intensive land uses
- CSO discharge volume and time of day
- Elapsed time between discharge and sample collection
- Laboratory and data analysis

A summary of the wet weather flow sampling context and results was presented in Table 3.

3.6.2.1 Precipitation

As described in Section 2.0, increased precipitation can potentially increase dilution of parameters.

Total rainfall amounts for the five days leading up to each WWF event were shown in Table 3. Environment and Climate Change Canada – Meteorological Service of Canada's total precipitation data [11] was used. The data was compared to the City's 16 rain gauges (Campbell's rainfall data) associated with CSO locations and the data was found to be similar.

WWF Event 1 (September 5-7, 2023) and WWF Event 3 (May 25-27, 2024) correlated with the smallest (10.7 mm) and largest (30.9 mm) pre-event precipitation. Notably, the September 5, 2023 wet weather event was a brief, intense storm that resulted in hail and extensive vegetation damage, especially on the north side of the city.

3.6.2.2 River Levels

The volume of water in a waterbody is a function of river levels. The higher the river level in the waterbody, the more potential dilution may occur. Higher river levels can also be associated with higher waterway flows, which can also increase the mixing and transport of parameters. Overall, river levels were lower during the 2023/24 program on average when compared to the 2014/15 program (223.99 geodetic m vs 224.17 geodetic m).

3.6.2.3 CSO Discharge Volume and Time of Day

The volume of discharges can potentially influence the sampling result, with larger discharge volumes anticipated to provide greater parameter dilution. The timing of a discharge can also be a factor in water quality, with nighttime discharges anticipated to be more concentrated due to less consumptive water use by sewer system users, resulting in less water flow to dilute parameters. WWF Event 1 occurred at nighttime, with the discharge trigger at approximately 3:30 AM on September 5, 2023. WWF Event 2 and 3 occurred during the daytime with triggers around 3:30 pm and 6:30 am on the days preceding the sampling events.

3.6.2.4 Ambient Temperature

As described in Section 2.0, increased ambient temperature can potentially increase the decay rate of bacteria. On average, the ambient temperature during the 2023/24 sampling was lower than the 2014/15 sampling. The lowest ambient temperature occurred during WWF Event 2 in 2023/24, with an average daily temperature of 10°C. *E.coli* levels were also the lowest during WWF Event 2.

3.6.2.5 Elapsed Time

The elapsed time between a discharge trigger and the start of river and stream sampling can influence water quality results. More elapsed time between the trigger and sampling start may result in more dilute river and stream water quality due to mixing, transport and/or decay of parameters in the river system.

As shown in Table 3, sampling began within 24 hours of rainfall ending for all WWF sampling events. WWF Event 1 had the shortest elapsed time between discharge trigger and start of sampling (12 hours); whereas, WWF Event 2 and 3 had a longer elapsed time (21 and 24 hours, respectively). Sampling response time depends on several factors including discharge timing, end of precipitation and daylight conditions to permit safe sampling.

3.6.2.6 Sampling Methods

See Section 3.5.2 for a description sampling method changes made in 2023/24 which are also applicable for wet weather flow monitoring.

3.6.2.7 Laboratory and Data Analysis

Laboratory methods selected can influence sample results and data analysis. For example, not using an endpoint analysis method for *E.coli* can result in a lack of qualitative results at higher concentrations. Non-endpoint methods have detection limits (e.g., 10 to 24,200 MPN/100 mL), beyond which, the colony forming units are not enumerated.

Section 3.5.2.3 described a change in data analysis approach that was implemented in 2023/24. In Table 3 above, data that was </> DL were treated as absolute values to allow for comparison to 2014/15. The new data analysis approach has been implemented in the 2023/24 program results provided in Appendix C.

3.6.3 WET WEATHER FLOW DISCUSSION

The 2023/24 wet weather flow results showed improved water quality for *E.coli* and total N, relative to 2014/15, with slightly lower water quality for total P. This result is not expected based on the 2023/24 environmental context which had lower river levels and lower precipitation.

Overall, 2023/24 had lower river levels, lower precipitation and lower temperatures than 2014/15, which may be expected to result in higher concentrations of POCs overall; however, that did not occur as *E.coli* levels and total N levels were lower in 2023/24 than in 2014/15, with total P levels being slightly higher. However, total P levels met or exceeded the MWQSOGs Tier III narrative guideline for all samples, including boundary samples, meaning water quality exceeds total P guidelines (by up to 11x) entering the city.

Based on the environmental context, it is as expected that WWF Event 1 had the highest *E.coli* concentrations of the three wet weather events, due to the following reasons:

- River levels were the lowest of all WWF events to date (223.67 geodetic m).
- Precipitation was the lowest of all WWF events to date (10.7 mm).
- Precipitation was the result of a brief, intense storm.
- The sampling response time was the shortest of all three 2023/24 events (12 hours).

In addition, based on the environmental context of higher river levels and greater precipitation, WWF Event 3 would be anticipated to have lower concentrations than WWF Event 2; however, WWF Event 3 concentrations were higher in most instances than Event 2.

A potential data anomaly in the 2014/15 data may be contributing to the relative improved performance in 2023/24. For WWF Event 1 Day 1 in 2014/15, the *E.coli* concentration for every sample location was 1,000.00 MPN/100 mL. *E.coli* concentrations on Day 1 of subsequent WWF events were not uniformly near or above 1,000 MPN/100 mL. Without WWF Event 1 in 2014/15, the data results are much closer to being similar between the two years.

3.6.4 RIVER AND STREAM MONITORING SUMMARY

Wet weather performance improved in 2023/24 for *E.coli* and total N in rivers and streams, with a slight decline in total P performance on the rivers. On average, streams performed better in 2023/24 than in 2014/15 by up to an order of magnitude in most cases.

During WWF, *E.coli* levels were low as they entered Winnipeg on the Red and Assiniboine rivers and became elevated above the MWQSOGs 200 CFU/100 mL WQO on the Red River starting at Provencher Bridge (RX2) downstream of the confluence with the Assiniboine River and as the river enters the downtown core at the Osborne Street Bridge (RX1). Notable increases occurred on the Red River immediately after the confluence with the Assiniboine River and again at the North Perimeter prior to leaving the city. Slight recoveries in water quality occurred downstream of these increases. On average, the levels did not return to the DWF level or below the MWQSOGs WQO at the SALD (R11) downstream boundary in Lockport, Manitoba.

In addition to increased *E.coli* at the North Perimeter Bridge (R10), increased concentrations of ammonia and BOD_5 were also noted at this location in 2023/24, relative to 2014/15 in all weather conditions, where data is available.

While the majority of streams exceeded the MWQSOGs *E.coli* WQO during WWF, every stream performed better for *E.coli* levels in 2023/24 as compared to 2014/15. Omand's Creek had poorer performance for ammonia, dissolved oxygen, and total N, primarily during WWF Event #1 only and poorer performance for *E.coli* and total P during DWF only.

All waterway samples, including upstream boundary samples, in both weather types were at, or exceeded, the MWQSOGs Tier III narrative guideline for total P, meaning total P is exceeding the guidelines entering the city. The intention of the narrative guideline is to prevent eutrophication. Total P performance was similar (i.e., within the range of variability) in dry and wet weather for rivers and streams and similar to 2014/15 performance.

All waterway samples in both weather types were within the MWQSOGs Total Nitrogen WQO (10 mg/L). In addition, on average, all waterways performed better for total N in all weather types, with the most marked improvement on the Assiniboine River in dry and wet and on the Red River and streams in dry weather.

4.0 CSO DISCHARGE MONITORING

The 2023/2024 CSO discharge monitoring objective was to assess CSO discharge water quality concentrations at two outfall locations during WWF conditions in 2023/24. A secondary objective was to compare the results against previously assessed performance (2014/15).

The following section describes the objectives, parameters, locations, sample collection method, sample triggers, sampler programming and sample analysis for the 2023/24 CSO discharge monitoring.

4.1 Locations

In 2023/24, discharge monitoring occurred at Ash (ID: 55) and Hawthorne (ID: 38) CSO locations (Figure 2). These locations were selected based on an assessment outlined in the 2023 Data Collection and Assessment TM. [4] The assessment considered and ranked nine sampling locations (the eight 2014/15 CSO sampling locations, plus Cockburn (ID:1)) on factors such as:

- CSO event capture likelihood
- Sample and location representativeness
- Sample collection logistics

Ash and Jessie (ID:10) CSOs were originally selected; however, the gate chamber depth at Jessie (>8m) was incompatible with the autosampler and replaced by Hawthorne. [4] The selected sites are described below.

Hawthorne

The Hawthorne outfall is located along the Red River in the Hawthorne Sewer District at the downstream extent of the combined sewer area. Primarily a residential area with some commercial and industrial areas along major transportation routes, the Hawthorne Sewer District is within the North End Sewage Treatment Plant catchment area. Hawthorne was primarily selected due to its:

- moderate catchment size;
- moderate combined sewer population consumption rates in 2019/2020; and
- relatively low dilution rate of the compatible CSO locations.

Ash

The Ash outfall is located along the Assiniboine River in the Ash Sewer District, which is primarily a residential area with some commercial areas along major transportation routes. The Ash Sewer District is located within the North End Sewage Treatment Plant catchment area. Ash was primarily selected due to its:

- large catchment size;
- relatively large combined sewer population consumption rates in 2019/2020;
- relatively low dilution rate of the compatible CSO locations; and
- low likelihood for river backwatering based on previous years.

4.2 Discharge Results

The 2023/24 discharge results at Ash and Hawthorne are summarized in Table 5 and in the sections below. For average values reported in Table 5, sample results that were >/<DL have been excluded from calculations to avoid skewing values. All sample results, including individual samples collected during each event, can be found in Appendix C.

TABLE 5: 2023/24 DISCHARGE MONITORING DATA SUMMARY

Location	Type	Ammonia (mg/L)	Biochemical Oxygen Demand (mg/L)	Total Phosphorus (mg/L)	Total Nitrogen (mg/L)	Total Suspended Solids (mg/L)	*E.coli* (MPN/100 mL)
Criteria		-	50[1]	1[1]	15	50[1]	1,000[1]
Ash	Event 1 AVG	5.13	29	**1.46**	8.57	**313**	**(24,200)***
	Event 2 AVG	6.91	44	**2.30**	11.2	**283**	**(24,200)***
	Event 3 AVG	2.93	**146**	**2.06**	9.23	**292**	**1,531,000**
	Event 4 AVG	4.88	**73**	**1.86**	11.19	**353**	**1,624,125**
	Event 5 AVG	1.66	NALE	**1.02**	5.90	**864**	**352,875**
	Full Dataset AVG	3.86	**75**	**1.56**	8.65	**520**	**935,778**
Hawthorne	Event 1 AVG	5.57	34	**1.58**	10.29	**362**	**(24,200)***
	Event 2 AVG	5.89	**(95)***	**3.33**	12.67	**768**	**(24,200)***
	Event 3 AVG	4.02	**73**	**1.49**	10.10	**230**	**2,063,083**
	Event 4 AVG	7.80	**99**	**2.34**	**18.51**	**555**	**1,477,500**
	Event 5 AVG	6.45	48	**1.32**	**17.86**	**120**	**2,501,111**
	Full Dataset AVG	6.05	**63**	**1.96**	14.44	**391**	**1,941,486**

Notes:
AVG = average; L = litre; mg = milligram; mL = millilitre; MPN = most probable number; NALE = not analyzed, laboratory error.
Values that were < or > detection limit were excluded from the average calculations.

* indicates that all values were >DL, with the DL indicated in parentheses.
[1] Environment Act Licence No. 3042
[2] Manitoba Water Quality Standards Objectives and Guidelines (MWQSOGs) Tier I Water Quality Standards

Bold values indicate an exceedance above criteria**.**

4.2.1.1 Multi-year Comparison

A multiyear comparison of the 2023/24 discharge monitoring results to the 2014/15 discharge monitoring results for the same locations is summarized in Table 6. To allow for direct comparison to 2014/15 results, >/< DL results have been treated as absolute values for averages reported in Table 6.

TABLE 6: MULTIYEAR DISCHARGE MONITORING RESULTS SUMMARY

Location	Factor	Ammonia (mg/L)	Biochemical Oxygen Demand (mg/L)	Total Phosphorus (mg/L)	Total Nitrogen (mg/L)	Total Suspended Solids (mg/L)	*E.coli* (MPN/100 mL)
Ash	2023/24 AVG	3.86	69	1.56	8.65	520	655,292
	2014/15 AVG	3.66	115	2.12	10.73	386	Not Tested
Hawthorne	2023/24 AVG	6.05	66	1.96	14.44	391	1,451,966
	2014/15 AVG	4.73	127	2.61	15.26	504	2,758,200

Notes:
AVG = average; L = litre; mg = milligram; mL = millilitre; MPN = most probable number
Values that were < or > detection limit were included in the average calculations as absolute values for comparison to 2014/15.

4.2.1.2 *E.coli*

The 2023/24 discharge results for *E.coli* were presented in Table 5 and are summarized below:

- *E. coli* concentrations were above the EAL No. 3042 criteria (1,000 MPN/100 mL) for all discharge samples in 2023/24.
- Overall, Hawthorne CSO had over two times higher *E.coli* concentrations than Ash (1,451,966 MPN/100 mL vs. 655,292 MPN/100 mL); however, the Hawthorne 2023/24 result was lower than 2014/15 (2,758,200 MPN/mL).
- *E.coli* results for Ash cannot be compared to 2014/15, because fecal coliforms were used in 2014/15. For reference, fecal coliforms in 2014/15 were determined to be 6,882,083 MPN/100 mL.
- Average *E. coli* concentrations at Hawthorne during Events 3 through 5 were determined to be 2,063,083 MPN/100 mL, 1,477,500 MPN/100 mL, and 2,501,111 MPN/100 mL, respectively.
- Event 3 average *E. coli* concentrations at Ash was determined to be 1,531,000 MPN/100 mL.
- Event 4 *E. coli* concentrations at Ash were similar to Event 3 at 1,624,125 MPN/100 mL; whereas, Event 5 concentrations were much lower (352,875 MPN/100 mL).

4.2.1.3 Total P

- Total P concentrations were above the EAL No. 3042 criteria (1 mg/L) in most samples collected during all events at both CSO locations. However, exceedances were not observed during the latter half of Events 4 and 5 at the Ash CSO.
- At Ash CSO, Total P values ranged from 0.55 mg/L to 5.20 mg/L.
- At Hawthorne CSO, Total P values ranged from 0.38 mg/L and 5.72 mg/L.
- On average, Total P was higher at Hawthorne than Ash (1.96 mg/L vs. 1.56 mg/L).
- In comparison to 2014/15, average total P values were lower at both CSOs in 2023/24 vs. 2014/15:
  - Ash: 1.56 vs 2.12 mg/L.
  - Hawthorne: 1.96 vs 2.61 mg/L.

4.2.1.4 Total N

- There is no established guideline for total N in EAL No. 3042. The MWQSOGs Tier I Water Quality Standard for total N (15 mg/L) has been used for comparison.
  - On average, the discharges at Ash and Hawthorne met the Tier I Standard, with instances above the standard at Hawthorne (Event 4 and Event 5).
  - The multiyear broad average also meets the Tier I Standard.
- At Ash CSO, total N values (non-averaged) ranged from 2.41 mg/L to 26.8 mg/L.
- At Hawthorne CSO, total N values (non-averaged) were higher (4.58 mg/L to 28.7 mg/L).
- Average total N at Hawthorne was higher than at Ash (14.44 mg/L vs. 8.65 mg/L).
- In comparison to 2014/15, average total N values were lower at both CSOs in 2023/24 vs. 2014/15:
  - Ash: 8.65 vs 10.73 mg/L.
  - Hawthorne: 14.44 vs 15.26 mg/L.

4.2.2 WATER QUALITY INFLUENCES – DISCHARGE

Discharge water quality can be influenced by:

- Precipitation
- Overflow dilution
- Portion of discharge sampled (i.e., start, mid end)
- Sampling method
- Laboratory and data analysis method

4.2.2.1 Precipitation

Precipitation amounts related to each CSO discharge monitoring event based on ECCC-MSC's total precipitation data [11] are shown in Table 7.

TABLE 7: RAINFALL DURING CSO DISCHARGE MONITORING EVENTS

Event	Date	ECCC-MSC - Total Rainfall (mm) [1]
Ash / Hawthorne Event #1	1-Aug-23	20
Ash / Hawthorne Event #2	10-Aug-23	8.4
Hawthorne Event #3	24-Aug-23	0.0
Ash Event #3	5-Sep-23	10.6
Ash Event #4	14-May-24	12.7
Hawthorne Event #4 / Ash Event #5	16-May-24	16.8
Hawthorne Event #5	17-May-24	10.7
	All Event Average	11.3

Notes:

ECCC-MSC= Environment and Climate Change Canada – Meteorological Service of Canada
[1] Based on WINNIPEG A CS Station, Climate ID: 502S001

The average daily precipitation during CSO discharge monitoring events was approximately 11.3-13.6 mm/day. Ash and Hawthorne Event 1 (August 1, 2023) had the most precipitation at 20 mm and Hawthorne Event 3 (August 24, 2023) had the least at 7.9 mm. Hawthorne Event 4 / Ash Event 5 (May 16, 2024) was notably above average in both data sets at 16.8-17 mm. Hawthorne Event 5 (May 17, 2024) was also notably below average at 10.7 mm; however, it was part of a multi-day rain event.

4.2.2.2 Overflow Dilution

The design standard for combined sewer overflows is a dilution rate of 2.75x the dry weather flow. The level of dilution that is predicted to occur at Ash and Hawthorne (over 4x the dry weather flow) before an overflow can occur is above the design standard. The magnitude of dilution that occurs at Ash is slightly higher than the dilution that occurs at Hawthorne relative to the 2.75x DWF design flow (1.64 vs. 1.57); therefore, Ash is slightly more dilute than Hawthorne, based on its design.

4.2.2.3 Portion of Discharge Sampled

The first flush of a CSO, or the initial combined flows that overtop the weir during significant wet weather flow events, is the most concentrated in parameters and becomes more dilute as the discharge occurs. Therefore, samples collected at the start of a discharge are more concentrated than samples collected during the middle or end of a discharge. The portion of the discharge sampled could be affected by the autosampler collection success, which may result in low sample volume during incremental sample draws or the lack of a sample for a certain increment. When low sample volume occurred, adjacent intervals were composited to provide sufficient sample volume for the suite of parameters.

4.2.2.4 Sampling Method

In 2023/24 a change was made in sampling method of discharge sampling, relative to 2014/15 to increase the safety of the program. A manhole sampling method was used, in which the autosampler is installed at grade outside of the CSO gate chamber and intake tubing is installed via a secure conduit in the chamber. The manhole sampling method eliminated the requirement for confined space entries into the gate chambers and met the City's intrinsic safety requirements. Due to the increased ease of accessibility, the autosampler was able to be filled with ice in advance of a forecasted event which aided in keeping the samples cool during the 6-hour sampling duration, which was not possible in 2014/15.

4.2.2.5 Laboratory and Data Analysis Method

The endpoint method was not used for Event 1 or 2 at Ash or Hawthorne due to a laboratory error; therefore, the *E.coli* results for these locations are >24,200 MPN/100 mL which affects the ability to use that data. Section 3.5.2.3 described a data analysis approach change that was made in 2023/24 regarding </> DL results.

Section 3.5.2.3 describes the data analysis method change made in 2023/2024. For the discharge results, the data averages presented in Table 5 and Appendix C have been calculated excluding </> DL results to avoid skewing the data. However, the data averages presented in Table 6 have been calculated including </> DL results as absolute values to allow for direct comparison to 2014/15 results.

Laboratory hold times and sample drop-off temperatures can significantly impact the density of microbiological indicators at the time of sample analysis. [7] The results for Ash Event 4 may have been impacted by laboratory hold time exceedance and elevated drop off temperature issues related to laboratory receipt and transfer of the samples. The Ash Event 4 results showed consistently high bacteria which is not characteristic of the water quality curve for a discharge event.

4.2.3 DISCHARGE DISCUSSION

The results analysis for *E.coli* focuses on CSO Events 3-5 for each site and ignores CSO Events 1 and 2 at each location due to the lack of an *E.coli* endpoint value due to lab error.

In comparison to rainfall data, the discharge date with the highest rainfall amount (May 16, 2024) correlated with the lowest *E.coli* levels for Hawthorne (Event 4: 1,477,500 MPN/100mL) and Ash (Event 5: 352,875 MPN/100 mL), suggesting that higher rainfall amounts provide dilution to *E.coli* levels in CSO effluents, as expected. However, the discharge dates with the lowest rainfall amount (August 24, 2023 and September 5, 2023) did not correlate with the highest *E.coli* levels, suggesting that precipitation is not the only factor influencing *E. coli* levels.

Five discharge events were captured at each of the CSOs (i.e., Ash and Hawthorne) monitored during the 2023/24 program. Key findings from the 2023/24 CSO discharge sample sets are summarized and the results of the 2023/24 discharge monitoring at Ash and Hawthorne were compared to the criteria outlined in EAL No. 3042 and MWQSOGs Tier I Water Quality Standard (for TN only).

4.2.4 DISCHARGE MONITORING SUMMARY

Overall, the results from the 2023/24 program showed discharge water quality improvements (lower average concentrations during overflow events) for POCs when compared to results from the previous program. POC concentrations were lower at the Ash CSO when compared to the Hawthorne CSO in 2023/24, which is as expected because Ash is more dilute than Hawthorne.

EAL No. 3042 criteria exceedances were observed during all events in 2023/24 for *E. coli* and total P at both monitored CSO locations. There is no established guideline for total N; however, when applying the MWQSOGs Tier I Water Quality Standard for total N in municipal effluent (15 mg/L), the discharges met the Standard on average, with instances above the standard at Hawthorne (Events 4 and 5).

In general, CSO discharge is highly variable and there is no discernable trend in the POC values based on the locations sampled during 2023/24.

The discharge sampling results from the two previous studies produced consistent results and were aligned with results from other published sources, as outlined in the CSO Management Study Problem Definition Technical Memorandum No. 1. (12) It was expected that results from additional data sets collected would be similar, showing a consistently repeated trend. In 2023/24, improvements to the discharge water quality were observed among the POCs, while the other parameters showed mixed results. In general, the results outlined in Tables 5 and 6 indicate that the 2023/24 results were aligned with previous data sets, with slight improvements in water quality, and in range with other published sources. (12)

5.0 DATA LIMITATIONS

In conducting the 2023/2024 sampling program, the following current and past data limitations were noted:

- **Discharge Samples Not Iced During Collection (2014/15):** the arrangement of the autosamplers within the gate chambers in 2014/15 was not conducive to icing discharge samples during collection. This may have affected the 2014/15 sample integrity and may have led to elevated coliform results.
- **pH method (2014/15):** in 2014/15, pH values were measured in a lab for river and stream samples. pH is most accurately measured on-site at the time of sample collection and can be subject to change when measured at a later time in a lab. As a result, pH values for 2014/15 river and stream sampling may have accuracy issues. Similarly, pH is measured in a lab for 2023/24 autosampler samples, because an autosampler precludes the ability to take on-site measurements at the time of sample collection.
- ***E.coli* End Point Method:** an end point method versus colilert quanti-tray method should be used laboratory analysis of bacteria because the former provides an actual estimate of bacteria in the sample; whereas, the latter indicates above or below detection limit (24,200 MPN/100 mL).
- **Data Analysis Method:** The 2014/15 data treated </> DL results as absolute values which has the potential to skew results. The 2023/24 program results were calculated excluding </> DL results (Appendix C). To allow for comparison to 2014/15 results, the 2023/24 results included within the tables in this report were calculated treating laboratory detection limits as absolute values.
- **St. Andrews Lock and Dam General Parameter River Results (R11; 2023/24):** 2023 general parameter samples for river and stream sampling at R11 were not analyzed due to laboratory error. 2023 bacteria results for R11 are available. No R11 data could be collected during wet weather flow Event 2 (May 3-5, 2024) due to inaccessibility of the site prior to the locking season.
- **BOD_5 Sample Seeding (2023):** no BOD_5 results are available in some instances due to improper laboratory seeding of the samples for BOD_5 analysis.
- **CSO Sample Collection (2023/24):** there were some issues with the sample collection success for CSO discharge sampling in 2023/24 which was attributed to high flows and intake positioning within the gate chamber. Where collection issues were encountered (e.g., Hawthorne Events 3 and 5), low volumes of water were drawn by the autosampler and required sample compositing by the laboratory for analysis.
- **Laboratory hold times and drop off temperatures:** Laboratory hold times and/or drop off temperatures were exceeded for some samples transferred by City staff and/or received by ALS Environmental.

5.1 Quality Assurance/Quality Control

Quality assurance and quality control (QA/QC) procedures implemented during the 2023/24 Rivers and Streams Monitoring program included field duplicates (rivers and streams locations) and field blanks (discharge locations).

For rivers and streams, field duplicates were collected at an equivalent of 10% of program samples. The field duplicates from the rivers and streams program were analyzed for the same water quality parameters analyzed during the discharge program. Relative percent differences (RPDs) were only calculated when both values were 5x the laboratory detection limit. Overall, calculated RPDs were between 0 and 47% for most parameters. Greater variability was seen for TSS, ammonia, and *E. coli* with RPD values ranging between 3 and 180%. The variability observed within duplicates can likely be attributed to sample variability and is not of concern.

For discharge sampling, the autosamplers did not allow for duplicate samples to be collected; therefore, field blanks were collected in 2023/24 to allow for field QA/QC. All analyzed parameters from the field blanks were below laboratory detection limits, except for ammonia during Events 1 and 2 at Hawthorne, which may have been attributable to ambient levels of ammonia near the gate chamber vents, and TSS during Event 5 at Ash.

5.2 Continuous Improvement

The City is committed to a continuous improvement approach for the program whereby lessons learned from the execution of sampling programs are applied to the design and execution of future programs. Some improvements were implemented prior to the 2023/24 program to address lessons learned from 2014/15, while other improvements were incorporated mid-program into the 2024 sampling season, such as:

- Site risk assessments were conducted at each river, stream and CSO sampling location to identify potential hazards and risks to sampling staff.
- Select stream locations (S2, S3, S4) were adjusted to safer locations that match the City's bi-weekly rivers and streams sampling program locations.
- A manhole sampling method was introduced for autosamplers to eliminate the need for confined space entry and allow for adding ice to the autosamplers in advance of a forecasted discharge event.
- Autosamplers were wired to the supervisory control and data acquisition (SCADA) system to use the existing instrumentation within the gate chamber to trigger the autosampler.
- Integrated Catchment Modelling (ICM) Live forecast and SCADA notifications were added to allow for monitoring potential wet weather flow and discharge events.
- Using end-point laboratory method for analyzing bacteria.
- Including Nitrate and Nitrite as parameters to allow total Kjeldahl nitrogen (TKN) to be calculated for InfoWorks modelling.

6.0 CONCLUSIONS

The preceding report was prepared to meet the associated Environment Act Licence requirements in the 2023 Approved Water Quality Monitoring Plan (Appendix A). It provides a point in time snapshot of river and stream quality in 2023/24 during both dry and wet weather.

In general, the results showed that river and stream water quality performed poorer in dry weather in 2023/24 in comparison to 2014/15; however, more data is needed because the 2023/24 data may have been influenced by antecedent rain prior to the dry weather sampling and may not reflect dry weather conditions.

During wet weather, the results showed improved performance relative to 2014/15. It is possible that the relative improvement is due to a data anomaly in the 2014/15 data, which once removed, no longer shows improved performance.

Additional data is required to determine long-term trends. The analysis of additional sampling results and the environmental and land use context in which they are collected, will provide additional data points to analyse for long-term trends and patterns.

6.1 Recommended Future Approaches and Considerations

Based on the results and lessons learned from the 2023/24 program, future programs should consider:

- Adding:
  - A sampling location on the Kildonan Settler's Bridge (on Chief Peguis Trail) to add a data point on the Red River downstream of the confluence with the Assiniboine River.
  - Additional sampling point(s) further afield upstream of the City on the Assiniboine River, Red River and/or streams to provide additional general background water quality data.
  - One to two additional antecedent dry days to the trigger criteria for a DWF event. This would aid in DWF events being more reflective of dry weather in the absence of CSO influence.
  - One to two additional sampling days to the WWF sampling program to capture the point at which *E.coli* levels return to DWF levels.
  - River and stream water level as a sampling data point to provide environmental context for all waterway types for data analysis.
- Removing:
  - Total N as a priority pollutant of concern, given the lack of exceedances on average across both campaigns. Total N should continue to be monitored as part of the program.
- Ensuring that:
  - An end point method is used to analyze all bacteria samples to achieve an absolute value.
  - Nitrite and Nitrate are included in the list of analytical parameters, to allow for the calculation of TKN, which may be useful for the 2030 CSO Update.
  - Data analysis for future sampling results excludes </> DL results from averaging calculations.
- In selecting future CSO discharge monitoring locations, select gate chambers that are:
  - Less than 8 m in depth.
  - Maximize the intake tube distance from the flap gate to potentially increase sample collection success.
  - Conducive to the manhole sampling method (i.e., not within a public sidewalk or parking lot).

7.0 REFERENCES

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STATEMENT OF LIMITATIONS AND CONDITIONS

Limitations

This memorandum has been prepared for City of Winnipeg in accordance with the agreement between KGS Group and City of Winnipeg (the "Agreement"). This memorandum represents KGS Group's professional judgment and exercising due care consistent with the preparation of similar documents. The information, data, recommendations and conclusions in this memorandum are subject to the constraints and limitations in the Agreement and the qualifications in this memorandum. This memorandum must be read as a whole, and sections or parts should not be read out of context.

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Geo-Environmental Statement of Limitations

KGS Group prepared the geo-environmental conclusions and recommendations for this memorandum in a professional manner using the degree of skill and care exercised for similar projects under similar conditions by reputable and competent environmental consultants. The information contained in this memorandum is based on the information that was made available to KGS Group during the investigation and upon the services described, which were performed within the time and budgetary requirements of City of Winnipeg. As this memorandum is based on the available information, some of its conclusions could be different if the information upon which it is based is determined to be false, inaccurate or contradicted by additional information. KGS Group makes no representation concerning the legal significance of its findings or the value of the property investigated.

APPENDIX A

2023 Approved Water Quality Monitoring Plan

Water and Waste Department • Service des eaux et des déchets

City of Winnipeg
Water Quality Monitoring Plan

Environment Act No. 3042

Prepared for

Manitoba Environment, Climate and Parks

January 2023

City of Winnipeg Water Quality Monitoring Plan

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Document History and Status

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Water and Waste Department • Service des eaux et des déchets

Executive Summary

The Water Quality Monitoring Plan outlines the City of Winnipeg (City) proposed approach to fulfill a requirement in the Manitoba Environment, Climate and Parks (formerly known as Manitoba Conservation and Climate) approval letter dated November 13, 2019. According to that letter, the City is required to collect combined sewer overflow (CSO) water samples and model river quality data every five years to demonstrate improvements in the river water quality due to implementation of Control Option No. 1 (85% capture in the 1992 representative year). The first river water quality report is due December 31, 2024.

The sampling program will track river and stream water quality under both dry and wet weather conditions. The information will be used to monitor in-stream water quality within the City and at the boundaries. The in-stream river and small stream sampling program will collect grab samples at nine (9) locations along the Red and Assiniboine Rivers and six (6) locations on small streams during dry and wet weather conditions.

The monitoring plan also discusses the feasibility of collecting CSO samples during wet weather periods, and proposes representative outfall locations for sample collection.

Samples will be tested and analyzed for concentrations of pollutants of concern (POC) including escherichia coli (E. coli), total phosphorus (TP), total nitrogen (TN), ammonia, and total suspended solids (TSS).

The river bacteria water quality data will be modeled to better understand its performance against Manitoba Water Quality Standards, Objectives and Guidelines (MWQSOG) thresholds.

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Acronyms and Abbreviations

BOD	biochemical oxygen demand
$CBOD_5$	five day carbonaceous biochemical oxygen demand
cfu	colony-forming unit
City	City of Winnipeg
CSO	combined sewer overflow
DWO	dry weather overflow
DYNHYD	Dimensional Hydrodynamic Flow Model
EA	Environment Act
E. coli	escherichia coli
EMC	event mean concentrations
HEC	Hydrologic Engineering Center
ID	identification
LDS	land drainage sewer
MECP	Manitoba Environment, Climate and Parks
mg/L	milligram per liter
ml	milliliter
ML	megaliter
MPN	most probable number
MWQSOG	Manitoba Water Quality Standards Objectives and Guidelines
No.	Number
NPDES	National Pollutant Discharge Elimination System
NPRI	National Pollutant Release Inventory
PH	Potential of hydrogen
POC	pollutants of concern
SCADA	Supervisory control and data acquisition
SOIS	Sewer Overflow Information System
SSO	sanitary sewer overflow
TKN	total keldahl nitrogen
TM	technical memorandum
TN	total nitrogen
TP	total phosphorus
TSS	total suspended solids
U.S. EPA	United States Environmental Protection Agency
WASP	Water Quality Analysis Simulation Program
WPCC	Water Pollution Control Centre
WWF	wet weather flow
XP-SWMM	Extreme Programming Storm Water Management Model

1. Purpose

This Water Quality Monitoring Plan is being submitted in conformance with a requirement in the Manitoba Environment, Climate and Parks (formerly known as Manitoba Conservation and Climate) approval letter dated November 13, 2019. The City of Winnipeg shall, from the date of issuance of the letter, collect combined sewer overflow (CSO) water samples and model river quality data every five years to demonstrate improvements in the river water quality due to implementation of Control Option No. 1, which refers to 85% capture in the 1992 representative year. The next river water quality report is due December 31, 2024.

The purpose of this Water Quality Monitoring Plan is to outline the work components, the proposed monitoring locations, the pollutants to be tested, and the timelines of the program.

This document provides background water quality monitoring to date, describes the rationale for the monitoring plan, and provides basic information on the sample collection approach. It also provides perspective on the planning details with the recognition that the plan will evolve as more site-specific field information is gathered and assessed and be adjusted as the program proceeds.

2. Background

As per the CSO Master Plan approval letter, dated November 13, 2019, the City of Winnipeg (City) will continue to work toward implementing 85% CSO capture in the 1992 representative year (Control Option No. 1) while further evaluating the volume reduction equivalent to a minimum of four (4) overflows in the 1992 representative year (Control Option No. 2). A water quality report will be submitted once every five years, starting on December 31, 2024. The implications of maintaining a percent capture program on water quality will be evaluated and will be provided in the 2030 Master Plan update submission.

The City has undertaken monitoring programs in the past and currently carries out monitoring programs relating to the operation of the collection system and its impact on water quality.

- Since 1977, the City has carried out a bi-weekly water quality monitoring program of the rivers and small streams during open water season (typically May – October, inclusive) at regular intervals to measure the health of Winnipeg's waterways.
- The 2002 CSO Management Study encompassed all of the available data with respect to water quality of the CSOs and the receiving environment as well as data from various related Water Quality monitoring campaigns.
- The 2014-2015 Water Quality Monitoring Program was carried out during 2014 and 2015 and included CSO and stream monitoring, which was used to develop event mean concentration (EMCs) for the CSO discharges and for the stream boundary flows. The monitoring was carried out for dry weather conditions, wet weather conditions, and for CSO discharges. This work was followed by a water quality modeling.
- The City's CSO Outfall Monitoring as of 2021 has installed instrumentation at 45 combined sewer discharge locations to monitor levels and flap gate inclination. These instruments are used to monitor the sewage collection system and report on overflows.
- The 2021 Dry Weather Overflow Water Quality Assessment was completed to evaluate the impact of Dry Weather Overflows (DWOs) on the receiving waterbodies within the City and downstream, including Lake Winnipeg.
- The City has recently created a near real time CSO Notification Tool alert when CSOs discharge to our rivers. The CSO Notification Tool can be accessed on the City's website at: MyUtilityInfo – Water and Waste Department – City of Winnipeg.

2.1 Bi-weekly River & Stream Water Quality Monitoring

Since 1977, the City has carried out a water quality monitoring program of the rivers and streams at regular intervals during the open water season (typically May – October, inclusive) to measure the health of Winnipeg's waterways. Samples are collected at 11 locations along the Red and Assiniboine rivers and at eight (8) locations on selected small streams. Testing is carried out for 17 parameters including nutrients, dissolved oxygen, and bacteria. The results are posted on the City's website.

The September 29, 2021 river survey monitoring report and July 15, 2021, small stream survey monitoring reports are attached in Appendix A as examples. The reports identify the sample locations and the parameters tested. The tables include location IDs to correspond to monitoring map locations. The river and stream sampling locations are shown on a map attached in Appendix B.

2.2 2002 CSO Management Study

The 2002 CSO Management Study was a comprehensive multi-year study that commenced in 1994, and concluded in 2002. The study incorporated river and discharge water quality data going back to 1988. It was undertaken in four phases as follows:

- Phase 1 – Wet Weather Flow (WWF) Management: Issues and Objectives
- Phase 2 – Addressing the WWF Problems
- Phase 3 – Potential Plans for Cleaner Rivers

- Phase 4 – Proposed Implementation Plan

The study included dry and wet weather river monitoring and small stream monitoring for various parameters (see Phase 1 Technical Memorandum for CSO Management Study – TM 4 Receiving Stream). Figure 1 shows 1988 River Monitoring Program Sampling Locations.

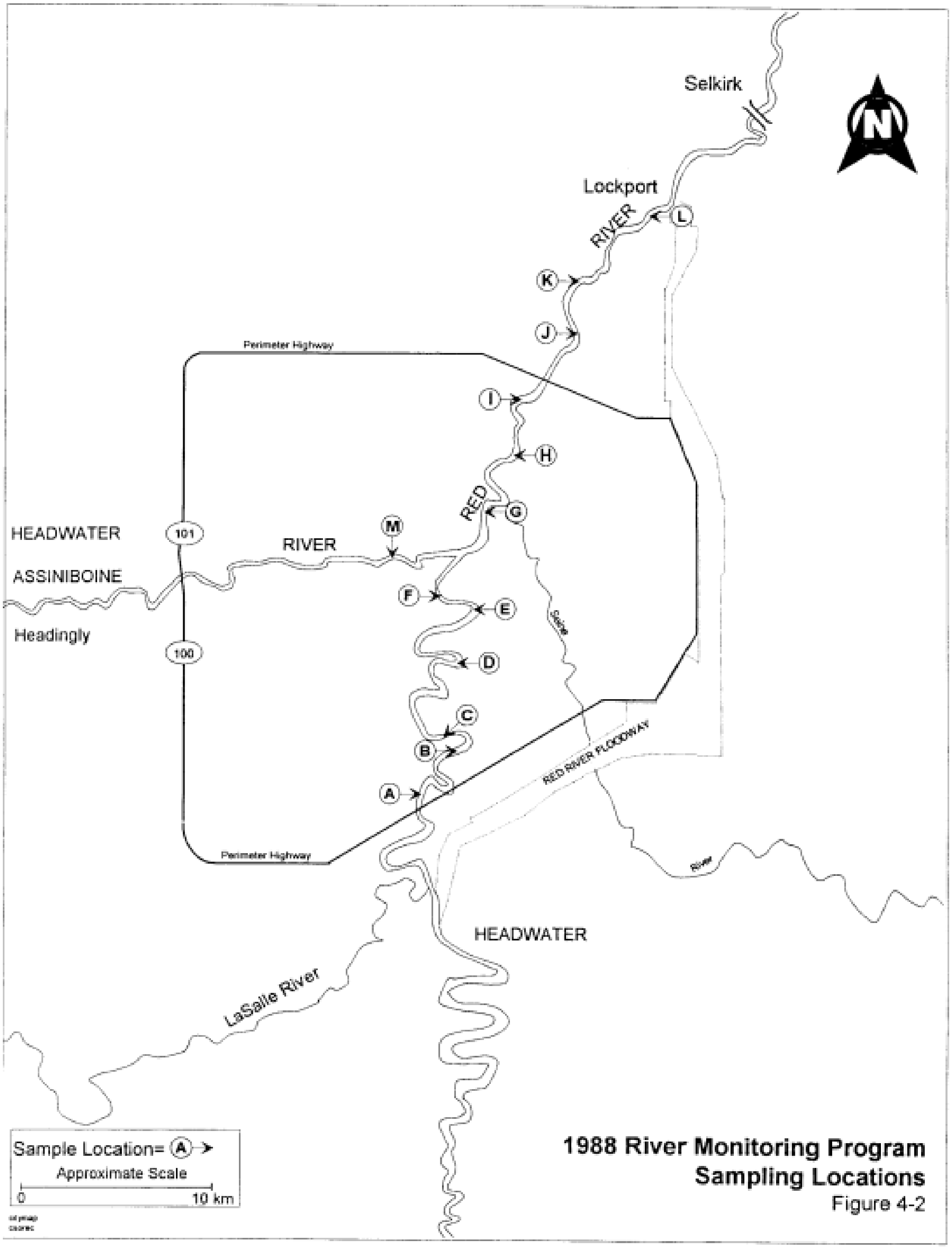

Figure 1 – 1988 River River Monitoring Program Sampling Locations

Technical Memorandum (TM) No. 4 – Receiving Streams of Phase 1 TM for CSO Managenent Study (June 1994) documented the review of previous studies and monitoring done on the Red and Assiniboine rivers from 1977 to 1993.

Discharge water quality monitoring was carried out at the Aubrey outfall to collect overflow discharge quality information and assess its treatability (Phase 3 TM – Appendix No. 3 – Treatability, 1997).

Hydraulic conditions were modeled using Extreme Programming Storm Water Management Model (XP-SWMM) computer software. Applied United States Environmental Protection Agency (U.S. EPA) Dimensional Hydrodynamic Flow Model (DYNHYD), along with the Hydrologic Engineering Center steady-state model (HEC2) were used to define hydraulic characteristics and travel times of the rivers. Detailed hydraulic information from DYNHYD was used to set up a cascading-pool description with the U.S. EPA Water Quality Analysis Simulation Program (WASP) model. The WASP software was then used to simulate river quality under dry and wet weather conditions.

The results of the analysis on CSO data collected between 1989 to 1992 in eight stations[1] indicated that the EMC were evenly distributed and no one station exhibited consistently high or low values.

Based on the 2002 CSO Management Study, the finding of no significant linear correlation between event mean concentrations (i.e., the typical quality of the CSO) and runoff volumes is important in that it means that it is not likely that the size of storms for different monitored events will have biased the EMC. Further, it indicates that refinement of methods to account for precipitation and runoff characteristics, antecedent conditions, etc. are not warranted, particularly for planning level studies. Accordingly, the EMC were applied to the dry and wet weather hydrographs to estimate loadings to the river for the various contaminants. EMC for CSO five day carbonaceous biochemical oxygen demand ($CBOD_{5)}$ and total suspended solids average 110 mg/L and 845 mg/L, respectively. These EMCs were based on the results of local sampling programs. The EMC for Fecal Coliforms used for the modeling of City discharges to the Rivers are provided in Table 1.

Table 1 – Fecal Coliform Event Mean Concentrations

Source		Fecal Coliform Density (Geometric Mean) cfu/100 mL
Water Pollution Control Centre (WPCC)	Average Dry Weather Flow	200,000
	Peak Dry Weather Flow	200,000
	Peak Wet Weather Flow	2,400,000
Land Drainage Sewer (LDS)	Direct to Stream	40,000
	Pond Discharge	20,000
CSO		2,400,000
Sanitary Sewer Overflow (SSO)		10,000,000
Interceptor	CSO	2,400,000
	SSO	10,000,000
Source: CSO Management Study – Final Report – Table 7-2, Wardrop Engineering Inc./TetrES Consultants Inc. in Association with CH2M Canada Limited and EMA Services Limited, November 2002		

2.3 2014–2015 Water Quality Monitoring Program

As per Clause 15 of Environment Act (EA) No. 3042, the City developed an Interim CSO Monitoring Plan to aid in the development of the CSO Master Plan. Based on the plan, a water quality monitoring program

[1] Reported in CSO Management Study, Phase 2 Technical Memorandum #1 – Problem Definition, Wardrop Engineering Inc. et al., 1995

was conducted in 2014 and 2015 to collect and update river and CSO water quality data for the development of the CSO Master Plan.

The water quality monitoring was targeted to dry and wet weather events. The river and stream monitoring for this portion of the program included the collection of samples at nine locations along the Red and Assiniboine rivers and at five locations on select small streams. Testing was carried out for 15 parameters. The results are posted on the City's website at https://winnipeg.ca/waterandwaste/sewage/monitoring/RiversSmallStreams.stm.

Computer models were used to estimate runoff from rainfall and snowmelt and river water quality based on pollutant loads for the baseline conditions. The escherichia coli (E. coli) bacteria regulatory limit of 200 cfu/100mL was shown to be met during dry weather conditions, but spiking above the limit during the rainfalls, with the elevated levels lasting a couple of days before returning to original levels. There was an absence of observed dry weather discharges during the dry day river and stream monitoring and absence of predicted DWOs.

Observed data and analysis for CSO total phosphorus (TP) and total nitrogen (TN) concluded that nutrient loading had only a small contribution to Lake Winnipeg at 0.3% and 0.1%, respectively, and was not an issue for the rivers.

EMC were created based on the data collected from the 2014 and 2015 water quality monitoring program are shown in Table 2. The EMC for TP and TN were used as the baseline for the water quality modeling and loading assessments for evaluation of control option alternatives for the CSO Master Plan.

EMC for ammonia, TN and TP are used to determine pollutant loads in the NRPI reports. The assessment indicated that the CSO discharge quality varied by location and between events but was within expected ranges for combined sewer discharges.

Table 2 – CSO Discharge Pollutants EMC from 2014-2015 Water Quality Monitoring Program

Substance Name	Unit	EMC
Ammonia[1]	mg/L N	5.72
Nitrate-N[1]	mg/L N	0.34
Total Phosphorus[1,2]	mg/L P	2.71
Total Nitrogen[2]	mg/L N	15.25
E. Coli[2]	MPN/100 mL	1.8×10^6

1. Parameters used in the NPRI reports
2. Parameters used in the CSO Master Plan nutrient loading assessments

A comparison between the data collected during 2002 and 2014-2015 water quality studies, and the ranges referenced in U.S.EPA is shown in Table 3.

Table 3 – Comparison of CSO Pollutants

Type	BOD_5 (mg/L)	Total P (mg/L)	Total N (mg/L)	TSS (mg/L)	*Bacteria*
2015 CSO Discharge[1]	13 – 410	0.5 – 10	3.4 – 55.5	73 – 2125	300,000 – 21,000,000 MPN/100 mL (E. coli)
2002 CSO Discharge[2]	14 – 191	1 – 4	8 – 26	184 – 720	100,000 – 34,000,000 cfu/100 mL (Fecal Coliform)
EPA – CSOs[3]	3.9 – 696	0.1 – 20.8	0 – 82.1	1 – 4420	3 – 40,000,000 cfu/100 mL (Fecal Coliform)

1. 2014-2015 Water Quality Monitoring Program
2. Phase 1 Technical Memorandum for CSO Management Study – Problem Definition – TM No. 1 – Table 2-7, Wardrop Engineering Inc. et al., June 1994
3. 2004 NPDES CSO Report to Congress – Chapter 4 Characterization of CSOs and SSOs, U.S. EPA, August 2004

2.4 CSO Outfall Monitoring

In 2009, the City began investing in CSO outfall event monitoring at 39 outfalls ($12 million up to 2019). Since 2013, the City has invested an additional $10 million to date for combined sewer outfall and gate chamber rehabilitation projects. This additional instrumentation and outfall chamber work increased the total CSO outfall event monitoring to 45 outfalls as of 2021. CSO monitored outfall locations are identified in the attached Appendix C.

This program provides observed data which is uploaded directly to the City's Supervisory control and data acquisition (SCADA) system to monitor the performance of the overflows. This observed data also allows for analysis of the overflow performance over time and can be used to improve model prediction.

2.5 2021 Dry Weather Overflow Water Quality Assessment

The 2021 dry weather water quality assessment was completed to evaluate the impact of DWOs on the receiving waterbodies within the City and Lake Winnipeg. Results from the City's DWO sample set were analyzed to determine the concentration of the select Pollutants of Concern (POC) including TP, TN and E. coli.

The study showed that DWOs do not significantly contribute to nutrient loading within the rivers or Lake Winnipeg. DWOs were shown to account for approximately 0.000050% of the nitrogen loading and 0.00013% of the phosphorus loading to Lake Winnipeg.

The WASP model results indicated that DWOs will increase the bacteria levels within the rivers, but that the level of bacteria in the rivers will rise only marginally following a typical DWO and will not increase above the regulatory guideline of 200 MPN/100 mL. Levels decrease back to baseline within 24 to 36 hours after the event begins. The increase in the level of bacteria from a DWO is limited to within the City limit with no increase above the regulatory guideline level simulated at the Lockport model location.

The Dry Weather Overflow Water Quality Assessment Report was submitted to Manitoba Environment, Climate and Parks (MECP) on December 24, 2021. Based on the response received on July 13, 2022 from MECP, sampling is no longer required for all DWO events. Sampling will still be required for overflow events that exceed 5 hours in duration, or if the expected flow will exceed 0.5 ML.

2.6 CSO Notification Tool

The CSO Notification Tool utilizes outfall instrumentation, a network of rain gauges and sewer computer model simulations to determine if an overflow has occurred in near real-time. It also pulls forecasting radar data, allowing the user to see if an overflow is likely to occur within the next 12 hours.

The CSO Notification Tool satisfies Clause 10 of EA No. 3042, and replaces the Sewer Overflow Information System (SOIS). The SOIS system alerted to the probability of an overflow somewhere in the City. The CSO Notification Tool provides overflow alerts for every combined sewer outfall through the open water season.

3. Water Quality Monitoring

Water quality monitoring is to be implemented to assess, track and report river and stream water quality performance during the implementation of the CSO Master Plan at the boundaries and through the City with reports required every five (5) years. In addition, CSO discharge monitoring is proposed to be implemented at two (2) outfall locations to confirm the data gathered from the previous studies.

The forthcoming water quality monitoring program is planned to be carried out starting in May 2023 in time to be used for the river water quality monitoring report due December 31, 2024. The program may extend into 2024 if sufficient data is not obtained. Sufficient data will be determined by the City and consultant based on analysis of the data against the requirements of the water quality monitoring.

The program timing will be aligned with the normal periods dry weather and for wet weather events, the extent of data collection will depend on suitable dry weather periods and the occurrence of wet weather events. The existing river water quality monitoring will continue as normal. The existing river quality monitoring program allows for continued monitoring of the river water quality at boundary locations.

Many factors may limit the City's ability to conduct a monitoring plan during the open water season such as flooding, high river levels, safety, equipment procurement, etc. When the monitoring program for each sampling season concludes, sufficient time will be required to analyze the raw data and prepare reports.

Monitoring water quality is required to comply with Provincial requirements and will provide data that can be used in CSO Master Plan evaluations and compliance reporting.

3.1 Proposed Approach for Water Quality Monitoring

The river water quality monitoring will capture water quality samples at City boundaries (upstream and downstream of the City) to assess conditions throughout the City. Wastewater treatment plant effluent discharge samples will be included in the water quality analysis to provide information on the plant wet weather discharge quality. CSO discharge samples will also be collected and analyzed to fine-tune the EMCs derived from previous studies.

3.1.1 Water Quality Parameters

The 2002 CSO Study and the 2019 CSO Master Plan (based on the 2014-2015 Water Quality Monitoring Program) identified bacteria as the most significant pollutant of concern, and the proposed monitoring program will support the 2030 CSO Master Plan modeling for bacteria, as well as loading assessments for nutrients and other POC.

The water quality parameters measured in previous studies and those proposed for the upcoming Water Quality Monitoring study are shown in Table 4.

Table 4 – Previously Measured and Proposed Water Quality Parameters

Parameter	Rivers & Small Streams Survey Monitoring Reports[1]	NPRI Report[2]	2002 CSO Study[3]	EA No. 3042	2014-2015 Water Quality Monitoring Program (Rivers & Streams)[4]	2021 DWO Water Quality Assessment[5]	MWQSOG[6]	Effluent Quality Limits (EA No. 3042)	Proposed for 2023-2024 Water Quality Monitoring	Comments
Temperature	✓	-	-	-	✓	-	-	-	✓	In-situ
Dissolved Oxygen	✓	-	-	-	-	-	-	-	-	In-situ
Oxygen Saturation	✓	-	-	-	-	-	-	-	-	
Biochemical Oxygen Demand	✓	-	✓	✓	✓	✓	✓	50 mg/L	✓	
pH	✓	-	-	-	✓	-	-	-	✓	
Total Solids	✓	-	-	-	-	-	-	-	-	

Parameter	Rivers & Small Streams Survey Monitoring Reports[1]	NPRI Report[2]	2002 CSO Study[3]	EA No. 3042	2014-2015 Water Quality Monitoring Program (Rivers & Streams)[4]	2021 DWO Water Quality Assessment[5]	MWQSOG[6]	Effluent Quality Limits (EA No. 3042)	Proposed for 2023-2024 Water Quality Monitoring	Comments
Total Suspended Solids	✓		✓	✓	✓	✓	✓	50 mg/L	✓	
Turbidity	✓	-	-	-	-	-	-	-	-	
Total Organic Carbon	✓	-	-	-	-	-	-	-	-	
Chlorophyll a	✓		-	-	-	-	-	-	-	
Ammonia Nitrogen	✓	✓	-	-	✓	✓	✓	-	✓	
Nitrite Nitrogen	-	-	-	-	✓	-	-	-		
Nitrate Nitrogen	✓	✓	-	-	✓	-	-	-	✓	
Total Kjeldahl Nitrogen (TKN)	-	-	-	-	✓	-	-	-	-	
Total Nitrogen	✓		✓		✓	✓		-	✓	Secondary POC
Soluble Phosphorus	✓	-	-	-	-	-	-	-	-	
Total Phosphorus	✓	✓	✓	✓	✓	✓	✓	1 mg/L	✓	Secondary POC
E. coli	✓	-	-	✓	✓	✓	✓	1000 MPN/100 mL	✓	Primary POC
Fecal Coliform	✓	-	✓	-	✓	-	✓	-	-	
Conductivity	-	-	-	-	✓	-	-	-	-	

Sources:
1. https://winnipeg.ca/waterandwaste/sewage/monitoring/RiversSmallStreams.stm
2. Report to the National Pollutant Release Inventory (NPRI) Program
3. 2002 CSO Management Study – Phase 1 – TM1, Wardrop et al., June 1994, Table 2-7
4. CSO Master Plan Water Quality Monitoring Program, CH2M et al., December 2015, Table 2
5. Dry Weather Overflow Water Quality Assessment, Jacobs, November 2021, Table 3-2
6. Manitoba Water Quality Standards, Objectives, and Guidelines, Manitoba Water Stewardship, November 2011, Table 1

The proposed parameters for 2023/2024 water quality monitoring include EA No.3042 parameters of biochemical oxygen demand (BOD), total suspended solids (TSS), TP and E. coli. Additional parameters to be monitored include PH, temperature, Ammonia Nitrate, TN and Nitrate Nitrogen.

3.1.2 CSO Discharge Water Quality Monitoring

The 2002 CSO Study reviewed prior research from a wide range of locations and found that discharge quality from CSOs was highly variable, and the overall loadings from CSOs were essentially uncorrelated with runoff volume. The intuitive first flush effect had been periodically but not consistently observed, the discharge concentrations changed from time to time and comparisons between locations which would have been expected to be similar were often quite different.

In addition, the 2014-2015 water quality monitoring program showed that CSO discharge was also highly variable and there was no discernable trend in the values of POC based on the locations sampled during 2015 or the intensity or duration of rainfall causing the overflow.

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 modeling and loading assessments used in the potential plan evaluations. The results from the two studies matched closely and are consistent with results from published information (i.e. they are within typical ranges for combined sewage).

The results of both data sets provided similar estimations of the values for each constituent.

Since the discharge sampling results from the two studies matched closely, and are consistent with results from published information, it is expected that results from additional sets collected would be similar showing a consistently repeated trend (see Table 5). Instead, the EMCs from the previous two studies, coupled with limited new CSO discharge monitoring will be used in this study. The impacts of the CSOs on the waterbodies will be assessed by additional river monitoring before, during, and after a rainfall event. This will ensure that CSO impacts are addressed in the study.

Table 5 – EMC values for select Pollutants of Concern

Parameter	Unit	2002 CSO Study EMC[1]	2015 Master Plan EMC[2]
Bacteria[3]	MPN/100 mL	2.4×10^6	1.5×10^6
Total Phosphorus	mg/L	3.0	3.1
Total Nitrogen	mg/L	15.0	17.8

Notes:
1. Source: CSO Management Study, Phase 1, TM 1, Table 2-8 & Phase 2, TM 1, page 16.
2. Source: CSO Master Plan Water Quality Monitoring Program, December 2015, Table 2 (average values of samples collected at eight outfall locations)
3. 2002 value is fecal coliforms and 2015 value is *E. coli*.

Event mean concentrations developed as part of the CSO MP and were used in conjunction with volume reduction to estimate improvements in water quality.

3.1.2.1 Proposed CSO Discharge Water Quality Monitoring Approach

The City is proposing CSO discharge monitoring at two (2) outfall locations, representative of the runoff and discharge sources throughout the City.

The locations will be selected to ensure city-wide representation. The select locations will be outfitted with an autosampler and set to collect discharge samples following a qualified wet weather event.

Feasibility of monitoring discharges from the locations monitored in 2014/2015 will be reviewed to ensure any changes to these locations have not impacted the ability to successfully monitor discharges. Site conditions (e.g. weather, river levels, etc.) will have an impact on when the samplers can be installed.

The proposed locations will be investigated to ensure they are suitable for the installation and regular access of the samplers based on the following:

- Suitable room is available for the sampler to be housed for the monitoring period.
- The sampler can be installed and removed safely and does not interfere with the operation of the structure.
- Safe regular access to the sampler can be achieved with minimal risk to the operator.
- There is suitable and safe access to and from the outfall structure where the sampler is installed.
- High river levels do not prohibit the safe and reliable installation and operation of the monitoring equipment.

The site locations will be maintained until a satisfactory set of data is collected and then moved to different locations. A satisfactory set of data will require the samplers to successfully capture 3-4 significant wet weather events.

An assessment of the results will be required to determine if the sampling for the event was satisfactory. The minimum requirements will be several hours of overflow with the sampler working properly. Other factors will be considered based on review of the results. Conditions such as low interevent times or too few samples may impact the results to such an extent that they do not prove to be representative.

The use of composite sample instead of multiple discrete samples to minimize the cost of sample testing will be considered.

2002 and 2014/2015 CSO discharge monitoring results from the two studies matched closely and are consistent with results from published information (i.e. typical ranges for combined sewage).

3.1.2.2 CSO Discharge Water Quality Monitoring Challenges

To capture CSO discharge water quality samples equipment needs to be installed in the outfall and has to be accessible to collect samples. The equipment needs to be triggered to activate and all be connected to a power source. The complexity of the trigger, arrangement of sampling equipment and its size limit the locations this work can feasibly be completed at. Automatic samplers collect samples as the discharge is occurring and can take samples at designated times to get an impression of the water quality changes through the event. Going to site when a storm is occurring to take a grab sample is not good practices as it would be impossible to determine how relevant it was to the overall discharge.

Installing automatic samplers requires feasibility assessments, designing layout of the equipment and trigger levels, testing, sample collection and testing. For the 2015/2015 work, it cost close to $0.5M and would be estimated to cost $1M to repeat this work in the future. The 2014/2015 work utilized the CSO Monitoring program contractor who had knowledge of all the Outfall locations and we already mobilized in Winnipeg. The City has had challenges with obtaining specialized contractors of this nature and any contractor bidding would need to include feasibility assessment portions of the work to their bids.

All designers and municipalities try to limit entries into underground confined spaces as it poses health and safety risks to operators. One off studies and investigations can fall into a lower risk category as they are low frequency but when we have long term programs where multiple entries are required over many years these confined space locations need to be designed for frequent safe access. The CSO outfall chambers are not designed for high frequency use so there is a potential larger cost to modifying these chambers and the embankments for safe operator frequent use.

The CSO MP is focused on investing in reducing the volume of CSO discharging into our rivers, while discharge monitoring represents a significant cost and time constraint on City resources to manage, which will take funds and time from eliminating the problem.

3.1.3 River Water Quality Monitoring Frequency

The monitoring plan will include river water quality monitoring for dry and wet weather. The dry weather flow monitoring will establish a baseline in the absence of wet weather inflows. The resulting water quality will provide an indication of the natural state of the river with wastewater treatment plant effluents and upstream sources as inputs. The wet weather flow monitoring will provide information on the impact from wet weather flows, including discharges from land drainage sewers, CSOs, wastewater treatment plants, and direct runoff on the river as they flow through the City.

This proposed approach aligns with the 2014/2015 approach.

The key components include:

- Collect two (2) dry weather river and stream water quality sample sets to assess performance in dry weather
    - Three (3) preceding dry days to trigger monitoring
    - Ideally a week day and a weekend day
    - Collect grab samples on a once daily cycle for three consecutive days
    - The dry weather sampling will terminate before the full three-day period if rain occurs.
- Collect three (3) wet weather sample sets to assess performance in wet weather
    - Wet weather events that result in majority of CSO location discharges to trigger monitoring

  - Collect samples for three (3) consecutive days

- Have an accredited laboratory complete the analysis 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
- Update the monitoring protocol
- Incorporate key learnings into CSO MP evaluations and planning for future water quality monitoring

3.1.4 River Water Quality Monitoring Locations

River water quality measurements during dry and wet weather events will be taken to assess river water quality. The locations proposed for the river sampling are listed below in Table 6 and Table 7, and are shown in Figure 2.

Table 6 – River Sampling Locations

Bridge Location	Map ID	Bi-weekly Rivers Survey Monitoring	Proposed for 2023-2024 Water Quality Monitoring	Sampling Description
Headingley Bridge	R1	✓	✓	Upstream Assiniboine boundary
West Perimeter Bridge	R2	✓	×	
Assiniboine Park Foot Bridge	R3	✓	✓	Assiniboine Intermediate
Main Street Bridge	R4	✓	×	
Osborne Street Bridge	Rx1	×	✓	Assiniboine CSO
St. Adolphe Pierre Delorme Bridge	R5	✓	✓	Upstream Red boundary
South Perimeter Bridge	R6	✓	×	
Fort Garry Bridge	R7	✓	✓	Red upstream
Norwood Bridge	R8	✓	✓	Red CSO
Redwood Bridge	R9	✓	✓	Red and Assiniboine CSO
Provencher Bridge	Rx2	×	✓	Red and Assiniboine CSO
North Perimeter Bridge	R10	✓	✓	Red and Assiniboine CSO
Lockport Bridge	R11	✓	✓	Downstream Red boundary
Total Number of Monitoring Locations		**11**	**10**	**N/A**

Table 7 – Small Stream Sampling Locations

Small Stream Location	Map ID	Bi-weekly Small Streams Survey Monitoring	Proposed for 2023-2024 Water Quality Minitoring	Sampling Description
Sturgeon Creek @ Perimeter	S1	✓	×	
Sturgeon Creek @ Portage Ave.	S2	✓	✓	
Truro Creek @ Portage Ave.	S3	✓	✓	
Omands Creek	S4	✓	✓	
La Salle River	S5	✓	✓	

Small Stream Location	Map ID	Bi-weekly Small Streams Survey Monitoring	Proposed for 2023-2024 Water Quality Minitoring	Sampling Description
Seine River @ Hwy 59	S6	✓	×	
Seine River @ Provencher Blvd.	S7	✓	✓	
Bunns Creek	S8	✓	✓	
Total Number of Monitoring Locations		**8**	**6**	

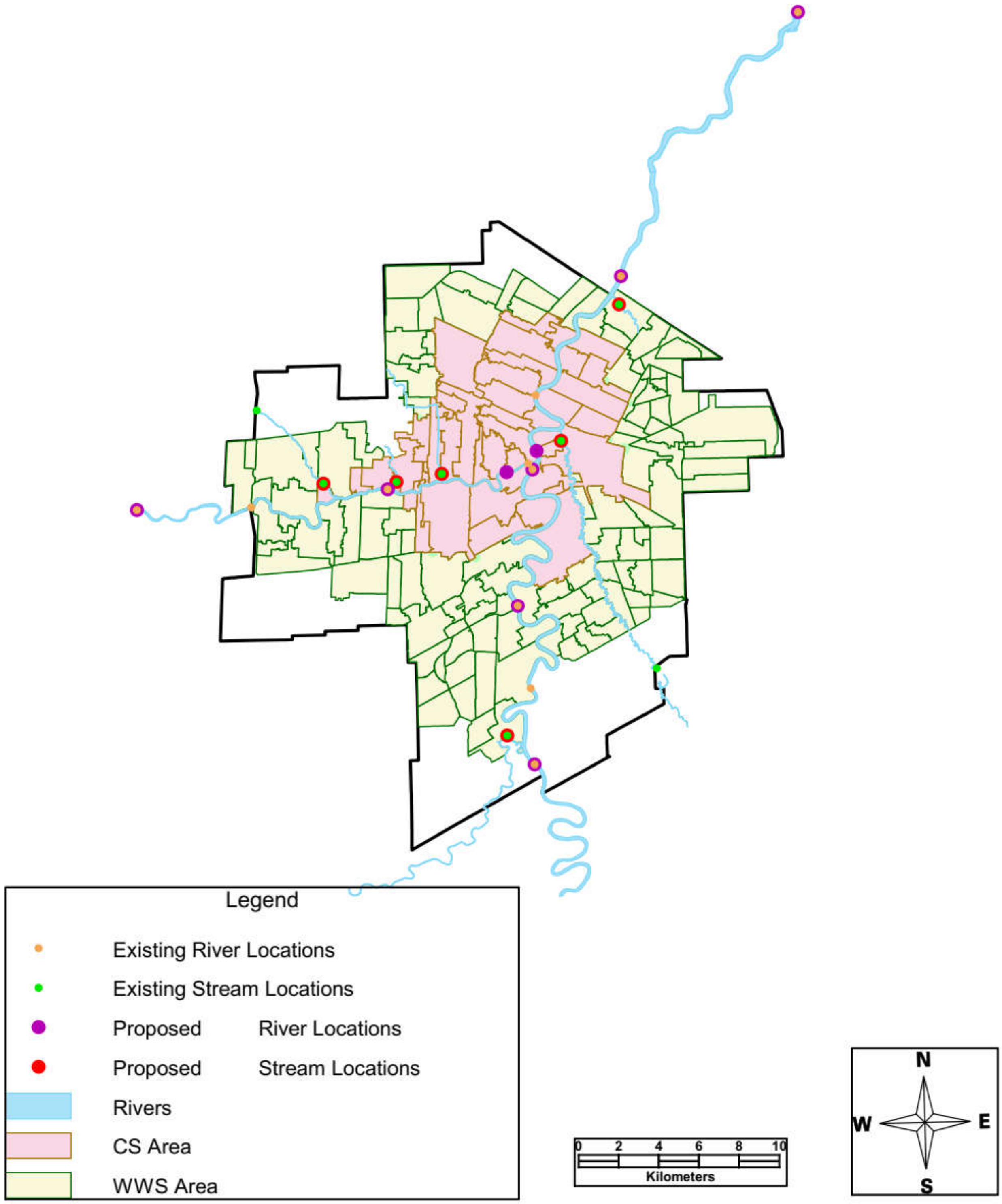

Figure 2 – River and Stream Sampling Locations Map

Figure 2 shows potential sampling locations for the rivers and streams program. The stream and river locations are shown in red and purpule circles, respectively. The small green and orange circles indicate the locations that are already included as part of the City's existing sampling program. A detailed Monitoring Locations Plan is included as Appendix C.

The upstream and downstream boundary conditions are required to calibrate and verify the river water quality model and evaluate the impacts of CSOs on the rivers. Quantification of the upstream sources and downstream outflows is essential to developing an accurate tool for evaluating system performance. The information will be used to build an understanding of the benefits of a CSO program in general and of the incremental improvements between programs designed to meet various performance targets.

Information under wet weather conditions will be collected at the study area boundaries to add perspective on the loading sources. Grab samples will be taken across the rivers under the in-stream monitoring program from roadway bridges as is currently done for the river monitoring program at the Headingley, St. Adolphe and Lockport bridges.

The upstream monitoring will provide perspective on the water quality prior to entering the urban zone, and the downstream perspective on the urban impacts. The findings and results of the monitoring programs will be included in River Water Quality Monitoring Report.

River and stream water quality data will be compared to Manitoba Water Quality Standards Objectives and Guidelines (MWQSOG) thresholds for performance assessment. Modeling will be undertaken where there are changes to values that may impact predicted design performance.

In summary, the proposed monitoring plan will include:

- Existing In-Stream River Water Quality Monitoring: Grab samples will continue to be taken from the existing current sampling locations over the course of the monitoring season.
- Additional In-Stream River Water Quality Monitoring: Grab samples will be taken from 15 sampling locations upstream and downstream of the combined sewer system to assess the impact of CSOs on the rivers, after prolonged dry periods (3 days or greater) and after significant rainfall events (10 mm depths of greater).
- Sewer System Outfall Level Instrumentation: Instrumentation installed at outfall locations in addition to river profile information will be used to estimate sewer flows.

Appendix A – Winnipeg River and Stream Sampling Report Examples

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2021 RIVERS SURVEY MONITORING REPORT

Survey Date:	September 29, 2021	Assiniboine River Sampling Locations				Red River Sampling Locations						
Parameter	**Unit**	**HEADINGLY BRIDGE (R1)**	**WEST PERIMETER BRIDGE (R2)**	**ASSINIBOINE PARK FOOT BRIDGE (R3)**	**MAIN STREET BRIDGE (R4)**	**SOUTH FLOODWAY CONTROL* (R5)**	**SOUTH PERIMETER BRIDGE (R6)**	**FORT GARRY BRIDGE (R7)**	**NORWOOD BRIDGE (R8)**	**REDWOOD BRIDGE (R9)**	**NORTH PERIMETER BRIDGE (R10)**	**LOCKPORT BRIDGE (R11)**
Sample Number		**427651**	**427657**	**427646**	**427655**	**427659**	**427665**	**427660**	**427663**	**427664**	**427662**	**427661**
Temperature	°C	17.7	17.6	17.3	17.8	17.0	16.7	18.1	16.7	16.4	16.3	16.8
Dissolved Oxygen	mg/L	9.7	9.8	8.9	8.7	10.5	9.9	8.8	7.4	7.6	8.3	7.5
Oxygen Saturation	%	102	102	93	91	108	103	93	76	78	84	77
Biochemical Oxygen Demand	mg/L	4	<4	<4	<4	<4	<4	<4	<4	<4	<4	7
pH	units	8.67	8.69	8.60	8.58	8.73	8.77	8.48	8.32	8.37	7.96	7.96
Total Solids	mg/L	696	712	678	682	758	762	760	758	732	708	732
Total Suspended Solids	mg/L	63	65	43	27	54	31	18	14	15	8	4
Turbidity	n.t.u.	31	34	29	21	32	20	11	7	8	5	3
Total Organic Carbon	mg/L	10.9	9.7	9.5	10.3	10.4	10.6	10.8	11.2	10.6	11.9	10.9
Chlorophyll a	ug/L	40.1	32.7	33.4	36.7	29.4	16.0	11.3	6.7	14.7	18.7	4.7
Ammonia Nitrogen	mg/L N	0.007	0.011	0.009	0.135	0.050	0.021	0.804	0.873	0.414	>2.00	1.18
Nitrate Nitrogen	mg/L N	<0.003	0.020	0.006	0.017	nr	0.032	0.211	0.207	0.145	0.280	0.365
Total Nitrogen	mg/L N	<0.2	<0.2	<0.2	0.5	0.3	<0.2	1.3	1.5	0.8	3.9	2.5
Soluble Phosphorus	mg/L P	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr
Total Phosphorus	mg/L P	0.13	0.14	0.11	0.13	0.10	0.08	0.20	0.19	0.15	0.43	0.35
Escherichia Coliform	MPN/100 mL	180	300	310	120	440	60	<10	20	70	40	10
Fecal Coliform	MPN/100 mL	250	410	290	50	200	130	20	<10	20	20	<10

Notes: ns - no sample na - not analyzed nr - no result

Red River elevation at South Floodway control gates: 734.02 ft
Weather conditions during monitoring:
- Wind Direction: South (S)
- Wind Speed: 28 km/h
- Cloud Coverage: 25%
- Precipitation: <0.1 mm
- Air Temperature: 26°C

Compiled By: H. Demchenko
Compliance Reporting Technician

Approved By: C.Diduck
Analytical Services Branch Head

Date Compiled: 30-Mar-22

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2021 SMALL STREAMS SURVEY MONITORING REPORT

Survey Date: **July 15, 2021**

Parameter	Unit	SEINE RIVER @ HWY 59 (S6)	SEINE RIVER @ PROVENCHER BLVD (S7)	STURGEON CREEK @ PERIMETER (S1)	STURGEON CREEK @ PORTAGE AVE (S2)	OMANDS CREEK @ PORTAGE AVE (S4)	LA SALLE RIVER @ HWY 75 (S5)	BUNNS CREEK @ BONNER AVE (S8)	TRURO CREEK @ PORTAGE AVE (S3)
		Small Streams Sampling Locations							
Sample Number		**407661**	**407662**	**407658**	**407660**	**407655**	**407651**	**407647**	**407663**
Temperature	°C	22.4	23.1	20.2	21.4	24.2	23.9	ns	ns
Dissolved Oxygen	mg/L	7.1	6.4	8.4	6.6	3.9	7.7	ns	ns
Oxygen Saturation	%	81	74	92	75	42	92	ns	ns
Biochemical Oxygen Demand	mg/L	<4	<4	4	<4	>15	4	ns	ns
pH	units	8.08	8.06	7.73	8.36	7.51	7.73	ns	ns
Total Solids	mg/L	388	362	1,500	1,360	1,310	704	ns	ns
Total Suspended Solids	mg/L	65	3	<3	<3.0	21	21	ns	ns
Turbidity	n.t.u.	46	5	2	1	8	17	ns	ns
Total Organic Carbon	mg/L	18.8	20.0	9.1	12.4	27.0	14.2	ns	ns
Chlorophyll a	ug/L	4.0	2.7	20.0	2.7	100.0	29.4	ns	ns
Ammonia Nitrogen	mg/L N	0.063	0.057	0.023	0.062	0.034	0.030	ns	ns
Nitrate Nitrogen	mg/L N	0.014	0.003	<0.003	0.024	<0.003	<0.003	ns	ns
Total Nitrogen	mg/L N	1.1	1.0	0.7	1.0	1.8	1.5	ns	ns
Soluble Phosphorus	mg/L P	0.13	0.27	0.04	0.15	0.25	0.60	ns	ns
Total Phosphorus	mg/L P	0.25	0.33	0.13	0.22	0.63	0.85	ns	ns
Escherichia Coliform	MPN/100 mL	60	20	20	20	500	30	ns	ns
Fecal Coliform	MPN/100 mL	40	20	60	50	14,100	50	ns	ns

Notes: ns - no sample   na - not analyzed   nr - no result

Weather conditions during monitoring:
- Wind Direction: South (S)
- Wind Speed: 19 km/h
- Cloud Coverage: 0%
- Precipitation: <0.1 mm
- Air Temperature: 13°C

Compiled By: H. Demchenko
Compliance Reporting Technician

Approved By: C.Diduck
Analytical Services Branch Head

Date Compiled: 12-Aug-21

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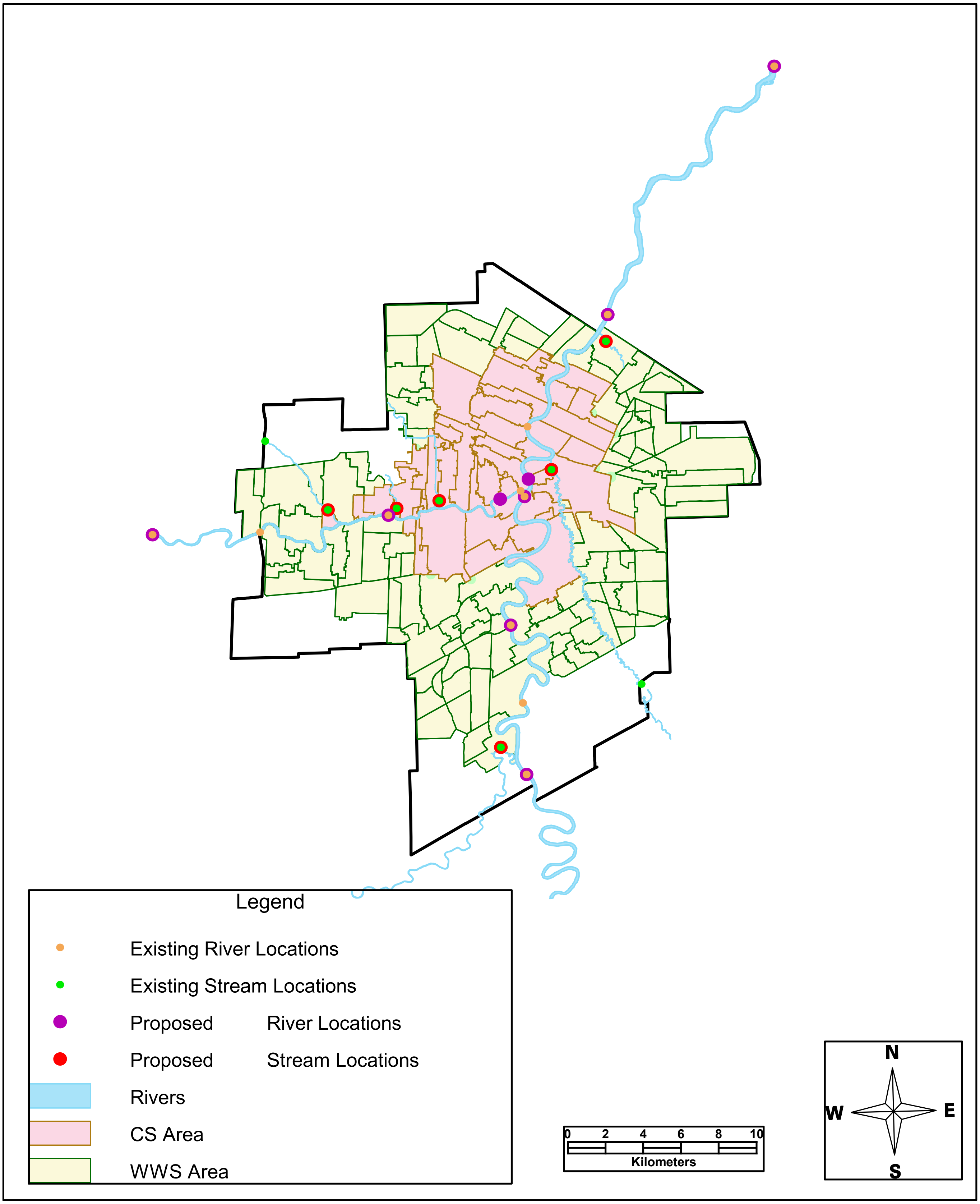
Appendix B – Winnipeg River and Stream Sample Locations



River and Stream Monitoring Locations

Appendix C – Monitoring Locations Plan

POTENTIAL CSO MONITORING LOCATIONS

ID	NAME	NORTHING	EASTING
1	Cockburn - 905 Cockburn St S	5524183.93	633688.02
4	Mager - 3 Mager Dr	5525031.61	635574.7
10	Jessie - 417 Mulvey Av E	5526361.46	633765.61
20	Mission - 91 Archibald St	5529202.97	635727.54
42	Strathmillan - 2396 Portage Av	5526101.21	625650.73
38	Hawthorne - 1178A Kildonan Dr	5533894.63	636641.79
65	Colony - 40 Granite Way	5527042.71	632599.46
71	Assiniboine - 60 Main St @ Assiniboine Av	5527608.03	634067.62

RIVER AND STREAM SAMPLING LOCATIONS

R1	Headingley Bridge	5525252	614620
R3	Assiniboine Park Foot Bridge	5526289	627111
RX1	Osborne Strret Bridge	5527129	633031
R5	Ste.Adolphe Pierre Delorme Bridge	5504675	635550
R7	Fort Garry Bridge	5520469	633584
R8	Norwood Bridge	5527264	634318
R9	Redwood Bridge	5530976	634478
RX2	Provencher Bridge	5528195	634530
R10	North Perimeter Bridge	5536904	638727
R11	Lockport Bridge	5550053	647541
S2	Sturgeon Creek at Portage Avenue	5526559	623908
S3	Truro Creek at Portage Avenue	5526647	627551
S4	Omands Creek at Portage Avenue	5527053	629796
S5	La Salle River at Highway 75	5513992	633059
S7	Seine River at Provencher Boulevard	5528699	635747
S8	Bunns Creek at Bonner Avenue	5535486	638628

CSO OUTFALL LOCATION TABLE

ID	NAME LOCATION	NORTHING	EASTING	ID	NAME LOCATION	NORTHING	EASTING
1	Cockburn - 905 Cockburn St S	5524183.93	633688.02	41	Olive - 2461 Assinboine Cr	5525990.44	625326.52
2	Churchill Dr @ Osborne St	5524310.8	634599.42	42	Strathmillan - 2396 Portage Av	5526101.21	625650.73
3	Kingston Row @ Edinburgh St	5524228.84	634741.95	43	Conway - 2200 Portage Av	5526240.85	626382.3
4	Mager - 3 Mager Dr	5525031.61	635574.7	44	~~44 Deer Lodge~~	5526256.84	627346.34
5	Baltimore - 250 Churchill Dr	5525648.3	635535.37	45	82 Douglas Park	5526114.99	627627.63
6	Metcalfe - 242 Metcalfe Av	5526033.61	635362.25	46	Ferry - 40 Ferry Rd	5526125.99	627945.39
7	Eccles St @ Churchill Dr	5525901.02	634818.35	47	Chataway - 1810 Wellington Cr	5526104.15	628520.25
8	Eccles St @ Churchill Dr	5525896.26	634805.41	48	Doncaster St @ Wellington Cr	5526167.98	628757.3
9	80 Churchill Dr	5525789.6	634324.78	49	Parkside Dr @ Assiniboine Av	5526191.15	628705.16
10	Jessie - 417 Mulvey Av E	5526361.46	633765.61	50	Riverbend Gate Chamber - 125 Parkside Dr	5526476.07	628739.83
11	Lyndale Dr @ Walmer St	5526911.71	634144.24	51	Opposite 1620 Wellington Cr	5526464.16	628837.83
12	Marion - 6 Lyndale Dr	5527159.5	634312.39	52	Tylehurst - 499 Tylehurst St	5526651.06	629348.25
13	Despins - 465 Tache Av	5527755.6	634722.67	53	West of 1345 Wellington Cr	5526640.61	629745.9
14	Dumoulin - 691 Tache Av	5528311.83	634546.08	54	Clifton - 1256 Wolseley Ave	5526795.8	630283.55
15	La Verendrye - 745 Tache Av	5528489.37	634464.19	55	Ash - 1057 Wellington Cr	5526728.49	630727.79
16	Lombard Av @ Waterfront Dr	5528658.05	634149.96	56	1020 Palmerston Av	5526533.41	631061.81
17	McDermot Av @ Waterfront Dr	5528733.6	634143.73	57	Aubrey - 1016 Palmerston Av	5527144.99	632783.72
18	Bannatyne - 20 Ship St	5528819.56	634101.44	58	980 Palmerston Av	5526533.84	631088.34
19	Galt - 401 Waterfront Dr	5529178.41	634329.48	59	Arlington Av @ Palmerston Av	5526490.39	631226.01
20	Mission - 91 Archibald St	5529202.97	635727.54	60	850 Palmerston Av	5526534.29	631484.93
21	Roland - 16 Watt St	5529600.23	635903.81	61	Cornish Av @ Maryland St	5526697.53	631739.43
22	Syndicate - 200 Syndicate St @ Rover	5529925.03	635109.88	62	393 Wellington Cr @ Grosvenor Av	5526718.57	632117.59
23	Selkirk - 108 Selkirk Av	5530580.4	634435.88	63	Cornish - 1 Cornish Av @ Langside St	5526207.92	632450.02
24	100 Pritchard Av	5530605.89	634442.75	64	Balmoral St @ Spence St	5526825.14	632521.82
25	123 Burrows Av	5530712.13	634408.32	65	Colony - 40 Granite Way	5527042.71	632599.46
26	150 Aberdeen Av	5530883.2	634401.13	66	Kennedy St @ Assiniboine Av	5527214.49	633386.7
27	Hart - 3 Hart Av	5531043.61	634584.9	67	River Av @ Cauchon St	5527189.9	633439.4
28	St John's - 20 Anderson Av	5531325.47	634642.3	68	348 Assiniboine Av @ Hargrave St	5527392.83	633692.43
29	380 Henderson Hw	5531374.72	635199.59	69	318 Assiniboine Av @ Donald St	5527458.35	633774.81
30	Polson - 75 Scotia St	5531705.51	635394.18	70	Mayfair - 105 Mayfair Av @ Main St	5527544.39	634087.52
31	Munroe - 530 Henderson Hwy	5531686.81	635569.92	71	Assiniboine - 60 Main St @ Assiniboine Av	5527608.03	634067.62
32	Scotia St @ Inkster Bv	5531843.14	635491.94	72	Strathcona St @ Portage Av	5526926.19	629911.77
33	Jefferson E - 299 Scotia St	5532767.33	635442.85	73	496 Plinguet St	5528387.53	636086.66
34	Linden - 856 Kildonan Dr	5533051.09	635614.84	74	493 Cherrier St	5527426.83	636208.96
35	Newton - 469 Scotia St	5533696.48	636070.9	75	500 Doucet St	5527339.32	636280.25
36	Armstrong Av @ Scotia St	5533743.88	636176.9	76	516 Prosper St	5527160.01	636315.68
37	10 Riverview Dr -(Kildonan Park)	5533771.55	636267.5	77	~~Dubuc St @ Seine St~~	5526783.55	636193.96
38	Hawthorne - 1178A Kildonan Dr	5533894.63	636641.79	78	Gareau St @ Evans St	5526611.51	636443.11
39	Whellams Ln @ Tamarind Dr	5534788.8	636528.17	79	~~Comanche Rd @ Iroquois Bay~~	5524631.67	636853.16
40	Woodhaven - 2784 Assiniboine Av	5525615.9	624080				

Legend	
A	Instrumented site (45 Sites)
B	Non Instrumented site (31 Sites)
*	Abandoned
**	Seperated

PROPOSED MONITORING PLAN
Monitoring Locations
DECEMBER 2022

Winnipeg
Water and Waste Department

O:\GeoMedia\Geoworkspaces\Mapping\Wastewater\CSO Monitoring Program\GM_2022_SB_EDIT_ProposedMonitoringPlanMonitoringLocationRev1.gws

APPENDIX B

Communications Report

River, Stream and Combined Sewer Overflow Discharge Water Quality Monitoring Project

ENGAGEMENT REPORT

December 2023

KGS GROUP

&

SCATLIFF + MILLER + MURRAY

Project Overview

The City of Winnipeg (the City) is carrying out a prescribed water quality monitoring program to track and report on the current performance of our rivers and streams in accordance with regulatory requirements (the Project). This work is being done as a con   ua   of studies begun by the City of Winnipeg in 1994, with the aim of implemen   g the City's CSO Master Plan.

Kontzamanis Graumann Smith MacMillan Inc. (KGS Group) undertook data coll   on and assessment; detailed water quality monitoring planning; management and ex   on of water quality monitoring; and repo   ng in accordance with Environment Act Licence (EAL) No. 3042 and related Provincial correspondence. Sca   + Miller + Murray (SMM), as a subconsultant to KGS Group, conducted public communica   andem with the Project's prescribed water quality monitoring program. Engagement for the Project addressed combined sewer over   ows as a topic of interest to residents.

This report re   ects the engagement t   s and process for public communica   conducted by SMM.

Engagement Process

Based on dir   on provided following the Project kick-o , SMM coordinated with KGS Group and the City on the appropriate level of public p   cipa   d subsequently managed and facilitated public communica   or the Project.

1.0 Engagement Planning

The Project Team's assessment of the level of engagement was determined to be an **Inform** level of public p   cipa   as per the Interna   Associa   n of Public P   cipa   s (IAP2's) public p   cipa   rum. This assessment was guided by the requirements of the Project, to demonstrate improvements in the river quality due to implementa   f the CSO Master Plan. No scope of public in   uence was iden   because the Project executed prescribed regulatory compliance.

The engagement team maintained clear communica   throughout the Project, following the Communica   lan developed by SMM, with support of the City and Project Team.

1.1 Communications Plan

The Communica   lan was developed in June 2023, se   the strategy and   eline for communica   ring the Project, and a   g as a roadmap for the process. Communica developed were made to build upon previous engagement undertaken for the CSO Master Plan, con   uing to inform the public, stakeholders, and rightsholders regarding CSO a   and the actual impact of CSOs. The engagement team maintained the goal of providing the public with balanced, obj   e and contextualized informa   on to foster an understanding of the current state of CSOs and water quality monitoring in the City and the plans for the Project.

The engagement objec   ves were as follows:

- Providing key informa   nd Project background clearly, consistently and in plain language.
- Suppo   ng accurate informa   ng, including the sampling campaign results with the associated environmental cond   ons (e.g., river levels,   ows and ambient temperatures) context.
- Informing   cipants about the linkages to the City's past and future   v   es including the CSO Master Plan.

As part of the communica plan, SMM completed a Public Communica able to iden y relevant stakeholder groups and the manner in which they should be engaged (Appendix A).

1.2 Communications Strategy and Tactics

SMM developed a communica trategy in which the City's Water and Waste Department webpage acted as the main informa on and communica b. Content on this webpage provided background and Project informa on that was factual, clear, and easy to understand. All communica aterials for the Project website were reviewed by the Project Team, represen g the City, KGS Group, and SMM. The background and technical informa gathered for the Project webpage also informed the development of a Project Fact Card, used in the eld as a method for maintaining accuracy and consistency of communica with people interested in the program.

All communica aterials directed the public to 311, 311@winnipeg.ca or the City webpage in accordance with City accessibility requirements.

Lastly, the Communica Strategy included four key messages to guide all public communica about the Project, as follows:

- This Project is part of the larger CSO Master Plan implementa long-term plan for CSOs in the City.
- The City is monitoring river water quality to check for improvements in water quality as a result of ongoing implementa of the CSO Master Plan.
- The Project is part of the City's regulatory compliance with Environment Act Licence No.3042.
- The City completes bi-weekly water quality tes g on rivers and streams to monitor the levels of nutrients and bacteria in the water, as well as several other water quality parameters related to the health of our streams and rivers.

2.0 Engagement Deliverables

SMM's engagement plan included a Project webpage, the development of a Project Fact Card, and online no or all wards. The following se ons iden y what each deliverable achieved.

2.1 Project Website Updates

SMM worked with the City to provide content for the CSO Master Plan Project website as the prime tool for keeping the public-at-large informed on the Project. Content included Project-speci c knowledge and a technical overview developed by SMM with con rma on from the Project Team.

2.2 Water and Waste Public Notice

SMM designed a bilingual Public No e (Appendix B) to be used by KGS Group eld crews as a communica ool during sampling es, sharing Project informa with interested members of the public that approached sampling st in the eld. The no e allowed for team members to maintain clear and consistent messaging with the public, as approved by the City and displayed on the Project webpage.

The no e was developed to:

- generate awareness about the Project.
- share informa out the water sampling program.
- present Project factors and considera ons.

The No e was also displayed on the City's Water and Waste Online No board for all electoral wards. The digital version of the card o ered the same informa on as the print version, iden ying the purpose of the Project, the sampling process, loca ons, and dura how these t within the overall CSO Master Plan implementa

3.0 Next Steps

Clause 16b of EAL No. 3042 requires the City to post grab sample dates, loca ons and analy al results summaries, as well as CSO dates on a public no ca on site (i.e., the City of Winnipeg website) within three months of the end of each year. The City will con ue to be responsible for pos g these data to the website.

Appendix A

PUBLIC COMMUNICATIONS TABLE

Project	River, Stream, and Combined Sewer Overflow Discharge Water Quality Monitoring		**Date:**	17-May-23				
Description	The City of Winnipeg is carrying out a monitoring program related to the operation of the City's combined sewer collection system and its impact on surface water quality.		**File No.:**	S-1259				
			Bid Opp. No.:	949-2022				
Project Component	**Messages (What)**	**Relevant Public (Who)**	**Timing/Frequency (When)**	**Engagement (Partner, Involve, Consult), Commuincation (Inform) or None Needed**	**Delivery Method/Media Type (How)**	**By Whom**	**Feed Back Mechanism**	**Rationale**
Sampling Program	The City completes water quality testing on rivers and streams to monitor levels of nutrients and bacteria in the water, as well as the temperature of the water every five years. This is happening in our City and in your neighbourhood.	Public-at-large	Prior to start of sampling program	Inform	CSO Master Plan website updates via Water and Waste Department Webpage; Project Fact Sheet; Water and Waste Online Notice	SMM	311	Provide project background, share information about the water sampling process, and present project factors and considerations.
Final Report	This water quality monitoring project is part of the larger CSO Master Plan implementation and long-term plan for CSOs in the City. The City monitors river water quality regularly to check for improvements in water quality as a result of ongoing implementation of the CSO Master Plan and CSO event reduction.	Public-at-large	Following completion of Final Report	Inform	CSO Master Plan website updates via Water and Waste Department Webpage; Our City, Our Stories	SMM	311	Report back on findings, connect the project to CSO Master Plan, and close the loop on the project.
Regulatory Compliance	The City of Winnipeg is undertaking sampling in accordance with licence requirements and environmental best practice to monitor the impact of CSOs and CSO event reductions due to on-going sewer separation projects.	Province of Manitoba	Early and often, especially prior to the field season	Consult	Meeting and letter correspondences	City of Winnipeg WWD	City of Winnipeg PMs	To obtain concurrence on sampling program design and methods to meet regulatory compliance requirements.

Appendix B

WATER AND WASTE PUBLIC NOTICE

Winnipeg

PROJECT NOTICE
2023 - 2024

River, Stream and Combined Sewer Overflow Discharge Water Quality Monitoring

The City of Winnipeg is taking water quality samples at 18 locations on local rivers, streams, and combined sewer outfalls.

Sampling will run to **October 31, 2023**. More testing may occur in 2024 during open water season, if needed.

We are measuring water quality as part of the Combined Sewer Overflow (CSO) Master Plan. The CSO Master Plan is a long-term plan to reduce the negative impacts of combined sewers.

A combined sewer is a sewer that accepts wastewater from homes and roadways. During very wet weather, these sewers can exceed their capacity and overflow. When these pipes overflow, the untreated wastewaster flows into local waterways.

By sampling the water, we will be able to see water quality changes, over time.

1

To learn more please call 311, email 311@winnipeg.ca, or visit winnipeg.ca/cso

Winnipeg

AVIS DE PROJET
2023 - 2024

Suivi de la qualité de l'eau des rivières, des ruisseaux et des surverses d'égouts unitaires

La Ville de Winnipeg effectue le contrôle de la qualité de l'eau à 18 points d'échantillonnage sur les cours d'eau locaux et les déversements d'égouts unitaires.

L'échantillonnage se poursuivra jusqu'au **31 octobre, 2023**. Des tests additionnels pourraient avoir lieu en 2024 pendant la saison des eaux libres, si nécessaire.

Nous contrôlons la qualité de l'eau dans le cadre du Plan Directeur sur les Surverses d'Égouts Unitaire (SEU). Le Plan Directeur sur les SEU est un plan à long terme pour réduire les effets négatifs des égouts unitaires.

Un égout unitaire est un égout qui récolte les eaux usées provenant à la fois des foyers et des routes. Durant les périodes très pluvieuses, ces égouts peuvent surpasser leur pleine capacité, ce qui provoque des surverses. Lorsque ceci se produit, les eaux usées non traitées sont rejetées dans les cours d'eau locaux.

À l'aide d'échantillons d'eau, nous serons en mesure d'observer les changements dans la qualité de l'eau au fur du temps.

2

Pour de plus amples renseignements, composez le 311, envoyez un courriel à 311@winnipeg.ca ou consultez le Winnipeg.ca/cso

APPENDIX C

Sampling Results

CSO Discharge Results

		2014-15	2023-24	2014-15	2023-24	2014-15	2023-24	2014-15	2023-24	2014-15	2023-24	2014-15	2023-24	2014-15	2023-24	2014-15	2023-24	2014-15	2023-24	2014-15	2023-24
Location		Ammonia	Ammonia	BOD	BOD	Nitrate + Nitrite	Nitrate + Nitrite	Total Phosphorus	Total Phosphorus	Total Kjeldahl Nitrogen	Total Kjeldahl Nitrogen	Total Nitrogen	Total Nitrogen	Total Suspended Solids	Total Suspended Solids	E.Coli	E.Coli	Temperature	Temperature	pH	pH *
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	MPN/100mL	MPN/100mL	C deg.	C deg.	-	-
Ash	Average	3.66	3.86	115	75	0.16	0.94	2.12	1.56	10.63	7.08	10.73	8.65	386	520	Not Tested	935,778	20.65	-	7.58	7.70
Ash	Minimum	0.26	1.09	20	16	0.07	0.04	0.55	0.55	1.90	3.60	1.90	2.41	81	102	Not Tested	>24,200	20.30	-	7.30	7.19
Ash	Maximum	12.10	14.10	540	286	0.53	2.63	4.37	5.20	23.60	26.60	23.60	26.80	808	3,530	Not Tested	6,490,000	21.30	-	7.85	7.98
Hawthorne	Average	4.73	6.05	127	63	0.22	1.36	2.61	1.96	15.09	16.89	15.26	14.44	504	391	2,758,200	1,941,486	15.27	-	7.48	7.52
Hawthorne	Minimum	1.24	0.96	20	23	0.07	0.01	0.65	0.83	4.50	7.50	5.00	4.58	99	42	393,000	>24,200	10.40	-	6.80	7.10
Hawthorne	Maximum	17.80	12.60	440	185	0.76	2.88	14.50	5.72	76.30	28.70	76.30	28.70	2400	2,360	15,500,000	4,350,000	22.00	-	8.00	7.87

2014/15 data includes >DL and <DL values as absolute values in average calculations, while 2023/24 data excludes >DL and <DL values as absolute values in average calculations

* pH in water/wastewater

				1	1	2	2	3	3	4	4	5	5	6	6
				La Salle River - S5	La Salle River - S5	Seine River - S7	Seine River - S7	Sturgeon Creek - S2	Sturgeon Creek - S2	Truro Creek - S3	Truro Creek - S3	Omands Creek - S4	Omands Creek - S4	Bunns Creek - S8	Bunns Creek - S8
Parameter	Unit		Type	2014/15 AVG	2023/24 AVG	2014/15 AVG	2023/24 AVG	2014/15 AVG	2023/24 AVG	2014/15 AVG	2023/24 AVG	2014/15 AVG	2023/24 AVG	2014/15 AVG	2023/24 AVG
Ammonia	mg/L	Average	Dry	0.034	NC	0.022	NC	0.041	0.075	0.012	0.054	0.024	0.136	0.144	0.143
Ammonia	mg/L	Min	Dry	0.010	<0.013	0.010	<0.013	0.013	<0.013	0.010	<0.013	0.010	0.016	0.010	<0.013
Ammonia	mg/L	Max	Dry	0.079	<0.013	0.039	<0.013	0.065	0.261	0.018	0.067	0.041	0.298	0.289	0.344
Ammonia	mg/L	Average	Wet	0.096	0.135	0.078	0.041	0.067	0.086	0.023	0.013	0.034	0.736	0.078	0.044
Ammonia	mg/L	Min	Wet	0.010	<0.003	0.018	<0.003	0.033	<0.013	0.010	<0.003	0.021	<0.003	0.022	<0.003
Ammonia	mg/L	Max	Wet	0.202	0.220	0.235	0.072	0.099	0.350	0.045	0.015	0.062	0.960	0.163	0.077
BOD	mg/L	Average	Dry	4.89	NC	4.86	3.00	4.86	NC	6.37	NC	4.66	4.00	4.68	3.7
BOD	mg/L	Min	Dry	2.00	<3	2.00	<3	2.00	<3	6.00	<3	2.00	<3	2.00	<3
BOD	mg/L	Max	Dry	6.00	<3	6.00	3.00	6.00	<3	7.90	<3	6.00	5.00	6.00	4.0
BOD	mg/L	Average	Wet	6.00	3.45	2.43	6.08	2.41	4.10	2.00	4.60	2.47	6.22	2.63	6.1
BOD	mg/L	Min	Wet	2.00	<3	2.00	<3	2.00	<3	2.00	<3	2.00	<3	2.00	3.0
BOD	mg/L	Max	Wet	10.30	3.90	3.00	13.00	4.20	4.20	2.00	6.00	6.00	>40	5.60	11.0
Dissolved Oxygen	mg/L	Average	Dry	9.4	6.40	8.7	6.40	9.6	6.24	10.2	3.85	9.1	2.06	6.5	8.83
Dissolved Oxygen	mg/L	Min	Dry	7.8	5.12	5.8	5.41	8.6	4.68	9.2	2.69	6.8	0.39	5.9	7.63
Dissolved Oxygen	mg/L	Max	Dry	10.4	7.26	10.8	7.78	10.5	7.13	12.4	5.45	10.8	6.34	8.6	10.2
Dissolved Oxygen	mg/L	Average	Wet	8.8	7.6	6.1	7.9	6.0	7.9	6.3	5.1	6.7	2.9	6.0	8.1
Dissolved Oxygen	mg/L	Min	Wet	6.1	5.8	5.3	5.0	5.4	6.7	5.3	3.9	5.8	0.5	5.2	6.2
Dissolved Oxygen	mg/L	Max	Wet	14.3	9.6	6.8	11.4	6.9	9.4	7.1	7.5	7.4	6.8	7.3	10.5
E.Coli (End Point)	MPN/100 mL	Average	Dry	164	82	135	218	175	65	34	490	300	320	192	593
E.Coli (End Point)	MPN/100 mL	Min	Dry	43	10	15	20	4	30	7	<10	4	40	23	120
E.Coli (End Point)	MPN/100 mL	Max	Dry	430	270	430	460	649	130	75	1,280	866	830	517	1,450
E.Coli (End Point)	MPN/100 mL	Average	Wet	1,224	75	2307	1746	6336	659	1519	678	5578	2608	1615	374
E.Coli (End Point)	MPN/100 mL	Min	Wet	23	2	411	350	186	60	69	2	201	16	172	<1
E.Coli (End Point)	MPN/100 mL	Max	Wet	10,000	180	10000	3790	24200	2650	10000	3650	24200	10500	10000	960
Nitrate + Nitrite	mg/L	Average	Dry	0.09	-	0.06	-	0.20	-	0.05	-	0.11	-	0.07	-
Nitrate + Nitrite	mg/L	Min	Dry	0.04	-	0.02	-	0.04	-	0.02	-	0.05	-	0.02	-
Nitrate + Nitrite	mg/L	Max	Dry	0.25	-	0.07	-	0.39	-	0.07	-	0.35	-	0.10	-
Nitrate + Nitrite	mg/L	Average	Wet	1.18	1.45	0.36	0.79	0.14	1.08	0.06	0.47	0.07	0.03	0.12	0.18
Nitrate + Nitrite	mg/L	Min	Wet	0.07	0.01	0.14	0.10	0.07	0.11	0.01	0.01	0.01	<0.004	0.07	0.01
Nitrate + Nitrite	mg/L	Max	Wet	3.67	3.96	0.87	1.98	0.31	2.19	0.13	2.29	0.14	0.08	0.31	0.52
pH	units	Average	Dry	8.47	8.02	8.22	8.17	8.20	7.78	8.43	7.57	8.25	6.96	8.17	8.03
pH	units	Min	Dry	8.30	6.04	8.11	7.54	8.10	7.10	8.10	7.16	8.10	4.79	7.80	5.61
pH	units	Max	Dry	8.76	8.53	8.30	8.46	8.30	8.43	9.06	7.93	8.43	7.64	8.50	8.61
pH	units	Average	Wet	8.63	8.05	8.20	8.04	8.20	7.96	8.16	7.73	8.09	7.75	8.36	8.43
pH	units	Min	Wet	8.13	6.57	7.93	7.06	8.08	7.29	7.93	7.10	7.95	7.26	8.05	7.85
pH	units	Max	Wet	9.55	8.85	8.50	8.58	8.38	8.42	8.44	8.50	8.30	8.65	8.72	8.62
Temperature	deg Celcius	Average	Dry	12.7	19.0	12.8	21.2	11.9	18.6	15.2	17.6	14.0	20.5	12.9	21.5
Temperature	deg Celcius	Min	Dry	6.3	12.7	7.4	18.3	8.8	13.7	8.1	14.2	7.8	14.8	6.0	18.4
Temperature	deg Celcius	Max	Dry	21.0	25.0	20.0	24.6	17.9	22.0	25.9	24.2	23.0	29.8	23.0	25.1
Temperature	deg Celcius	Average	Wet	22.1	14.8	20.2	14.9	19.4	13.5	18.1	13.9	18.6	14.2	20.5	15.8
Temperature	deg Celcius	Min	Wet	19.1	11.1	17.3	10.6	17.5	8.5	14.8	9.6	15.8	9.9	17.8	12.0
Temperature	deg Celcius	Max	Wet	25.5	20.7	22.8	20.5	21.5	19.5	20.3	19.0	21.3	20.0	24.3	22.3
Total Kjeldahl Nitrogen	mg/L	Average	Dry	1.27	-	0.78	-	0.74	-	1.26	-	0.84	-	1.49	-
Total Kjeldahl Nitrogen	mg/L	Min	Dry	0.71	-	0.61	-	0.50	-	0.48	-	0.72	-	0.80	-
Total Kjeldahl Nitrogen	mg/L	Max	Dry	1.59	-	0.88	-	1.04	-	2.96	-	1.01	-	2.26	-
Total Kjeldahl Nitrogen	mg/L	Average	Wet	2.29	1.10	1.30	1.05	0.85	1.30	0.69	0.72	0.88	1.17	1.05	1.22
Total Kjeldahl Nitrogen	mg/L	Min	Wet	1.27	0.40	1.14	0.40	0.61	0.50	0.38	0.20	0.38	0.20	0.27	0.50
Total Kjeldahl Nitrogen	mg/L	Max	Wet	3.76	2.00	1.76	1.60	1.08	2.10	0.91	1.60	1.14	2.30	1.66	1.90
Total Nitrogen	mg/L	Average	Dry	1.30	0.80	0.78	0.52	0.68	0.35	1.26	0.33	0.86	0.77	1.46	1.10
Total Nitrogen	mg/L	Min	Dry	0.73	0.42	0.61	0.25	0.50	<0.20	0.48	<0.20	0.72	0.30	0.80	0.51
Total Nitrogen	mg/L	Max	Dry	1.59	1.20	0.88	0.73	0.87	0.44	2.96	0.41	1.10	1.06	2.16	1.54
Total Nitrogen	mg/L	Average	Wet	3.44	1.96	1.47	1.51	0.96	2.11	0.72	1.19	0.91	1.69	1.21	1.45
Total Nitrogen	mg/L	Min	Wet	1.83	0.58	0.18	<0.20	0.72	<0.20	0.46	<0.20	0.52	<0.20	0.86	0.61
Total Nitrogen	mg/L	Max	Wet	6.44	5.17	2.17	3.12	1.28	3.96	0.91	3.90	1.14	2.63	1.66	2.36
Total Phosphorus	mg/L	Average	Dry	0.41	0.42	0.15	0.19	0.12	0.17	0.34	0.32	0.13	0.51	0.19	0.25
Total Phosphorus	mg/L	Min	Dry	0.08	0.35	0.11	0.13	0.07	0.13	0.05	0.18	0.08	0.41	0.15	0.22
Total Phosphorus	mg/L	Max	Dry	0.76	0.48	0.26	0.24	0.22	0.21	0.95	0.41	0.18	0.62	0.24	0.30
Total Phosphorus	mg/L	Average	Wet	0.542	0.392	0.233	0.200	0.130	0.388	0.129	0.108	0.289	0.281	0.303	0.226
Total Phosphorus	mg/L	Min	Wet	0.300	0.301	0.184	0.136	0.084	0.131	0.090	0.046	0.079	0.132	0.183	0.158
Total Phosphorus	mg/L	Max	Wet	0.897	0.586	0.275	0.282	0.144	0.849	0.175	0.166	0.383	0.456	0.910	0.306
Total Suspended Solids	mg/L	Average	Dry	33	25	19	12	18	9	27	11	49	5	17	20
Total Suspended Solids	mg/L	Min	Dry	16	17	7	7	5	<3.0	5	<3.0	5	<3.0	5	12
Total Suspended Solids	mg/L	Max	Dry	60	37	29	20	35	13	47	18	123	6	51	49
Total Suspended Solids	mg/L	Average	Wet	57	53	67	21	22	25	9	5	8	6	10	24
Total Suspended Solids	mg/L	Min	Wet	21	14	37	10	7	<3	5	<3	5	<3	5	12
Total Suspended Solids	mg/L	Max	Wet	126	157	114	46	37	58	17	8	13	8	26	40

2014/15 data includes >DL and <DL values as absolute values in average calculations, while 2023/24 data excludes >DL and <DL values as absolute values in average calculations

				1	1	2	2	3	3
				Headingley Bridge - R1	Headingley Bridge - R1	Assiniboine Park Bridge - R3	Assiniboine Park Bridge - R3	Osborne Street Bridge - RX1	Osborne Street Bridge - RX1
Parameter	**Unit**		**Type**	**2014/15 AVG**	**2023/24 AVG**	**2014/15 AVG**	**2023/24 AVG**	**2014/15 AVG**	**2023/24 AVG**
Ammonia	**mg/L**	**Average**	Dry	0.017	NC	0.017	0.017	0.015	NC
Ammonia	**mg/L**	**Min**	Dry	0.010	<0.013	0.010	<0.013	0.010	<0.013
Ammonia	**mg/L**	**Max**	Dry	0.026	<0.013	0.033	0.017	0.021	<0.013
Ammonia	**mg/L**	**Average**	Wet	0.013	0.008	0.014	0.019	0.015	0.043
Ammonia	**mg/L**	**Min**	Wet	0.010	0.003	0.010	<0.013	0.010	<0.003
Ammonia	**mg/L**	**Max**	Wet	0.022	0.011	0.032	0.044	0.032	0.095
BOD	**mg/L**	**Average**	Dry	4.86	5.0	4.86	3.5	4.86	4.0
BOD	**mg/L**	**Min**	Dry	2.00	<3	2.00	<3	2.00	<3
BOD	**mg/L**	**Max**	Dry	6.00	6.0	6.00	4.0	6.00	4.0
BOD	**mg/L**	**Average**	Wet	2.33	3.70	2.01	2.70	2.00	2.90
BOD	**mg/L**	**Min**	Wet	2.00	<3	2.00	<3	2.00	<3
BOD	**mg/L**	**Max**	Wet	4.67	3.70	2.10	2.70	2.03	2.90
Dissolved Oxygen	**mg/L**	**Average**	Dry	9.0	6.96	8.9	7.35	8.9	6.06
Dissolved Oxygen	**mg/L**	**Min**	Dry	7.1	5.46	6.7	5.08	6.7	3.76
Dissolved Oxygen	**mg/L**	**Max**	Dry	10.2	9.00	10.2	9.99	10.2	8.92
Dissolved Oxygen	**mg/L**	**Average**	Wet	7.2	8.19	7.3	8.36	7.2	7.77
Dissolved Oxygen	**mg/L**	**Min**	Wet	6.6	5.87	6.8	5.96	6.6	4.86
Dissolved Oxygen	**mg/L**	**Max**	Wet	7.7	11.3	7.7	10.6	7.5	10.2
E.Coli (End Point)	**MPN/100 mL**	**Average**	Dry	28	94	29	206	40	132
E.Coli (End Point)	**MPN/100 mL**	**Min**	Dry	3	<10	6	<10	9	10
E.Coli (End Point)	**MPN/100 mL**	**Max**	Dry	100	190	62	550	78	330
E.Coli (End Point)	**MPN/100 mL**	**Average**	Wet	1171	47	1234	180	1270	2245
E.Coli (End Point)	**MPN/100 mL**	**Min**	Wet	17	1	28	3	34	<1
E.Coli (End Point)	**MPN/100 mL**	**Max**	Wet	10000	180	10000	1410	10000	19900
Nitrate + Nitrite	**mg/L**	**Average**	Dry	0.29	-	-	-	-	-
Nitrate + Nitrite	**mg/L**	**Min**	Dry	0.21	-	-	-	-	-
Nitrate + Nitrite	**mg/L**	**Max**	Dry	0.36	-	-	-	-	-
Nitrate + Nitrite	**mg/L**	**Average**	Wet	0.29	0.29	-	0.33	-	0.32
Nitrate + Nitrite	**mg/L**	**Min**	Wet	0.14	0.20	-	0.19	-	0.18
Nitrate + Nitrite	**mg/L**	**Max**	Wet	0.44	0.51	-	0.59	-	0.58
pH	**units**	**Average**	Dry	8.43	8.26	8.429	8.20	8.45	7.92
pH	**units**	**Min**	Dry	8.23	6.75	8.20	7.23	8.23	5.02
pH	**units**	**Max**	Dry	8.71	8.75	8.73	8.80	8.73	8.74
pH	**units**	**Average**	Wet	8.62	8.10	8.62	8.16	8.63	8.24
pH	**units**	**Min**	Wet	8.50	6.06	8.44	6.50	8.50	7.43
pH	**units**	**Max**	Wet	8.77	8.80	8.78	8.66	8.77	8.52
Temperature	**deg Celcius**	**Average**	Dry	14.6	18.4	14.6	19.6	14.8	21.7
Temperature	**deg Celcius**	**Min**	Dry	8.2	12.2	8.5	12.7	8.9	15.2
Temperature	**deg Celcius**	**Max**	Dry	23.9	22.8	23.8	29.1	23.8	31.3
Temperature	**deg Celcius**	**Average**	Wet	21.6	14.2	21.6	13.4	21.5	14.7
Temperature	**deg Celcius**	**Min**	Wet	18.3	8.5	18.7	9.0	18.5	10.0
Temperature	**deg Celcius**	**Max**	Wet	23.8	19.9	23.7	19.1	23.6	20.6
Total Kjeldahl Nitrogen	**mg/L**	**Average**	Dry	1.22	-	-	-	-	-
Total Kjeldahl Nitrogen	**mg/L**	**Min**	Dry	0.90	-	-	-	-	-
Total Kjeldahl Nitrogen	**mg/L**	**Max**	Dry	1.65	-	-	-	-	-
Total Kjeldahl Nitrogen	**mg/L**	**Average**	Wet	1.09	0.73	-	0.72	-	0.72
Total Kjeldahl Nitrogen	**mg/L**	**Min**	Wet	0.90	0.20	-	0.20	-	0.40
Total Kjeldahl Nitrogen	**mg/L**	**Max**	Wet	1.37	1.20	-	0.90	-	1.00
Total Nitrogen	**mg/L**	**Average**	Dry	1.52	0.66	1.53	0.56	1.57	0.60
Total Nitrogen	**mg/L**	**Min**	Dry	1.12	0.24	1.18	0.22	1.28	0.23
Total Nitrogen	**mg/L**	**Max**	Dry	1.94	1.15	1.89	0.85	1.83	1.26
Total Nitrogen	**mg/L**	**Average**	Wet	1.38	0.917	1.42	0.844	1.44	0.849
Total Nitrogen	**mg/L**	**Min**	Wet	1.17	<0.20	1.09	0.230	1.09	<0.20
Total Nitrogen	**mg/L**	**Max**	Wet	1.62	1.660	1.67	1.360	1.91	1.480

Total Phosphorus	**mg/L**	**Average**	Dry	0.23	0.18	0.22	0.17	0.23	0.17
Total Phosphorus	**mg/L**	**Min**	Dry	0.15	0.16	0.15	0.15	0.16	0.15
Total Phosphorus	**mg/L**	**Max**	Dry	0.34	0.20	0.33	0.18	0.32	0.19
Total Phosphorus	**mg/L**	**Average**	Wet	0.17	0.215	0.18	0.221	0.18	0.220
Total Phosphorus	**mg/L**	**Min**	Wet	0.11	0.132	0.11	0.130	0.11	0.106
Total Phosphorus	**mg/L**	**Max**	Wet	0.28	0.331	0.28	0.312	0.28	0.330
Total Suspended Solids	**mg/L**	**Average**	Dry	258	49	258	42	237	43
Total Suspended Solids	**mg/L**	**Min**	Dry	213	35	213	31	208	29
Total Suspended Solids	**mg/L**	**Max**	Dry	331	64	322	54	273	60
Total Suspended Solids	**mg/L**	**Average**	Wet	193	165	199	156	190	171
Total Suspended Solids	**mg/L**	**Min**	Wet	121	34	119	36	123	29
Total Suspended Solids	**mg/L**	**Max**	Wet	276	356	335	342	280	358

2014/15 data includes >DL and <DL values as absolute values in average calculations, while 2023/24 data excludes >DL and <DL values as absolute values in average calculations

				1	1	2	2	3	3	4	4	5	5	6	6	7	7
				Ste. Adolphe Pierre Delorme Bridge - R5	Ste. Adolphe Pierre Delorme Bridge - R5	Fort Garry Bridge - R7	Fort Garry Bridge - R7	Norwood Bridge - QE Way R8	Norwood Bridge - QE Way R8	Provencher Bridge - RX2	Provencher Bridge - RX2	Harry Lazarenko Bridge - R9	Harry Lazarenko Bridge - R9	North Perimeter Bridge - R10	North Perimeter Bridge - R10	Lockport Bridge - R11	Lockport Bridge - R11
Parameter	Units		Type	2014/15 AVG	2023/24 AVG	2014/15 AVG	2023/24 AVG	2014/15 AVG	2023/24 AVG	2014/15 AVG	2023/24 AVG	2014/15 AVG	2023/24 AVG	2014/15 AVG	2023/24 AVG	2014/15 AVG	2023/24 AVG
Ammonia	mg/L	Average	Dry	-	0.031	0.131	0.018	0.104	0.026	0.047	0.022	-	0.018	0.181	0.718	0.188	-
Ammonia	mg/L	Min	Dry	-	<0.013	0.029	<0.013	0.055	<0.013	0.025	<0.013	-	<0.013	0.095	0.283	0.041	-
Ammonia	mg/L	Max	Dry	-	0.031	0.214	0.018	0.156	0.036	0.077	0.032	-	0.022	0.244	1.200	0.276	-
Ammonia	mg/L	Average	Wet	-	0.078	0.034	0.126	0.059	0.057	0.039	0.043	-	0.030	0.110	0.405	0.077	0.104
Ammonia	mg/L	Min	Wet	-	<0.003	0.018	<0.003	0.037	<0.003	0.021	<0.003	-	0.012	0.082	0.039	0.047	0.082
Ammonia	mg/L	Max	Wet	-	0.104	0.050	0.196	0.089	0.146	0.063	0.101	-	0.104	0.138	1.480	0.112	0.144
BOD	mg/L	Average	Dry	-	NC	4.54	NC	4.73	NC	4.83	NC	-	NC	5.02	NC	5.01	-
BOD	mg/L	Min	Dry	-	<3	2.00	<3	2.27	<3	2.13	<3	-	<3	2.30	<3	2.45	-
BOD	mg/L	Max	Dry	-	<3	6.00	<3	6.00	<3	6.00	<3	-	<3	6.03	<3	6.00	-
BOD	mg/L	Average	Wet	-	NC	2.15	NC	2.70	NC	2.12	4.00	-	5.00	2.48	4.90	3.01	4.00
BOD	mg/L	Min	Wet	-	<2	2.00	<3	2.00	<2	2.00	<2	-	<2	2.00	<3	2.00	<3
BOD	mg/L	Max	Wet	-	NC	2.67	NC	3.90	NC	2.50	4.00	-	5.00	3.60	4.90	6.40	4.00
Dissolved Oxygen	mg/L	Average	Dry	-	7.52	8.6	6.81	8.7	6.70	9.2	6.81	-	6.88	9.0	6.35	9.0	6.51
Dissolved Oxygen	mg/L	Min	Dry	-	5.23	6.2	4.70	6.3	4.84	6.8	4.64	-	5.32	6.5	4.76	6.4	4.33
Dissolved Oxygen	mg/L	Max	Dry	-	11.2	10.1	9.52	10.2	8.42	10.7	10.74	-	10.2	10.8	9.16	10.7	9.52
Dissolved Oxygen	mg/L	Average	Wet	-	8.69	6.7	8.63	6.4	8.39	6.8	8.36	-	7.51	6.5	7.68	6.2	8.70
Dissolved Oxygen	mg/L	Min	Wet	-	6.07	6.2	6.40	5.8	6.78	6.2	7.30	-	4.78	5.9	4.66	5.5	8.27
Dissolved Oxygen	mg/L	Max	Wet	-	11.5	7.6	10.9	7.0	9.61	7.3	9.97	-	8.68	7.0	9.94	7.0	9.27
E.Coli (End Point)	MPN/100 mL	Average	Dry	-	56	27	26	78	33	95	97	-	231	92	111	277	83
E.Coli (End Point)	MPN/100 mL	Min	Dry	-	<10	9	<10	18	<10	15	<10	-	10	30	50	23	30
E.Coli (End Point)	MPN/100 mL	Max	Dry	-	160	60	60	251	100	411	490	-	1,620	168	260	840	180
E.Coli (End Point)	MPN/100 mL	Average	Wet	-	107	1,235	58	1,602	163	1,287	1,106	-	675	1,401	3106	1,811	933
E.Coli (End Point)	MPN/100 mL	Min	Wet	-	2	11	3	27	6	37	7	-	17	145	22	151	30
E.Coli (End Point)	MPN/100 mL	Max	Wet	-	580	10,000	170	13,333	550	10,000	14,100	-	3,080	10,000	>24200	10,000	3,650
Nitrate + Nitrite	mg/L	Average	Dry	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate + Nitrite	mg/L	Min	Dry	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate + Nitrite	mg/L	Max	Dry	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate + Nitrite	mg/L	Average	Wet	-	1.40	-	1.46	-	1.35	-	0.92	-	1.00	-	0.95	-	1.50
Nitrate + Nitrite	mg/L	Min	Wet	-	0.23	-	0.31	-	0.40	-	0.25	-	0.25	-	0.28	-	0.96
Nitrate + Nitrite	mg/L	Max	Wet	-	2.92	-	3.35	-	3.34	-	2.40	-	2.56	-	2.45	-	2.35
pH	units	Average	Dry	-	8.60	8.50	8.55	8.47	8.52	8.49	8.55	-	8.58	8.43	8.44	8.43	8.38
pH	units	Min	Dry	-	8.39	8.33	8.41	8.30	8.39	8.37	8.41	-	8.50	8.27	8.39	8.35	8.32
pH	units	Max	Dry	-	9.02	8.60	8.69	8.60	8.67	8.60	8.71	-	8.69	8.57	8.55	8.50	8.49
pH	units	Average	Wet	-	8.32	8.27	8.39	8.26	8.40	8.36	8.41	-	8.39	8.34	8.33	8.35	8.45
pH	units	Min	Wet	-	7.44	8.11	7.73	8.08	7.88	8.17	7.96	-	7.89	8.17	7.78	8.19	8.23
pH	units	Max	Wet	-	8.81	8.42	8.82	8.46	8.79	8.56	8.78	-	8.71	8.52	8.66	8.52	8.65
Temperature	deg Celcius	Average	Dry	-	17.9	14.9	18.9	15.0	19.4	14.8	19.8	-	20.6	14.9	20.6	14.7	21.8
Temperature	deg Celcius	Min	Dry	-	10.5	8.4	12.8	8.7	14.8	9.0	16.2	-	13.7	8.7	16.0	8.7	15.6
Temperature	deg Celcius	Max	Dry	-	23.8	24.2	23.8	24.5	25.8	24.0	26.2	-	26.6	24.1	26.3	24.0	27.8
Temperature	deg Celcius	Average	Wet	-	14.4	21.2	14.3	21.2	14.9	21.3	15.2	-	16.1	29.6	16.1	21.8	17.1
Temperature	deg Celcius	Min	Wet	-	9.4	17.9	9.6	17.9	10.7	17.9	9.8	-	11.0	18.3	10.1	18.4	13.8
Temperature	deg Celcius	Max	Wet	-	21.8	23.7	20.6	23.5	19.9	23.4	21.3	-	21.2	95.6	22.1	24.1	20.8
Total Kjeldahl Nitrogen	mg/L	Average	Dry	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Kjeldahl Nitrogen	mg/L	Min	Dry	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Kjeldahl Nitrogen	mg/L	Max	Dry	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Kjeldahl Nitrogen	mg/L	Average	Wet	-	1.0	-	1.1	-	1.1	-	1.0	-	0.9	-	0.9	-	1.0
Total Kjeldahl Nitrogen	mg/L	Min	Wet	-	0.4	-	0.6	-	0.7	-	0.4	-	0.3	-	0.4	-	0.5
Total Kjeldahl Nitrogen	mg/L	Max	Wet	-	1.4	-	2.0	-	2.0	-	1.7	-	1.7	-	1.3	-	1.5
Total Nitrogen	mg/L	Average	Dry	-	0.65	1.36	0.83	1.34	0.86	1.54	0.69	-	0.81	1.62	1.40	1.61	-
Total Nitrogen	mg/L	Min	Dry	-	0.35	1.11	0.58	1.05	0.65	1.28	0.52	-	0.46	1.52	0.89	1.46	-
Total Nitrogen	mg/L	Max	Dry	-	0.92	1.66	1.24	1.84	1.16	1.84	1.01	-	1.25	1.74	1.95	1.71	-
Total Nitrogen	mg/L	Average	Wet	-	1.72	1.90	1.87	1.96	1.75	1.74	1.41	-	1.43	1.82	1.76	1.82	2.49
Total Nitrogen	mg/L	Min	Wet	-	0.28	1.62	0.43	1.65	0.32	1.50	0.39	-	0.22	1.59	1.32	1.56	1.66
Total Nitrogen	mg/L	Max	Wet	-	4.33	2.34	5.38	2.36	5.31	2.07	3.68	-	4.28	2.23	2.90	2.20	3.85
Total Phosphorus	mg/L	Average	Dry	-	0.21	0.17	0.22	0.17	0.21	0.29	0.20	-	0.19	0.21	0.28	0.20	-
Total Phosphorus	mg/L	Min	Dry	-	0.17	0.16	0.19	0.15	0.17	0.16	0.18	-	0.15	0.17	0.23	0.17	-
Total Phosphorus	mg/L	Max	Dry	-	0.23	0.19	0.26	0.18	0.25	0.87	0.23	-	0.24	0.25	0.33	0.23	-
Total Phosphorus	mg/L	Average	Wet	-	0.281	0.22	0.240	0.24	0.216	0.22	0.254	-	0.251	0.20	0.296	0.22	0.392
Total Phosphorus	mg/L	Min	Wet	-	0.156	0.14	0.121	0.14	0.110	0.14	0.143	-	0.146	0.15	0.208	0.15	0.326
Total Phosphorus	mg/L	Max	Wet	-	0.563	0.32	0.576	0.42	0.529	0.33	0.420	-	0.463	0.27	0.448	0.35	0.480
Total Suspended Solids	mg/L	Average	Dry	-	21	102	23	111	13	183	18	-	21	117	21	78	-
Total Suspended Solids	mg/L	Min	Dry	-	18	49	11	35	8	115	15	-	18	97	15	53	-
Total Suspended Solids	mg/L	Max	Dry	-	25	214	35	260	17	239	22	-	23	145	27	128	-
Total Suspended Solids	mg/L	Average	Wet	-	229	239	175	299	145	257	207	-	205	195	180	220	373
Total Suspended Solids	mg/L	Min	Wet	-	23	95	32	176	14	154	18	-	18	97	18	76	274
Total Suspended Solids	mg/L	Max	Wet	-	727	407	567	458	543	417	433	-	473	368	447	399	503

2014/15 data includes >DL and <DL values as absolute values in average calculations, while 2023/24 data excludes >DL and <DL values as absolute values in average calculations

APPENDIX D

Other Parameter Results

1.0 RESULTS

1.1 Rivers and Streams

A summary of 2023/24 river and stream monitoring results is presented in Table D1 below, with full results available in Appendix C.

TABLE D1. 2023/24 RIVERS AND STREAMS DATA OVERVIEW

Location	Weather Type	Ammonia (mg/L)	Biochemical Oxygen Demand (mg/L)	Total Phosphorus (mg/L)	Total Nitrogen (mg/L)	Total Suspended Solids (mg/L)	*E.Coli* (MPN/100 mL)
MWQSOG Criteria		varies	-	0.05	10	varies	200
Assiniboine River	DWF	NC	4	**0.174**	0.61	**45**	145
	WWF	0.024	3	**0.219**	0.87	**164**	**816**
Red River	DWF	0.242	NC	**0.219**	0.87	19	99
	WWF	0.139	4	**0.264**	1.70	**200**	**857**
Streams	DWF	0.109	4	**0.310**	0.69	15	**289**
	WWF	0.152	6	**0.266**	1.66	24	**1,036**

Notes:
Average values across events; L = litre; mg = milligram; mL = millilitre; MPN = most probable number; MWQSOG = Manitoba Water Quality Standard and Objective Guidelines NC = not calculated.
Reported values that were <detection limit (DL) or >DL were not included in the average calculations; NC values likely a result of <DL/>DL values.

Bold values indicate an **exceedance above MWQSOG criteria.**

1.1.1 OTHER PARAMETERS

The following sections summarize the results in other parameters that are not POCs.

1.1.1.1 Ammonia

- ***2023/24 Program:*** Ammonia on all waterway types in wet weather ranged from <0.003 mg/L to 1.48 mg/L. In dry weather, ammonia ranged from <0.01 mg/L to 1.20 mg/L in all waterway types. Average ammonia levels were higher in dry weather (0.17 mg/L) than in wet weather (0.12 mg/L).
- ***Criteria Comparison:*** When screened against the MWQSOGs Tier II WQO for ammonia (calculated criteria, varies based on temperature and pH), no exceedances were identified in DWF or WWF samples collected from the rivers or streams during the 2023/24 program.
- **Multi-year Comparison:** The Red River ammonia levels were lower during WWF than DWF in 2023/24, at 0.12 mg/L on average compared to 0.24 mg/L, respectively. Ammonia levels increased notably at

the North Perimeter Bridge (R10) (0.41 mg/L) and to a lesser extent at the Fort Garry Bridge (R7) (0.13 mg/L) and SALD (R11) (0.10 mg/L) during 2023/24 WWF. The North Perimeter and SALD were also the locations with the highest average ammonia concentrations on the Red River in 2014/15 during WWF at 0.18 and 0.19 mg/L, respectively. The increased ammonia levels at the North Perimeter Bridge (R10) also occur in the baseline DWF data for 2023/24 (0.72 mg/L) at a higher concentration than in the WWF. The increase in ammonia levels on the Red River at the North Perimeter Bridge may be attributable to the North End Sewage Treatment Plant.

In general, the ammonia level in the Red River was higher than the Assiniboine River. Ammonia levels on the Assiniboine in dry weather were below detection limits except for one instance at the Assiniboine Park Bridge (R3) (0.02 mg/L). Similar ammonia trends were observed for WWF events as DWF events, but concentrations were increased during WWF. The Assiniboine River performed similarly for ammonia levels during dry and wet flows as in 2014/15 at about 0.02 mg/L on average. Streams performed poorer in 2023/24 for ammonia levels compared to 2014/15. Values ranged from below detection limits to 0.96 mg/L of ammonia in 2023/24 wet and to 0.34 mg/L in dry weather flow. The highest 2023/24 concentration in streams on average was 0.74 mg/L in Omand's Creek (S4) during WWF sampling (highest during WWF Event #1); however, Omand's Creek was not the highest location for ammonia concentration in 2014/15 stream data. Bunn's Creek was highest on average for ammonia in 2014/15 at 0.14 mg/L.

1.1.1.2 TSS

- ***2023/24 Program:*** TSS on all waterway types in wet weather ranged from <3 mg/L to 727 mg/L, with an average of 130 mg/L. In dry weather, TSS ranged from <3 mg/L to 64 mg/L in all waterway types, with an average value of 24 mg/L.
- ***Criteria Comparison:*** The Tier II WQO for TSS is variable and depends on the background TSS levels, with 25 mg/L and 250 mg/L being relevant background levels. If the background TSS level is:
  - <25 mg/L, the WQO is a 5 mg/L induced change from background
  - >25 mg/L but <250 mg/L, the WQO is a 25 mg/L induced change from background.

  All waterways except for the Assiniboine River locations had an average DWF TSS level of less than 25 mg/L; therefore, the applicable Tier II WQO for TSS on the Red River and streams is an induced change of 5 mg/L; whereas, on the Assiniboine River the WQO is an induced change of 25 mg/L.

  Wet weather samples were above the Tier II WQO for Red River and Assiniboine River locations, as well as most streams, except for Bunn's Creek (S8; 3.0 mg/L induced change), Truro Creek (S3; 6.3 mg/L TSS improvement from DWF background) and Omand's Creek (S4; 1.0 mg/L induced TSS change).
- **Multi-year Comparison:** The average TSS concentration across all Assiniboine River sites was 44.9 mg/L which is lower than previous results from the 2014/15 program.

  Compared to 2014/15, TSS performance improved in most streams during dry and wet weather in 2023/24 except for Bunn's Creek (S8) in dry and wet and Sturgeon Creek (S2) in wet, although the results were within 3 to 14 mg/L in all cases. TSS performance also improved on the Assiniboine River in dry and wet compared to 2014/15 (45 mg/L vs. 251 mg/L avg. DWF; 164 mg/L vs. 194 mg/L avg. WWF). On the Red River, TSS performance improved at all locations in dry and wet except for SALD (R11) in WWF (373 mg/L vs. 220 mg/L avg.). The average DWF Red River performance in 2014/15 was 118 mg/L compared to 19 mg/L in 2023/24 and the average WWF Red River performance was 242 mg/L and 216 mg/L in 2014/15 and 2023/24, respectively. There is no 2014/15 comparison for Harry Lazarenko (R9) or St. Adolphe Bridge (R5).

1.1.1.3 BOD_5

- ***2023/24 Program:*** BOD_5 on all waterway types in wet weather ranged from <3 mg/L to 13 mg/L, with an average of 5 mg/L. In dry weather, BOD_5 ranged from <3 mg/L to 6 mg/L in all waterway types, with an average value of 4 mg/L.
- ***Criteria Comparison:*** There is no comparable guideline in the MWQSOGs for BOD_5 in surface water. There is a Tier I Standard for effluent discharge for BOD_5 (25 mg/L). No sample results during DWF and WWF events in 2023/24 exceeded 25 mg/L, except one result of >40 mg/L BOD_5 on Day 2 of WWF Event #3 (May 26, 2024) at Omand's Creek (S4); however, it appears to be an anomalous data outlier relative to the surrounding dates (BOD_5 values of 5 mg/L and 13 mg/L) and has not been included in the data average calculation.
  Dry weather BOD_5 levels on the rivers and streams were low, with most analyzed samples below detection limits (<3 mg/L). Samples with detectable concentrations were still low, with maximum concentrations observed in the Assiniboine River at 6 mg/L. Wet weather BOD_5 levels on the rivers were low, with most analyzed samples below detection limits (<3 mg/L). Samples with detectable concentrations on the rivers were still low, with maximum concentrations observed in the Red River at 4.9 mg/L. These results are similar to DWF trends.
  However, BOD_5 concentrations in streams during WWF were increased in comparison to baseline concentrations, with a maximum concentration of 13 mg/L in Omand's Creek (S4) and the Seine River (S7).
- **Multi-year Comparison:** In comparison to 2014/15 data, BOD_5 performance was relatively poorer in 2023/24 for all waterways on average in wet and dry weather, except for the Assiniboine River, which performed slightly better in DWF in 2023/24 vs. 2014/15. The 2014/15 vs. 2023/24 BOD_5 comparison by waterway type on average, where comparable data exists, is:
  - Red River: WWF: 2.49 mg/L vs. 4.30 mg/L; DWF: result not available due to lab error.
  - Assiniboine River: WWF: 2.12 vs. 3.10 mg/L; DWF: 4.86 mg/L vs. 4.2 mg/L.
  - Streams: WWF: 2.99 mg/L vs. 5.08 mg/L; DWF: 4.73 mg/L vs. 3.56 mg/L.

1.1.1.4 pH

- ***2023/24 Program:*** pH on all waterway types in wet weather ranged from 6.06 to 8.85 units, with an average of 8.26 units. In dry weather, pH ranged from 4.79 to 9.02 units in all waterway types, with an average value of 8.29 units.
- ***Criteria Comparison:*** pH levels on the rivers and streams were generally within the MWQSOG Tier III WQG for Surface Water (Recreation) criteria (5 to 9 pH units) during DWF and WWF, with the following exceptions that are considered anomalous for the reasons provided:
  - Omand's Creek DWF Event #2, Day 1 (Sept. 11, 2023): 4.79 pH units considered anomalous relative to adjacent data and may be attributable to a pH meter or user error on-site.
  - *St.* Adolphe Bridge (R5) DWF Event #2, Day 2 (September 12, 2023): 9.02 pH units on one subsample, considered anomalous to adjacent data from other subsamples in transect (8.75 and 8.68 pH units) and may be attributable to a pH meter or user error on-site.

  During DWF and WWF, average pH was lowest in streams at 7.76 and 8.0 units and highest in the Red River at 8.53 and 8.38 units, respectively.

- **Multi-year Comparison:** pH was similar in 2023/24 to 2014/15. Results in 2023/24 were slightly higher in pH for the Red River and slightly lower in pH for the Assiniboine River and streams but all within the WQG:
  - Red: WWF: 8.31 vs. 8.40; DWF: 8.46 vs. 8.49
  - Assiniboine: WWF 8.63 vs. 8.17; DWF: 8.44 vs. 8.13.
  - Streams: WWF: 8.27 vs. 7.99; DWF: 8.29 vs. 7.76.

In 2023/24, the average stream result for wet and dry weather decreased slightly below 8 pH units.

1.2 CSO

1.2.1 OTHER PARAMETERS

The following is a results summary for other parameters that are not POCs.

1.2.1.1 TSS

- ***2023/24 Program:*** Values ranged from 102 mg/L to 3,530 mg/L at the Ash CSO, while the range at Hawthorne was between 42 mg/L and 2,360 mg/L. Average TSS at Ash (520 mg/L) was higher than average TSS at Hawthorne (391 mg/L). TSS concentrations were typically highest at the event start and would decrease throughout the event.
- ***Criteria Comparison:*** TSS concentrations in all samples from the Ash CSO and almost all samples from the Hawthorne CSO, were above the EAL No. 3042 criteria (50 mg/L) during all events, except in four of ten collected samples during Event #5.
- ***Multiyear Comparison:*** In comparison to the 2014/15 data, average TSS values were higher at Ash CSO in 2023/24 (520 vs 386 mg/L) and lower at Hawthorne (391 vs 504 mg/L).

1.2.1.2 Ammonia

- ***2023/24 Program:*** Average ammonia values ranged from 1.09 to 14.1 mg/L at the Ash CSO and 0.96 to 12.6 mg/L at the Hawthorne CSO. Average ammonia concentrations were higher at the Hawthorne CSO (6.05 mg/L) when compared to the Ash CSO (3.86 mg/L).
- ***Criteria Comparison:*** There is no established guideline for ammonia in EAL No. 3042.
- ***Multiyear Comparisons:*** In comparison to the 2014/15 data, average ammonia values were higher at both CSOs in 2023/24 (3.86 vs 3.66 mg/L at Ash and 6.03 vs 4.73 mg/L at Hawthorne).

1.2.1.3 BOD_5

- ***2023/24 Program:*** Average BOD_5 concentrations ranged from 16 to 286 mg/L at Ash and 23 to 185 mg/L at Hawthorne. Average BOD_5 concentrations were slightly higher in samples collected at the Ash CSO (69 mg/L) when compared to the Hawthorne CSO (66 mg/L). BOD_5 concentrations were not analyzed during Event #5 at Ash and in most samples from Event #4 at Hawthorne due to a laboratory error.
- ***Criteria Comparison:*** Laboratory seeding errors resulted in unquantifiable BOD_5 concentrations above 35 mg/L in most samples during Event #1 at Ash and Hawthorne; therefore, exceedances beyond criteria could not be assessed.
- BOD_5 concentrations were above the EAL No. 3042 criteria (50 mg/L) during all other events at both CSOs. Concentrations did not necessarily remain above criteria throughout each event.

- ***Multiyear Comparisons:*** In comparison to the 2014/15 data, average BOD_5 values were lower at both CSOs in 2023/24 (69 vs 115 mg/L at Ash and 66 vs 127 mg/L at Hawthorne).

1.2.1.4 pH

- ***2023/24 Program:*** pH ranged from 7.19 to 7.98 units at Ash and 7.10 to 7.87 units at Hawthorne. Average pH values were higher at Ash (7.70 units) when compared to Hawthorne (7.52 units).
- ***Criteria Comparison:*** There is no established guideline for pH in EAL No. 3042. The Canadian guideline for recreational water quality indicates that natural waters usually have pH values in the range of 4.0 to 9.0; however, most are slightly basic (e.g., greater than a pH of 7.0 at 25°C). (1) The values from the CSO discharges that ultimately end up in recreational waters were slightly alkaline.
- ***Multiyear Comparisons:*** In comparison to the 2014/15 data, average pH values were higher at both CSOs in 2023/24 (7.70 vs 7.58 units at Ash and 7.52 vs 7.48 units at Hawthorne).

References

1. Health Canada. 2015. Guidelines for Canadian Recreational Water Quality: Physical, Aesthetic and Chemical Characteristics. Available at: https://www.canada.ca/en/services/health/publications/healthy-living/guidelines-canadian-recreational-water-physical-aesthetic-chemical-characteristics.html#a2.1

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