Water and Waste Department • Service des eaux et des déchets

City of Winnipeg
2021 CSO Annual Report

Environment Act Licence No. 3042
Clause 13

Prepared for

Environment, Climate and Parks

March 2022

City of Winnipeg 2021 CSO Annual Report

Client File No:	3205.00
City File No.	S-734, EMS 020-17-08-11-00 020-17-08-11-0N
Document Title:	City of Winnipeg 2021 CSO Annual Report
Revision:	01
Date:	March 30, 2022
Prepared by:	City of Winnipeg Water and Waste Department Wastewater Planning and Project Delivery Branch Florence Lee, P.Eng Patrick Coote, P.Eng

Document History and Status

Revision	Prepared by	Reviewed by	Date	Approved by	Date
01	FL, PTC	MP, RG, JF, HL, BR, MG, AM, NC	03/09/2022	MP, LM, CW, SL, CC	03/30/2022

Water and Waste Department • Service des eaux et des déchets

Executive Summary

In November 2019, Manitoba Conservation and Climate now Environment, Climate and Parks (the Province) approved the City of Winnipeg's (City) Combined Sewer Overflow (CSO) Master Plan (MP). Approval of the CSO Master Plan triggered Clause 13 of Environment Act Licence No.3042 (EA No.3042), which requires the CSO Annual Report to include a progress report on the CSO Master Plan on or before March 31 of the preceding year (see section 2.2).

CSO Master Plan Progress

This is the third report on progress of the CSO Master Plan and covers the year 2021. It includes costs, budget, schedules, completed work, and performance along with 2022 planned contracts and forecasts.

The CSO Master Plan was on schedule and budget for Program Scenario 1 in 2021. To meet the Provincial requested deadline of 2045, the City will need funding support from both the Provincial and Federal Governments by 2023 or earlier. Without the funding support, the CSO Master Plan will move to Program Scenario 3, which is based on City only funding and has a longer implementation timeline.

The CSO Master Plan estimated capital cost of $1.15 billion in 2019 dollars (see section 3.2), which is based on the required infrastructure to meet the 85% control target. In 2021, the City's CSO Master Plan budget was $30 million with an additional $42 million budget holdover from 2020. These funds have been held over to maintain a committed average budget spend and to be able to award Ferry Road Contract 6 Rutland Trunk, which is scheduled for 2024 (see sections 4.2.2). In 2021, the City Council proposed an increase of $60 million to the City portion of the CSO Master Plan budget which was adopted in the 2022 updated City balanced budget. The proposed increase is to be split over 4 years ($15 million a year) and be available from 2024 to 2027. The approximate City cumulative committed capital spend since 2019 is $70 million.

There is no additional percent CSO volume reduction in the 2020 sewer network[1] for the 1992 Representative Year. This results in maintaining a CSO volume percent capture to 75 percent (section 4.1). Improvements from completed combined sewer separation works are planned to be in future model updates.

Current Year Results

The amount of rainfall and the river levels during rainfall events has the most impact on CSO results and sewer network performance.

There was approximately 2 percent less precipitation in 2021, compared to the 1992 Representative Year. The last nine years have shown an average one percent decrease in total precipitation compared to the 1992 Representative Year (section 5).

The 2021 river level was lower overall than the 1992 Representative Year and one in five-year average in the recreation season (May – September). The low river level was attributable to low precipitation in

[1] 2020 sewer network refers to the hydraulic model that contains the best representation of the existing sewer system at the time it was developed.

winter 2020/2021, and throughout the 2021 recreation season. In 2021, there were approximately 30% less precipitation during the recreation season compared to 1992 Representative Year.

2021 had a total number of 910 CSO events with an estimated annual sewage discharge of 10,601 ML. The 2021 CSO results, when compared to 2020, show a reduction in number of events but an increase in CSO volume (see section 5). In 2021, the CSO instrumented locations were increased from 42 to 45 locations, which improved the accuracy of the reported results. 83 percent of the CSO results totals were validated.

In 2021, City Council and the Province approved a strategic approach to remove challenges for small developments in combined sewer areas by offsetting Clause 8 requirements. Any increases in runoff are to be addressed by the CSO Master Plan and reported annually (section 3.1.5 and section 5.7).

Next Steps

As directed in the CSO Master Plan, the City will continue to work on sewer district separation projects currently underway (section 4.5). The 2022 planned capital projects include planning and implementation in the Armstrong, Ferry Road / Riverbend, Cockburn / Calrossie, Jefferson East, and Hawthorne districts.

The City will continue to explore opportunities for greater sewer system optimization, and additional storage options that will improve CSO performance progress monitoring and promote further CSO volume reduction. Furthermore, the City will continue regular communication with regulatory bodies and stakeholders throughout the delivery of the CSO Master Plan.

Contents

Executive Summary ..... **i**

Acronyms and Abbreviations ..... **vi**

1. Purpose **1**

2. Background **2**

2.1 Sewer Network 2

2.2 Regulations 2

2.3 CSO Master Plan History 3

3. CSO Master Plan Implementation **6**

3.1 Master Plan Key Components 6

3.1.1 Hydraulic Modelling 6

3.1.2 Design Basis 7

3.1.3 Representative Year 7

3.1.4 Baseline Conditions 7

3.1.5 Planning Projections 7

3.1.6 CSO Control Technologies 8

3.1.7 Water Quality 8

3.1.8 Climate Change 9

3.1.9 Public Engagement 10

3.1.10 Regulatory Engagement 10

3.1.11 District Engineering Plans 11

3.2 Capital Cost Summary 11

3.3 Funding Scenarios 11

3.4 Changes in Funding 13

3.5 Design Development of Proposed Projects 13

3.6 Program Implementation Strategy 13

3.7 Schedule 14

3.8 Capital Projects Overview 14

3.9 Risks and Opportunities 16

3.9.1 Risks 16

3.9.2 Opportunities 17

4. CSO Master Plan Performance **19**

4.1 CSO Volume Performance Tracking 19

4.2 Financial Tracking 20

4.2.1 Capital Cost Estimation Tracking 20

4.2.2 Budget Tracking 20

4.3 Schedule Tracking 22

4.4 Districts Design Status 22

4.5 Capital Projects Tracking 22

4.6 Milestones 22

4.7 City Investments on CSO Mitigation to Date 23

5. Current Year 2021 ..... **24**

5.1 CSO Results 2021 24

5.2 Rainfall 2021 24

5.3 River Elevations 2021 26

5.4 Treatment Plant Flows 2021 26

5.5 Collections System Operational Observations 2021 27

5.6 Reporting Process 27
5.6.1 Hydraulic Model Maintenance 27
5.6.2 CSO Reporting Limitations 27
5.7 Clause 8 Compliance 28
6. Water Quality 30
7. Climate Change 31
8. Pollution Prevention Plan 32
9. Communications 33
9.1 Public Engagement 33
9.1.1 Public Education 33
9.1.2 Public Notification System 33
9.2 Regulatory Engagement 33
9.3 Other Agencies/Initiatives 34
9.3.1 OurWinnipeg 34
10. Compliance 35
11. Risks and Opportunities 37
11.1 Risks 37
11.1.1 Risks Tracking 37
11.2 Opportunities 37
11.2.1 Green Infrastructure 37
11.2.2 Floatable Management 38
11.2.3 Real Time Control 38
12. Record Keeping and Documentation 39
13. Next Steps 40
14. References 41

Appendices

Appendix A – Manitoba Conservation and Climate - Environmental Licence No. 3042

Appendix B – 2020 CSO Master Plan Provincial Approval Letter

Appendix C – Clause 8 Provincial Approval Letters

Appendix D – District Program Scenario 1 Implementation Schedule

Appendix E - CSO Master Plan Program Scenario 1 Tracked Against Actual Implementation Schedule 3 Year Window

Appendix F - District Plans Design Status

Appendix G – 2021 Ongoing / Completed Capital Projects

Appendix H - 2022 Planned Capital Projects

Appendix I – 2021 Record of Meeting Minutes

Tables

Table 1 - Pollutants EMC from 2014/2015 Water Quality Monitoring Program 9
Table 2 - Potential Plans Bacteria Metrics (CH2MHill et al., 2015) 9
Table 3 - CSO Master Plan Capital Cost Estimate (2019 dollars) 11
Table 4 - CSO Master Plan Funding Scenario Evaluation Results (2019 Dollars) (Jacobs, 2019) 12
Table 5 - CSO Master Plan Performance Tracking 19
Table 6 - CSO Master Plan (2019 dollar values) and Revised 2021 Annual Budget Difference 20
Table 7 - 2022 to 2024 Capital Budget Forecast (2021 Dollars) 21
Table 8 - 2021 Past Projects Milestone 22
Table 9 - 2022 Planned Projects Milestone 23
Table 10 - CSO Overview Results 2021 24
Table 11 - Single Rain Gauge at the Forks 25
Table 12 - Regulatory Submissions 35
Table 13 - CSO Master Plan Submission Milestone 36

Figures

Figure 1 - CSO Master Plan Development Timeline 5
Figure 2 - CSO Master Plan Implementation Timeline 6
Figure 3 - Screen Capture of the City Webpage 10
Figure 4 - CSO Master Plan Program Scenario 1 Capital Budget Inflated at 3 Percent Annually 12
Figure 5 - Key Design Stages in Life of a CSO Project 13
Figure 6 - CSO Master Plan Program Scenario 1 Overview Schedule 14
Figure 7 - CSO Master Plan Capital Cost Summary (2019 Dollars) 15
Figure 8 - CSO Master Plan Project Overview Map 15
Figure 9 - CSO Master Plan and 2021 Actual and Forecast Capital Budget 21
Figure 10 - Total Precipitation Yearly Trend Single Rain Gauge 25
Figure 11 - James Ave River Level Comparison 26
Figure 12 – Pre and Post Development CSO Estimate Example 1 for Two Duplexes 28
Figure 13 - Pre and Post Development CSO Estimate Example 2 for Two Duplexes 28
Figure 14 – Pre and Post development CSO Estimate Example for Two SFDs 29
Figure 15 – Pre and Post Development CSO Estimate Example for Two SFDs with Secondary Suites 29

Acronyms and Abbreviations

CEC	Clean Environment Commission
AACE	American Association of Cost Engineers International
AAF	average annual flow
City	City of Winnipeg
CO	Control Option
CS	combined sewer
CSO	combined sewer overflow
DEP	district engineering plan
EA	Environment Act Licence
ECP	Environment, Climate and Parks
EMC	event mean concentrations
GI	green infrastructure
LDS	land drainage sewer
MCC	Manitoba Conversation and Climate
MDS	Manitoba Sustainable Development
NEWPCC	North End Sewage Treatment Plant
No.	Number
NPRI	National Pollutant Release Inventory
O&M	operations and maintenance
PLUM	Planning Land Use Model
POC	pollutants of concern
PWWF	peak wet weather flow
P2	Pollution Prevention Plan
RTC	real time control
SEWPCC	South End Sewage Treatment Plant
SFD	single family dwelling
SOIS	Sewer Overflow Information System
SRS	storm relief sewer
TP	total phosphorus
TN	total nitrogen
WEWPCC	West End Sewage Treatment Plant
WSER	Wastewater Systems Effluent Regulations
WWF	wet weather flow
WWS	wastewater sewer

1. Purpose

The operation of the City of Winnipeg (City)'s combined sewer overflow system is governed by Environment Act Licence (EA) No. 3042. To comply with Clause 13 of EA No. 3042, the City is required to submit an annual report documenting Combined Sewer Overflow (CSO) Master Plan implementation progress and work planned for the subsequent year by March 31 of each year (referred to throughout this document as the "annual report").

The CSO Annual Report provides an overview of: cost, budget, schedule, performance, CSO volume reduction toward the 85% Capture, current year CSO results, capital improvements, milestones achieved, and the work plan for subsequent year. It also provides an overview of the process used in the evaluation of CSO discharge documented in the CSO results reports, which is mandated by Clause 14 of EA No. 3042.

As part of Clause 14 of EA No. 3042, the City is required to submit an annual CSO results report for the preceding year by February 15 of each year. The annual CSO results report documents the estimated sewage volume discharged to receiving streams from CSO events of the preceding year. It complies with the National Pollutant Release Inventory (NPRI) and Wastewater Systems Effluent Regulations (WSER) annual reporting requirements. Additional CSO results reports requirements pursuant to Clause 14 of the licence include quarterly CSO results and CSO reports triggered by significant rainfall events.

The CSO Annual Report demonstrates the progress made on the CSO Master Plan pursuant to Clause 11 of the licence, to meet the required level of treatment for CSO control, and provides an overview of the process involved to demonstrate compliance with both the Provincial and Federal requirements. It is important to note any reporting outside of the scope of this annual report is not included.

2. Background

Combined sewers are regulated by federal and provincial requirements. On an annual basis, the City submits annual CSO discharge data to NPRI, WSER and the Province to comply with both the federal and provincial regulations.

2.1 Sewer Network

Like many cities in North America, Winnipeg has a combined sewer system. Combined sewers are designed to collect both land drainage (rainwater and snowmelt) and wastewater (sewage from homes and businesses) in the same pipe, and transport both to the sewage treatment plant before being released into the river. In large wet weather events, however, the sewer capacity can be exceeded with excess rainwater or snowmelt, causing the contents of the combined sewers to overflow into the rivers.

2.2 Regulations

In 1999, the Federal Government required reporting on estimated sewerage lost from the sewer network under the Canadian Environmental Protection Act, as part of the NPRI.

In 2012, the Federal Government under WSER mandated the City to keep CSO records from 2013 and provide annual CSO Reporting due February 15 each subsequent year.

In 2013, the Province issued the first Combined Sewer Overflow Licence to the City of Winnipeg, EA No. 3042. It contained 16 clauses (see Appendix A) requiring public education, CSO reporting, interim water quality sampling and analysis, public notification, and the development of a CSO Master Plan. The City of Winnipeg's responses to date concerning each of regulatory requirements contained within EA No. 3042 are listed below:

- The Public Education Plan was submitted to the Province in December 2013. This plan outlined a high level schedule for public engagement activities to comply with Clause 9. The Province requested bi-annual report updates; this requirement was completed with the last report dated June 2019.

- The Combined Sewer Overflow Notification Plan was submitted to the Province in April 2014. This plan described the significant event, and outlined the quarterly and annual CSO reporting processes to comply with Clause 14.

- The Interim Monitoring Plan was submitted to the Province in January 2014. This plan outlined the processes required to comply with Clause 15. The analysis of the samples collected were documented in the December 2015 Preliminary Proposal submission.

- The CSO Public Notification System Plan was submitted to the Province in December 2015. This plan outlined a new notification system to inform the public in the event of an overflow to comply with Clause 10.

- The CSO Master Plan was submitted to the Province on August 28, 2019 (see section 2.3) and was subsequently approved by the Province on November 13, 2019 (see Appendix B). This triggered Clause 13 of EA No.3042, which requires the City to submit an annual report documenting the CSO monitoring progress and results of the preceding year, and work plan for the subsequent year by March 31 of each year. Clause 13 specifically states:

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

pursuant to Clause 11 including monitoring results and the work plan for the subsequent calendar year.

The Provincial approval letter dated November 13, 2019 contained the following additional requirements:

a) The Licencee shall submit for approval an outline of the content of the annual report as required by Clause 13 of the Licence by December 31, 2019;

b) The Licencee shall, prior to submission of the annual report, submit a monitoring plan for approval;

c) The Licencee shall include in the annual report the monitoring report, the proposed planning for the year ahead, and the milestones achieved;

d) The Licencee shall, from the date of issue of this Letter, collect CSO water samples and model river quality data every 5 years to demonstrate improvements in the river water quality due to implementation of Control Option No. 1. The next river water quality report is due December 31, 2024;

e) The Licencee shall carry out an assessment of the impact of climate change to the performance of the CSO program and shall include the assessment report along with the CSO Master Plan for Control Option No. 2 which is due April 30, 2030; and

f) The Licencee shall, on or before April 30, 2025, submit for approval a report demonstrating that the percent capture performance measure, an alternative to Control Option No. 2 as proposed in the CSO Master Plan dated August 28, 2019, will provide equivalent water quality protection to Control Option No. 2 (i.e., four overflows in a representative year).

The City met with the Province to discuss the proposed outline for the CSO Master Plan annual reports on December 16, 2019. A proposed outline was submitted prior to the December 31 deadline.

On July 8, 2021, the Province requested the estimated increase in volume of CSOs caused by small scale developments and the estimated decrease in volume as a result of infrastructure development on the overall combined sewer system on an annual basis, see Appendix C. Refer to sections 3.1.5 and 5.7 for further information.

2.3 CSO Master Plan History

Prior to establishment of the Federal and Provincial regulations summarized in Section 2.2, the City made major investments in wastewater treatment upgrades and focused on the combined sewer approach to eliminate dry weather overflows and protect the river water quality within Winnipeg. Projects that the City has invested in to reliving CSO and protecting basement flooding prior to the Federal and Provincial licensing requirements include:

- In 1937, diversion weirs and interceptor sewer system were put in place to divert combined sewer flows to the North End Sewage Treatment Plant (NEWPCC).
- Since 1960s, municipal regulations were in place to ensure that no new property developments were permitted to be serviced by combined sewers. All new developments must be serviced by a two-pipe system.
- The City also focused on completing infrastructure upgrades to eliminate CSOs to the river and reduce risks of basement flooding such as sewer separation works, sustainable drainage systems, latent storage dewatering stations, and outfall chamber upgrades.

After proclamation of the Environment Act on March 31, 1988, the Province of Manitoba requested the Clean Environment Commission (CEC) hold hearings on protecting Winnipeg's rivers and waterways. In 1992, the hearings concluded with recommendations to the City that a CSO study be commissioned. The CSO Management Strategy study was completed in 2002 and the final report was presented at the CEC

public hearings completed in response to a raw sewage spill which occurred at the North End Sewage Treatment Plant (NEWPCC) in 2003. The 2002 CSO study documented the water quality impacts of combined sewers and formulated remedial measures for CSO control.

Following the 2003 CEC hearings, the CEC provided a report with advice and recommendations in August 2003. It was recommended in this report that the required funding to address CSOs in Winnipeg should be shared by the Federal and Provincial Governments in addition to the City. It was recommended the City be directed to complete the CSO work within the next 25 years, monitor CSOs, and implement a public notification system. An excerpt from this 2003 CEC report is shown below:

> *The City of Winnipeg should be directed to shorten the timeframe to complete its combined sewer overflow plan from the proposed 50 years to a 20 to 25-year period.*
>
> *The City of Winnipeg should be directed to take immediate action to reduce combined sewer overflows by instrumenting outfalls, adjusting weirs, accelerating combined sewer replacement, advancing the pilot retention project and undertaking other reasonable measures to reduce combined sewer overflows within two years.*

Based on the CEC recommendations, the Province issued EA No. 3042 on September 4, 2013, mandating the development of The City's Combined Sewer Overflow Master Plan.

In response to the Clause 11 Licence requirements, the CSO Master Plan Preliminary Proposal was completed on December 18, 2015, recommending an 85% CSO volume capture long term control target. This proposal included plans, costs, evaluation criteria, and recommendations for the five different targets to address CSOs. These targets are known as Control Options and each of the five Control Options studied are listed below:

- Control Option 1: 85 Percent Capture in a Representative Year
- Control Option 2: Four Overflows in a Representative Year
- Control Option 3: Zero Overflows in a Representative Year
- Control Option 4: No More than Four Overflows per Year
- Control Option 5: Complete Sewer Separation

The Province responded to the City on November 24, 2017 with approval to the CSO Master Plan Preliminary Proposal. The letter specifically directed the City to:

- *Submit a Master Plan including detailed engineering plans, proposed monitoring plans, and an implementation schedule for Control Option No. 1 as identified in your CSO Master Plan Preliminary Proposal on or before August 31, 2019 and for Control Option No. 2 as identified in your CSO Master Plan Preliminary Proposal on or before April 30, 2030, and*

- *Implement the CSO Master Plan for Control Option No. 1 by December 31, 2045, unless otherwise approved by the Director.*

On August 28, 2019, the City submitted the CSO Master Plan. The Master Plan included the District Engineering Plans (DEPs), proposed monitoring plans, and an implementation schedule for Control Option No. 1 with potential migration to Control Option No. 2.

Upon receipt of the CSO Master Plan submission, the Province responded to the City with the following requests on November 13, 2019:

- Part 1: complete an outline of the content of the annual report as required by Clause 13 of the Licence by December 31, 2019,
- Part 2: complete a monitoring plan for approval prior to the submission of the annual report, which will include the monitoring report, the proposed planning for the year ahead, and the milestones achieved,

- Part 3: complete a water quality assessment once every 5 years to demonstrate improvements in the river water quality as a result of implementation of Control Option No. 1. The next report is due December 31, 2024,
- Part 4: complete an assessment of the impact of climate change to the performance of the CSO program and an assessment report with the CSO Master Plan for Control Option No. 2, which is to be submitted by April 30, 2030,
- Part 5: complete a report demonstrating that the percent capture performance measure complies with Control Option No. 2, by April 30, 2025, and
- Part 6: implement CSO Master Plan for Control Option No. 1 by December 31, 2045.

The overview of the CSO Master Plan development timeline is illustrated in Figure 1.

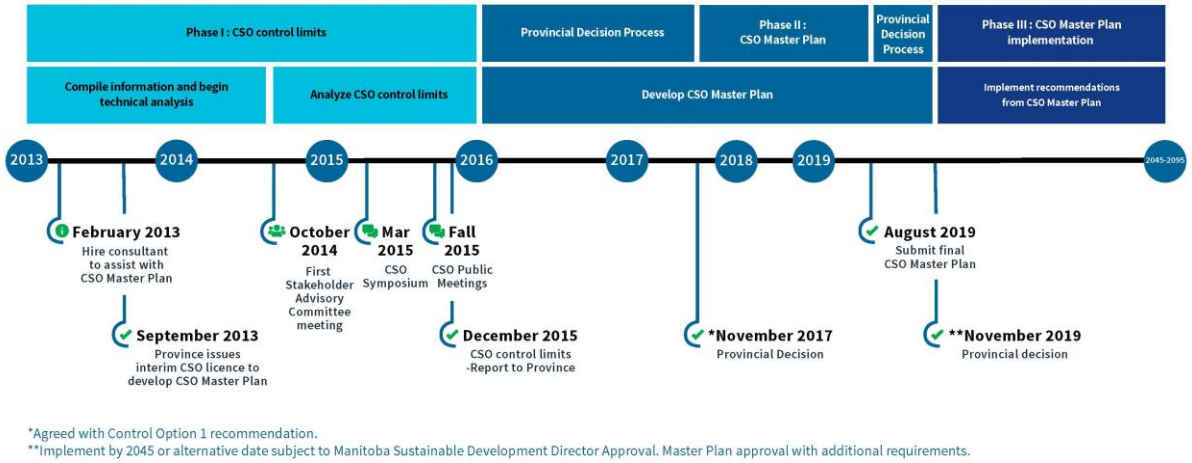


Figure 1 - CSO Master Plan Development Timeline

3. CSO Master Plan Implementation

The CSO Master Plan began its implementation phase upon the receipt of the Provincial approval letter in November 2019. A high level CSO Master Plan Implementation timeline with a number of the future significant milestones is provided in Figure 2.

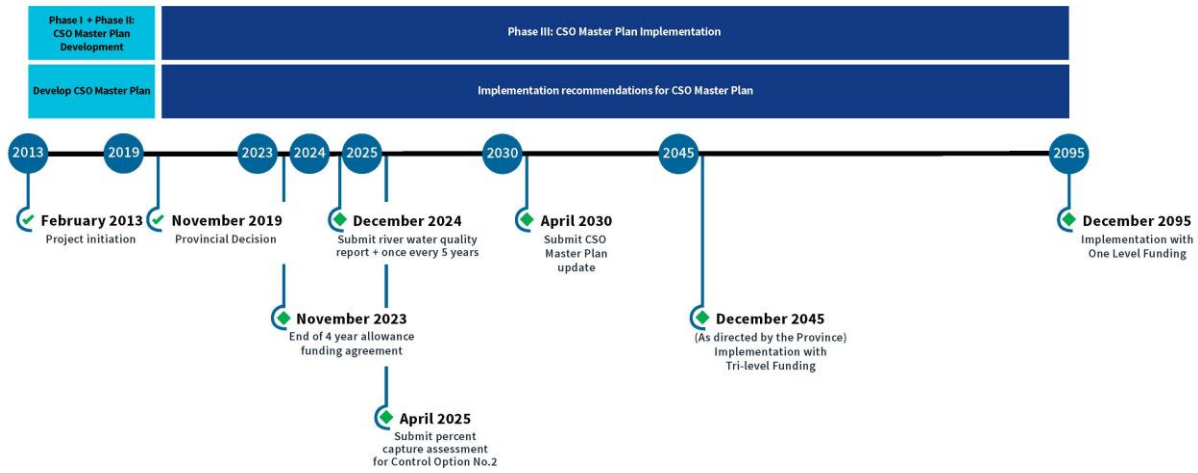


Figure 2 - CSO Master Plan Implementation Timeline

3.1 Master Plan Key Components

The following subsections identify the major considerations in the design of the CSO Master Plan to meet the requirements of EA No. 3042. These considerations will shape the reporting process for implementation of the CSO Master Plan.

3.1.1 Hydraulic Modelling

Monitoring instrumentation and analysis tools are crucial components to the development of the proposed solutions for the CSO Master Plan. At the beginning of the federally mandated CSO reporting period in 2002, no permanent CSO outfall instrumentation was in place. The estimation of percent sewerage volume lost from CSOs was based purely on analytical assumptions up until 2012. With the recommendation from the CEC in 2003, the City invested in CSO event monitoring and volume calculation tools to improve the confidence intervals of CSO estimations. The CSO Monitoring Program commenced in 2009 and by 2013, CSO instruments were successfully installed at 25 locations. Using the available data from the 25 monitored locations, the model estimates of wastewater flows from CSOs were validated.

Due to the difficulties of installing and maintaining instruments in harsh conditions with no local power source, detailed modeling of the combined sewer networks was undertaken to assess the feasibility of estimating the performance of the remaining combined sewer outfalls. An advanced hydraulic and hydrological model was built to represent the existing wastewater collections system. In 2014, the model was calibrated based on temporary instruments at five locations.

This model was further developed as more monitoring data became available. In 2015, the CSO Master Plan Regional Model was completed, which represented each of the CSO districts and outfalls. By 2015, CSO instruments were successfully installed in 14 additional combined sewer outfalls, bringing the total number of outfalls being monitored to 39. The model was then utilized to produce annual CSO results estimation with validation at the 39 permanent CSO instrumented locations.

In 2017, the City created a CSO overflow validation tool to identify and track differences between model estimated and instrumented observed overflows. This information was used to identify instrument maintenance, model maintenance, and areas for operational improvement.

To utilize the hydraulic software's latest and advanced features, the City upgraded the hydraulic model from sewer systems to an integrated catchment modelling platform software. Changes and impacts resulting from the software conversion process were documented.

In 2020 and 2021, CSO instruments were installed in three additional outfall locations each year. The permanent CSO instrumented locations increased from 39 to 45 locations of the total 76 CSO outfalls.

3.1.2 Design Basis

The technical evaluation of the five proposed control options in the Preliminary Proposal recommended the implementation of Control Option No.1: 85 percent capture in a representative year. This option was the highest ranked of the control options considered in the study and was later approved by the Province in 2017 for implementation.

3.1.3 Representative Year

The CSO Master Plan adopted the year 1992 as the representative year for annual rainfall intensities and river levels. Based on a detailed review of 53 years of historic rainfall records at the Winnipeg International Airport, it was determined that the year 1992 would be a suitable rainfall year to be representative of typical conditions with respect to accumulated rainfall (i.e. mm per event), number of annual events, and total annual precipitation characteristics. Similar evaluations of the historic river level records were completed and determined that the year 1992 could also be suitable as representative of typical river level conditions in Winnipeg. As such, the 1992 river level trends and rainfall intensities were used in sophisticated numerical modeling to estimate the volume and frequency of CSO events during the recreation season (May through September, inclusive). It was agreed with the Province as part of the CSO Master Plan Preliminary Proposal development that the year 1992 would form the representative year and would be utilized for planning and evaluation of current and future CSO performance.

3.1.4 Baseline Conditions

The CSO Master Plan was developed with the 2013 year as the baseline year. The Preliminary Proposal, existing hydraulic models, and other CSO related relevant reports were developed based on this baseline condition.

To ensure a common basis for control system sizing and regulatory compliance that is not affected by the annual variations in precipitation and river levels, the CSO Master Plan adapts the 2013 hydraulic model with the 1992 Representative Year precipitation and river levels as the baseline condition for planning and evaluation of control options.

3.1.5 Planning Projections

The Master Plan accounts for population growth in the design process. Clause 8 of EA No. 3042 requires no increase in frequency or volume of CSO in the existing system due to new and upgraded land development. With the growth in population, the sewage flow is anticipated to increase in the sanitary sewer system with any growth in the combined sewer districts to be offset with reductions in runoff area.

To demonstrate compliance with the licensing requirements, the City regulates the development process generally by reviewing and ensuring that the post development peak wet weather flows (PWWF) in the combined sewer districts is equal to or less than the pre-development PWWF. As the City continues to regulate the development process and prohibit the use of combined sewers in new developments, it is anticipated that there would be no impact in the combined sewer systems from new development. The CSO Master Plan projections account for an increase in sewage flow only in the separate sewer areas.

In 2020, the City presented to Council and engaged with the Province for acceptance of the use the CSO Master Plan to meet Clause 8 for small developments by removing additional flows in the combined sewer areas. Strategic CSO mitigation projects from the CSO Master Plan will be used to offset any additional flows from small scale developments. This aligns with the goals of OurWinnipeg and the Complete Communities Direction Strategy by enabling population growth in existing built-up areas through these developments without costly on-site land drainage management. The City received Council approval for this strategic approach in December 2020. On July 8, 2021, the Province requested the estimated increase in volume of CSOs caused by small scale developments and the estimated decrease in volume as a result of infrastructure development on the overall combined sewer system on an annual basis, please see section 5.7 for the current year's estimates. The Provincial approval letters can be found in Appendix C.

3.1.6 CSO Control Technologies

Clause 8 of EA No. 3042 requires the use of green technology and innovative practices in the design and operation of all new and upgraded storm and wastewater infrastructures. Both green and grey infrastructures are considered in the CSO Master Plan design. Green infrastructure (GI) refers to the use of natural hydrologic processes to reduce, store, or attenuate surface runoff from entering the combined or land drainage sewer systems. Many of the GI projects also improve water quality of the surface runoff received. Grey infrastructure refers to the conventional infrastructure projects to address sewer system incapacity, such as pipes and storage tanks.

The control technology selection for each of the combined sewer districts was developed through a two-step approach selection process. The first step of the review included the evaluation of the applicability of sewer control option for the district. This evaluation was based on a number of criteria, including compatibility with existing sewer infrastructure, proximity to the primary CSO outfall/interceptor sewers, and estimated hydraulic performance. The initial solution configurations were implemented within the model based on system hydraulics and then locations were verified with GIS in terms of constructability and feasibility.

The second step of the process included the refinement of the initial control option selection to achieve the 85 percent capture target in the most cost-effective manner. These refinements included:

- A review and further evaluation of sewer districts with screening operational challenges,
- Incorporation of additional complete or partial sewer separation where cost-effective,
- The addition of sewer system control and/or CS-SRS interconnection adjustments to accommodate additional latent storage,
- Incorporation of additional off-line storage where required to provide the remaining volume capture required to meet Control Option No. 1.

Further details to each of these refinements can be found in Section 3.5.4 of CSO Master Plan Part 2.

3.1.7 Water Quality

As per Clause 15 of EA No. 3042, the City developed an Interim Combined Sewer Overflow Monitoring Plan to aid in the development of the CSO Master Plan. The Interim Plan was a multi-year water quality monitoring program that was conducted to collect and update river and CSO water quality data for the development of the CSO Master Plan. The water quality monitoring data was collected in 2014 and 2015. The event mean concentrations (EMC) of the data collected from the 2014 and 2015 water quality monitoring program are provided in Table 1. The EMC of ammonia, nitrate, and total phosphorus (TP) were used to determine pollutant loads in the NRPI reports, while TP, total nitrogen (TN), and nutrient loading were used as the baseline for the water quality modeling and loading assessments for evaluation of control option alternatives for the CSO Master Plan. The assessment indicated that the CSO discharge quality varied by location and between events but was within expected ranges for combined sewer discharges and there was very little difference in performance among the control option alternatives.

Table 2 indicates the number of days the bacteria objective may be exceeded for each alternative. The detailed analysis and results of the CSO Master Plan water quality monitoring work are documented in the Preliminary Proposal.

Table 1 - Pollutants EMC from 2014/2015 Water Quality Monitoring Program

Substance Name	Unit	EMC
[1]Ammonia	mg/L N	5.72
[1]Nitrate-N	mg/L N	0.34
[1,2]Total Phosphorus	mg/L P	2.71
[2]Total Nitrogen	mg/L N	15.25

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

Table 2 - Potential Plans Bacteria Metrics (CH2MHill et al., 2015)

Plan Alternative	Control Limit	Number of Exceedances (days/year)
-	Baseline	44
1	85% Capture in a representative year	44
2	Four Overflows in a representative year	41
3	Zero Overflows in a representative year	35
4	No More Than Four Overflows per year	39
5	Complete Sewer Separation	42

As per the CSO Master Plan approval letter, the City will continue to work towards implementing Control Option No. 1 while further evaluating the bacteriological water quality improvement identified for Control Option No. 2. A water quality report will be submitted once every 5 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.

3.1.8 Climate Change

Climate change considerations were accounted for in the planning and development of the CSO Master Plan. As documented in the CSO Master Plan Preliminary Proposal, historic precipitation information (1960 to 2012) was reviewed to understand precipitation trends and the impact climate change may have on the precipitation trends over time.

Precipitation trends indicate that climate change is linked to less frequent but larger rainfall events. Winnipeg is expected to experience an increase in the frequency of small rainfall events but a consistent trend for larger events. Since the smaller events can be captured in the CSO control system, it is expected that the trend would not be detrimental to the CSO program performance. However, there is a high degree of uncertainty in long-term trends if the frequency of large events increases.

GI has been identified as an opportunity to improve CSO performance levels and provide resiliency to the potential future impacts of climate change. The City will continue to undertake GI pilot projects to evaluate their benefits and long-term performance for future application. An allowance of 10 percent of the total CSO Master Plan capital cost estimates has been included for future GI implementation and to achieve regulatory compliance for Clause 8 of EA No. 3042.

Furthermore, the sewer separation work which has been prioritized will provide the program with climate change resiliency. Any additional runoff generated from climate change impacts on precipitation trends will continue to be directed to the land drainage sewers for the districts which have been separated.

The City will continue to monitor and track weather patterns to assess any impact to the CSO Master Plan and the use of 1992 as the representative year to represent the long term typical conditions in the City of Winnipeg.

3.1.9 Public Engagement

The City established a public engagement program to inform, engage, and consult the public on the CSO Master Plan in the first stage of the Master Plan. The public engagement program included multiple public consultation events for the public to provide input. In addition to public consultation events, a Stakeholder Advisory Committee (SAC) was established to provide advice and direction on the study phase.

The general public was engaged through various public presentations and workshops, internet-based tools, including a blog open for public comments, an email Q&A option, a CSO educational video, and media interviews. The information gathered from the public engagement was evaluated and integrated into the Preliminary Proposal.

Upon submission of the Preliminary Proposal, the City continued to inform and educate the public on the development of the Master Plan using the internet-based tools. The City optimized the public webpage dedicated to the CSO Master Plan work by restructuring and updating it to allow more content and the most up-to-date information be made available to the public. The updated website also allows the public to access the information and navigate the website in a more effective and user-friendly manner. A screen capture of the updated City public webpage can be found in Figure 3.

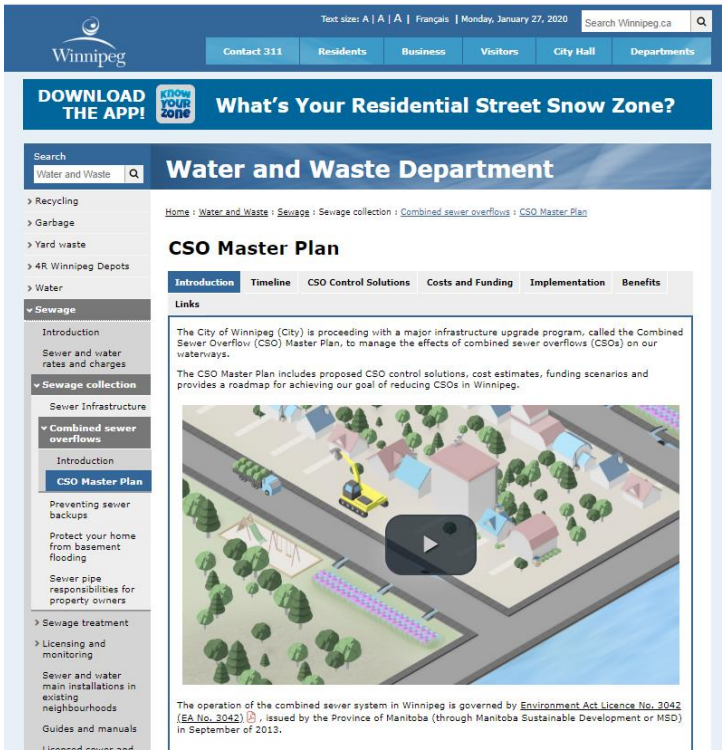


Figure 3 - Screen Capture of the City Webpage

3.1.10 Regulatory Engagement

The City worked closely with the Province to develop the CSO Master Plan. During the development phase of the Master Plan, the City met with two different regulatory groups, a regulatory liaison (management) group and a regulatory working group to raise challenges, report on project progress updates, and to promote collaboration with the regulator to ensure successful program delivery.

3.1.11 District Engineering Plans

The DEPs were developed to provide conceptual solutions for the Control Option No. 1 performance target (85 percent capture in a representative year) for each of the 43 combined sewer districts.

The DEPs are ongoing, live documents. Each of the districts will undergo preliminary and detailed levels of design based on the solutions recommended in the DEPs, and will be updated throughout the implementation phase as required. The current version of the DEPs can be found in the CSO Master Plan Part 3B.

3.2 Capital Cost Summary

A conceptual level Class 5 estimate was developed for the CSO Master Plan. A Class 5 estimate is defined by the *American Association of Cost Engineers International,* (AACE) *Cost Estimate Classification System - As Applied In Engineering, Procurement, and Construction for the Process Industries* (AACE, 1997) as having a project definition of zero to two percent to be used in a conceptual study with an expected range of accuracy from -50 percent to +100 percent.

The total capital cost to implement the CSO Master Plan including the 10 percent GI allowance is estimated as $1,150,400,000 in 2019 dollars. Applying the maximum +100 percent of the Class 5 estimating range, the total capital cost for budgeting purposes is estimated to be $2,300,800,000. The capital cost summary is shown in Table 3.

Table 3 - CSO Master Plan Capital Cost Estimate (2019 dollars)

Item	2019 Capital Cost Estimate
Class 5 Estimated Capital Costs	$1,045,800,000
Green Infrastructure Allowance (10%)	$104,600,000
Subtotal – Capital Cost Estimate	**$1,150,400,000**
Class 5 Estimate Range of Accuracy: -50% to +100%	$575,200,000 to $2,300,800,000
Total Capital Cost for Budgeting Purposes	**$2,300,800,000**

3.3 Funding Scenarios

The current City funding method for the CSO Master Plan is through the Sewer Utility. The sewer rates have been steadily rising to cover the inflation rate and the costs required for assorted water and wastewater infrastructure upgrades. However, to meet the mandated timeframe in EA No. 3042, an aggressive increase in sewer rates is required and this amount was determined to be unaffordable by utility rate payers. An affordability assessment documented in the Preliminary Proposal suggested that the Master Plan would not be able to meet the licencing requirements based on the current and forecast utility rates without additional external funding support.

Based on the recommendation from the CEC for sharing the cost equally between the Municipal/Provincial/Federal governments, the CSO Master Plan was developed with the following three funding scenarios.

- Scenario 1 – Tri-level funding agreement between the Government of Canada , Manitoba Government, and the City of Winnipeg with each contributing $30 million per year each (a total capital budget of $90 million dollars per year)
- Scenario 2 – Bi-level funding agreement between the City of Winnipeg and either the Manitoba Government or the Government of Canada with each contributing $30 million per year each (a total capital budget of $60 million dollars per year
- Scenario 3 – City-only funding with a total estimated capital budget of $30 million per year.

The funding scenario is based on the following assumptions:

- three percent inflation per year for annual funding and construction costs,
- a four-year initialization period at beginning of program, which includes a two-year allowance for alterations of EA No. 3042 and a two-year allowance for securing Federal and Provincial funding commitments, and
- consistent funding arrangements established throughout the entire implementation period.

The 2019 CSO Master Plan described the funding impacts in detail. The summary of the impact of the three funding scenarios are provided in Table 4.

Table 4 - CSO Master Plan Funding Scenario Evaluation Results (2019 Dollars) (Jacobs, 2019)

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

The City requires funding from the Federal and Provincial governments to meet the 2045 Provincial deadline due to the scale of the work required as per the intent of the 2003 CEC recommendations. However, any changes to inflation rates or delay to annual funding approvals to the request will result in overall project cost increases and a longer implementation timeline.

The CSO Master Plan is currently on schedule and budget for Program Scenario 1. If no additional funding is provided by the Provincial and Federal Governments by 2023 or earlier, the CSO Master Plan will move to the Program Scenario 3 which is based on City only funding and has a longer implementation timeline.

The Program Scenario 1 Capital Budget with 3 percent annual inflation can be seen in see Figure 4 below.

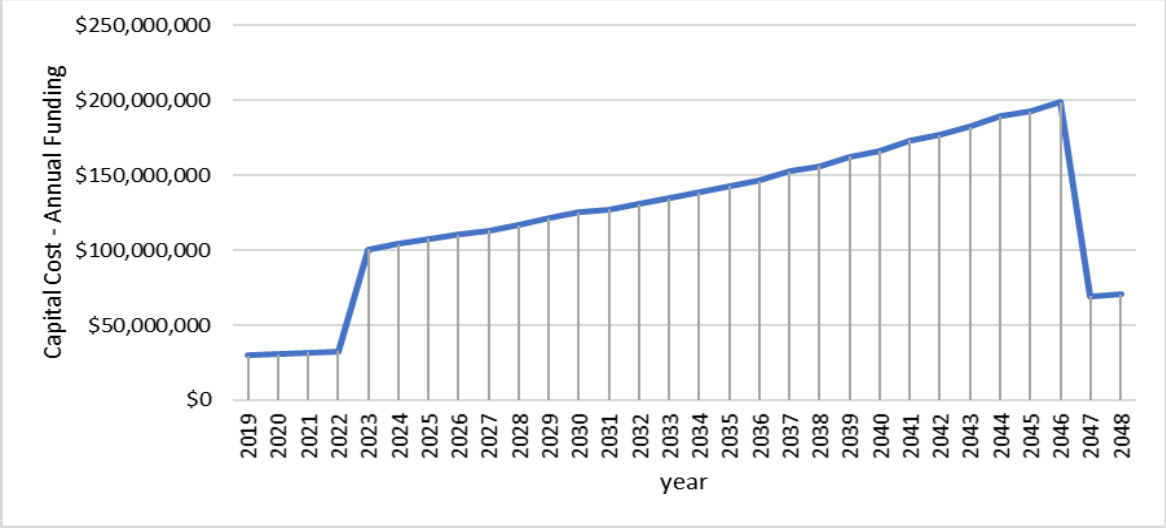


Figure 4 - CSO Master Plan Program Scenario 1 Capital Budget Inflated at 3 Percent Annually

3.4 Changes in Funding

In 2021, City Council proposed an increase of $60 million to the City portion of the CSO Master Plan budget adopted in the 2022 updated City balanced budget. The proposed increase is to be split over 4 years ($15 million a year) and be available from 2024 to 2027.

3.5 Design Development of Proposed Projects

The CSO Master Plan and the DEPs were developed to a conceptual level of detail. The individual project selections and designs are based on the hydraulic model evaluations and high level assessments of constructability. It is expected that the proposed projects identified will change and adapt as further information is collected during the program implementation and individual project design studies. This process is illustrated in Figure 5.



Figure 5 - Key Design Stages in Life of a CSO Project

The City plans to complete a number of additional evaluations based on the details presented in the DEPs to form the basis for further design and construction within each of the sewer districts. Each of the proposed projects will undergo a preliminary and detailed design stage to confirm their constructability. A potential approach to the design process would be for several neighboring sewer districts to the district in question under design to be further refined as a package during the preliminary design phase. Additional detail would be collected and evaluated to fully understand the existing sewer system surrounding each specific district prioritized, and confirm selection of the optimal CSO control technology. This would be followed by detailed design where the parameters of the control technology would be finalized for construction.

Each of the combined sewer districts with the solutions constructed will be monitored to determine the level of performance achieved. This information will be input into the current hydraulic model and applied as part of future design evaluations. CSO volume monitoring and operation and maintenance of sewer systems will continue for the life of the infrastructure.

3.6 Program Implementation Strategy

In addition to the program criteria, an implementation strategy has been defined in the CSO Master Plan documentation to balance resources, risks, and costs of the projects. Additionally, projects were scheduled based on the funding scenario.

Sewer separation work is an ongoing priority for the program implementation due to the high benefits and low risks. As cost escalation can have significant impacts to the cost of long-term programs, completing more expensive work upfront can reduce the relative impact of cost escalation. Sewer separation reduces basement flooding risk and reduces wet weather runoff to the combined sewer system. It addresses the required CSO reduction targets, while also improving the basement flooding level of service for the area.

There are a number of additional opportunities which require further investigation as part of program implementation, such as GI solutions and floatable management.

GI was assessed separately from the other control options. It was not been included in the base solutions because of unknowns and uncertainty with its application. Each district will require a detailed assessment on potential GI locations and will require the development of policies and design standards with engagement and by-in from residential, commercial, and industrial customers to optimize opportunities. The analysis of the main technology evaluations and pilot studies are scheduled to be completed within

the first ten years. This will provide confirmation that these proposed options are appropriate and suitable for the Winnipeg sewerage system. GI and sustainable solutions should be reviewed as part of every sewer infrastructure project to comply with Clause 8 of EA No.3042. GI projects will provide the necessary performance improvements to meet CSO volume capture targets and will assist with mitigating detrimental impacts from climate change. An allowance of 10 percent of the total CSO Master Plan capital cost estimates has been included for future implementation of GI solutions.

The floatables management approach in the CSO Master Plan is based on outfall screening. Screening is not the most effective approach for many of our sewer districts due to many factors including the surrounding environment and the sewer system hydraulics. Floatables management is required for outfalls in which combined sewage is discharged. For districts in which complete sewer separation is to be completed, combined sewage will no longer be discharged from the outfalls in these districts and floatable management will not be required.

The City has identified an alternative approach to screening to address the floatable management requirements, which is similar to a successful program run by the City of Ottawa. This proposed new approach targets source control as a potential alternative to screening. This is expected to achieve similar or better results while eliminating end-of-pipe screening. The alternative floatables management plan provides a significant opportunity to achieve the intended results, while avoiding the high capital and long-term operations and maintenance (O&M) costs of screening facilities.

Additional sewer storage and mechanical controls solutions are scheduled to follow sewer separation work. In order to appropriately size and operate this type of infrastructure, sewer network, power, communications, monitoring, and operational infrastructure need to be in place and allow for a detailed understanding of network performance.

3.7 Schedule

The schedule is based on funding and the evaluation of the scope of work involved with each of the districts, CSO volume detriment, cost-benefits analysis, and district prioritization. See Appendix D for the district Program Scenario 1 implementation schedule and Figure 6 for the high level schedule which shows for the implementation strategy more clearly.

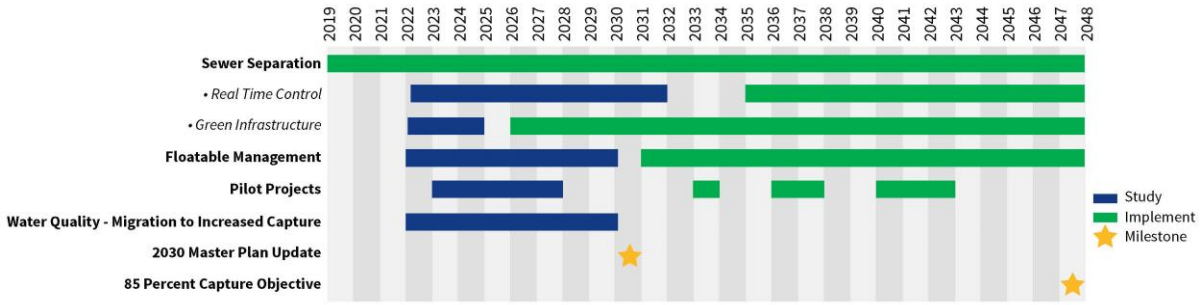


Figure 6 - CSO Master Plan Program Scenario 1 Overview Schedule

3.8 Capital Projects Overview

To achieve 85% CSO volume capture in a Representative Year, sewer separation work is a major component and is proposed for 15 districts. A breakdown of the cost for each control technology applied in the CSO Master Plan is shown on Figure 7.

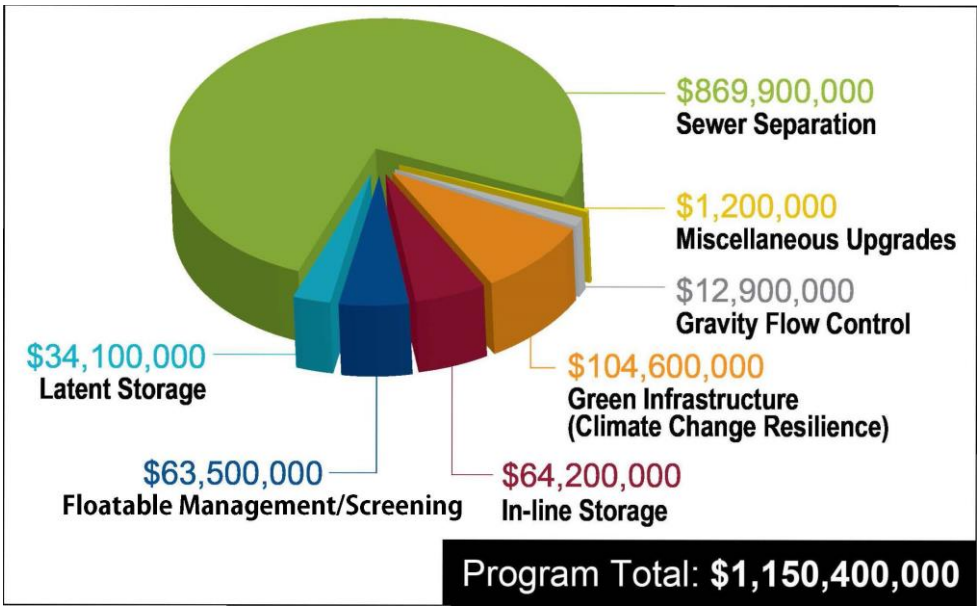


Figure 7 - CSO Master Plan Capital Cost Summary (2019 Dollars)

Figure 8 provides an overview map of the location of the proposed control options for each district.

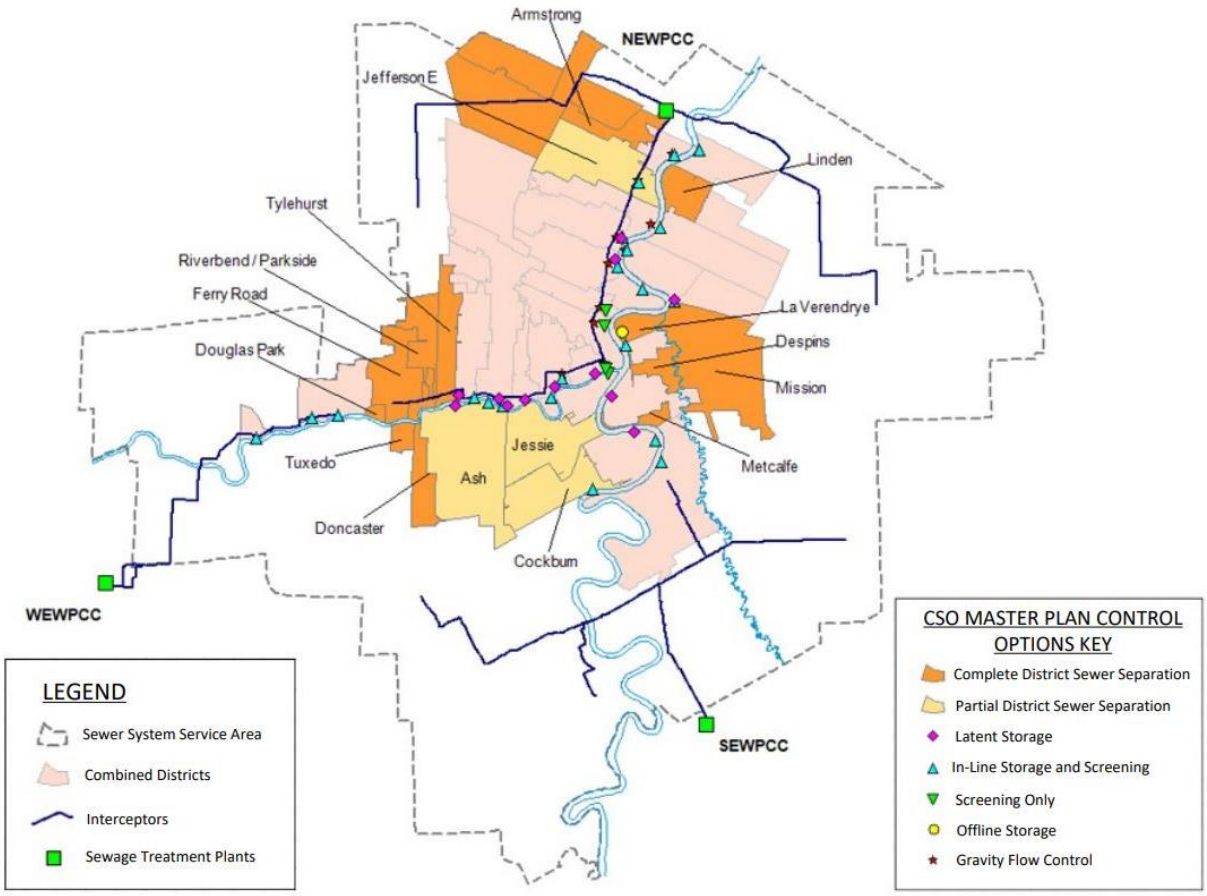


Figure 8 - CSO Master Plan Project Overview Map

3.9 Risks and Opportunities

This section provides an overview of the risks and opportunities identified in the development of the Master Plan.

3.9.1 Risks

Program Implementation

Factors that may pose a risk to the program implementation are as follows:

- Funding – There is a risk that funding from other levels of government will not be available over the life of the CSO Master Plan. The City will continue its work with the allocated average $30 million annual budget and adapt to increases as rates allow.
- Technology – There is a risk that implementation of the green and innovative technologies as per Clause 8 of EA No. 3042 may not perform as expected. Technologies that are proven to be successful in other jurisdictions may not apply the same to Winnipeg due to the environment. The City will undertake research and seek for experience and knowledge from other jurisdictions on the technologies prior to implementation.
- Resource – Market fluctuation and insufficient local resources may pose a risk to a cost increase and a delay in implementation schedule.
- Schedule – There are many sources of risk associated with the planning and execution of the program. Such risks include funding shortages or high bid costs, limitation of engineering and construction service capacity, and extended project approvals.
- Migration to Control Option No. 2 – The change in performance target (from Control Option No. 1 to Control Option No. 2) would increase costs and likely increase the timeline of the Master Plan due to the increase level of effort required for the increased CSO volume reduction.

Climate Change

An increase in extreme weather events is a potential risk to the performance of the CSO Master Plan program. The program is based on a 1992 Representative Year. Long-term monitoring of rainfall trends will continue during the execution of the Master Plan to monitor any trends.

Basement Flooding

Modification and upgrade of existing infrastructure may pose a risk to basement flooding due to potential system operation issues.

Program Feasibility and Sustainability

Factors to be considered regarding the feasibility and sustainability of the program include: affordability, public impact, City resources, construction capacity, services overlap, and control option re-evaluation.

Affordability: The City's finances its capital and operating budgets for the sewer utility on a user-pay basis through sewer rates. To ensure that the rates are affordable to rate payers, the City takes a longer-term view of rates. The rates have steadily been rising for several years and are expected to continue to rise due to wastewater treatment plant upgrade works and replacement and refurbishment of aging infrastructure.

Public Impact: Sewer separation projects are planned throughout the combined sewer system and will encompass large sections of the sewer districts. Each of these will include large programs that will each take several years to complete. This may pose an impact on both the residents and businesses.

City Resources: City resources will need to increase to achieve the new requirements and implement all the components of the CSO Master Plan.

Construction Capacity: With the additional construction projects demand, there is a risk that Winnipeg may not be equipped with sufficient local construction industries to undertake the work, posing a potential risk of a schedule delay.

Services Overlap: There are multiple competing infrastructure needs within the City to consider as well as the possibility of additional requirements in the future that cannot be forecast. Coordination with other City services will be required to minimize impacts and identify planning overlaps.

Control Option re-evaluation: As technologies evolve overtime, there is a risk that the selected control option may need to be re-evaluated to validate the best control option available. This implies that there is a possibility of rejection, which may lead to the need for more costly substitutes.

District Engineering Plan Risks

The District Engineering Plan comprises of individual conceptual solution to CSO mitigation for each of the combined sewer districts. Each of the risks and opportunities applicable to the control solutions recommended within each sewer district to meet Control Option No. 1 are documented in the Part 3B – District Engineering Plans of the CSO Master Plan.

Any changes to the control solution could cascade to a reevaluation of risks associated with each of the specific projects.

3.9.2 Opportunities

A number of opportunities to improve the volume percent capture during the program were identified during the development of the CSO Master Plan. The following section describes the main areas that the City could benefit from during the development of the Master Plan.

Green Infrastructure

Clause 8 of EA No. 3042 requires the use of green technology in the design and operation of all new and upgraded infrastructures. In the CSO Master Plan, each of the combined sewer district control solutions contains a GI component. GI technologies will be evaluated to promote additional CSO volume storage and sustainability. A budget of 10 percent of the capital program is included in the CSO Master Plan budget for the implementation of the GI technology.

Floatable Management

Clause 12 of EA No. 3042 requires the Master Plan to demonstrate the prevention of floatable materials in CSO effluent. The Master Plan proposed investigating the use of both screening and the alternative floatable management approach to prevent floatable materials from entering the river.

Real Time Control

Real time control (RTC) provides a method of increasing system performance by improving the operation of the system. With Winnipeg's flat topography and large diameter pipe network, application of RTC becomes very valuable as it can adapt and balance the system for real precipitation events that are spatially and temporally distributed. The incorporation of RTC and monitoring instrumentation will provide an increased understanding of operation and a better control on a real time basis, and an optimization of flows in the system and to the treatment plants.

Stakeholder Collaboration

Working together with other stakeholders including industry groups and the public will provide partnership opportunities that may provide additional benefit to the CSO Master Plan. Furthermore, this will provide an opportunity to further engage, communicate, and educate the community on the ongoing work with the program.

Further details associated with both the risks and opportunities of the program can be found in the CSO Master Plan.

4. CSO Master Plan Performance

To track CSO performance, the City of Winnipeg first utilizes the 2013 Regional Model Baseline Network performance, specifically with the CSO design event the 1992 Representative Year rainfall with the associated river levels applied. This provides the baseline performance levels and is in line with the procedure used to evaluate the 2015 CSO Master Plan Preliminary Proposal results. The current year model network, which is the best representation of the sewer network condition at that time, is then utilized with the same 1992 Representative Year rainfall and river levels. This produces the current performance and is compared to the baseline performance to estimate the performance improvement and track progress.

4.1 CSO Volume Performance Tracking

To track progress towards meeting the Control Option 1, 85% CSO Volume capture for the 1992 Representative Year, the estimated volume and frequency of CSO events for the 2013 Regional Model Baseline Network were compared against the 2020 Regional Model Current Network, both with the 1992 Representative Year design basis.

The 2013 baseline hydraulic model represents the model conditions for the 2013 sewer network used during the Preliminary Proposal. The 2020 network is the most current model and provides the best representation of the sewer network condition for the current year 2021. Future updates to the model will be made as construction works are completed and modeling resources allow.

The total CSO volume discharged for the current 2021 year is 5,106 ML, which is 154 ML less than the 2013 baseline CSO volume. The reduction in CSO volume and the overall percent capture demonstrate that the combined sewer relief projects that were undertaken in recent years have improved the overall CSO performance of the collections system. Table 5 presents the CSO performance of the baseline, current year, and the Preliminary Proposal's control target (85 percent capture) under 1992 Representative Year design event. The total wet weather flow volume captured for 2021 was calculated based on the baseline's dry and wet weather flows, in conjunction with the 2021 CSO volume.

Table 5 - CSO Master Plan Performance Tracking

Condition	Total CSO Volume (ML)	Total Dry Weather Flow Volume (ML)	Total Wet Weather Flow Volume Captured (ML)	Target Reduction in CSO Volume (ML)	*Percent Capture (%)
Baseline Performance - 2013 Baseline with 1992 Rep. Year	5,260	7,749	7,317	-	74
Current (2021) Year's Performance - 2020 Network with 1992 Rep. Year	5,106	7,749	7,471	-	75
Target Performance - CSO Preliminary Proposal 85 Percent Capture with 1992 Rep. Year	2,980	7,749	9,593	2,300	85

$$*Percent\ Capture = \frac{(Total\ Dry\ Weather\ Flow\ Volume + Total\ Wet\ Weather\ Flow\ Volume\ Captured)}{(\text{Total CSO Volume+Total Dry Weather Flow Volume+Total Wet Weather Flow Volume Captured})}$$

No additional CSO volume reduction is reported in 2021 as no additional model maintenance was undertaken in 2021. The 2021 CSO volume percent capture was estimated at 75% relative to the 2013 baseline year. The improved performance to date is primarily attributed to Capital improvements represented in the model for the Ferry Road completed contracts and Cockburn completed contracts (-

108ML). Construction works continue and network changes or improved data will be included in subsequent model updates. The 2020 year network is the best available representation of the City sewer system.

4.2 Financial Tracking

The CSO Master Plan developed an overall capital cost in 2019 dollars for each of the combined sewer districts, which includes a 53 percent makeup on construction cost for engineering, burdens and contingency, and a 10 percent allowance for GI. The cost is based on a Class 5 level of estimate. The following section provides the financial status of the program. The financial budget is provided based on the current year's actual spend with a three-year window forecast. As preliminary design is completed for a district, updated class 3 cost estimates will be prepared and utilized in the financial tracking process.

4.2.1 Capital Cost Estimation Tracking

No new City wide capital cost estimates have been created since the August 2019 submission of the CSO Master Plan.

4.2.2 Budget Tracking

The CSO Master Plan is on schedule and budget for Program Scenario 1. If no additional funding is provided by both the Province and Federal Governments by 2023 or earlier, the CSO Master Plan will move to the Program Scenario 3, which is based on City only funding and has a longer implementation timeline.

The method for City funding for the CSO Master Plan is through the sewer utility. Sewer rates have been steadily rising to cover inflation rates and the cost required for infrastructure upgrades. However, to meet the mandated timeframe in EA No. 3042, an aggressive unsustainable increase in utility rates would be required and was considered unaffordable for utility rate payers. An affordability assessment documented in the Preliminary Proposal suggested that the Master Plan is unaffordable to be completed in accordance to licencing requirements based on the current and forecast utility rates without additional funding support.

In 2021, the City Council proposed an increase of $60 million to the City portion of the CSO Master Plan budget adopted in the 2022 updated City balanced budget. The proposed increase is to be split over 4 years ($15 million a year) and be available from 2024 to 2027.

The City requires funding from all three levels of governments to meet the 2045 Provincial deadline due to the scale of the work required as per the intent of the 2003 CEC recommendations. However, any changes to inflation rates or delay to annual City funding approvals will result in overall project cost increases and a longer implementation time.

A three-year window budget of the CSO Master Plan and revised 2021 annual budget is presented in Table 6 below.

Table 6 - CSO Master Plan (2019 dollar values) and Revised 2021 Annual Budget Difference

	Year 1	Year 2	Year 3	
	2022	2023	2024	Average
CSO Master Plan Forecast	$32,786,411	$33,770,003	$34,783,103	$35,826,596
2021 Budget Forecast	$30,000,000	$28,000,000	$47,000,000	$41,500,000
% Deviation	-9%	-21%	+26%	+14%

The City only CSO Master Plan 2021 budget was $32 million with an additional $27,206,162 budget holdover from 2020. The additional budget is being held for Ferry Road Contract 6, a large strategic tunneling project proposed along Rutland Street with a Class 3 estimate in excess of available annual

average budget funding. Ferry Road Contract 6 is forecast to be awarded in 2023. See Table 7 - 2022 to 2024 Capital Budget Forecast (2021 dollar values).

Table 7 - 2022 to 2024 Capital Budget Forecast (2021 Dollars)

Budget Source	Budget	2021 Committed Capital Projects To Date	2021 Forecast Capital Projects	% of Annual Budget Committed
2020 (hold over)	$27,206,162			
2021 Budget	$32,000,000	$17,464,838		29%
Total Budget Available	**$59,206,162**			
2021 (hold over)	$41,741,324			
2022 Budget	$30,000,000		$31,697,275	44%
Total Budget Available	**$71,741,324**			
2022 (hold over)	$40,044,049			
2023 Budget	$28,000,000		$67,670,000	99%
Total Budget Available	**$68,044,049**			
2023 (hold over)	$374,049			
2024 Budget	$47,000,000		$31,130,000	66%
Total Budget Available	**$47,374,049**			

Approximately $17.5 million was invested in 2021. Since 2019, the approximate cumulative committed capital spend is $69 million. The CSO Master Plan and 2021 actual and forecast annual capital spend with a three-year window are provided in Figure 9.

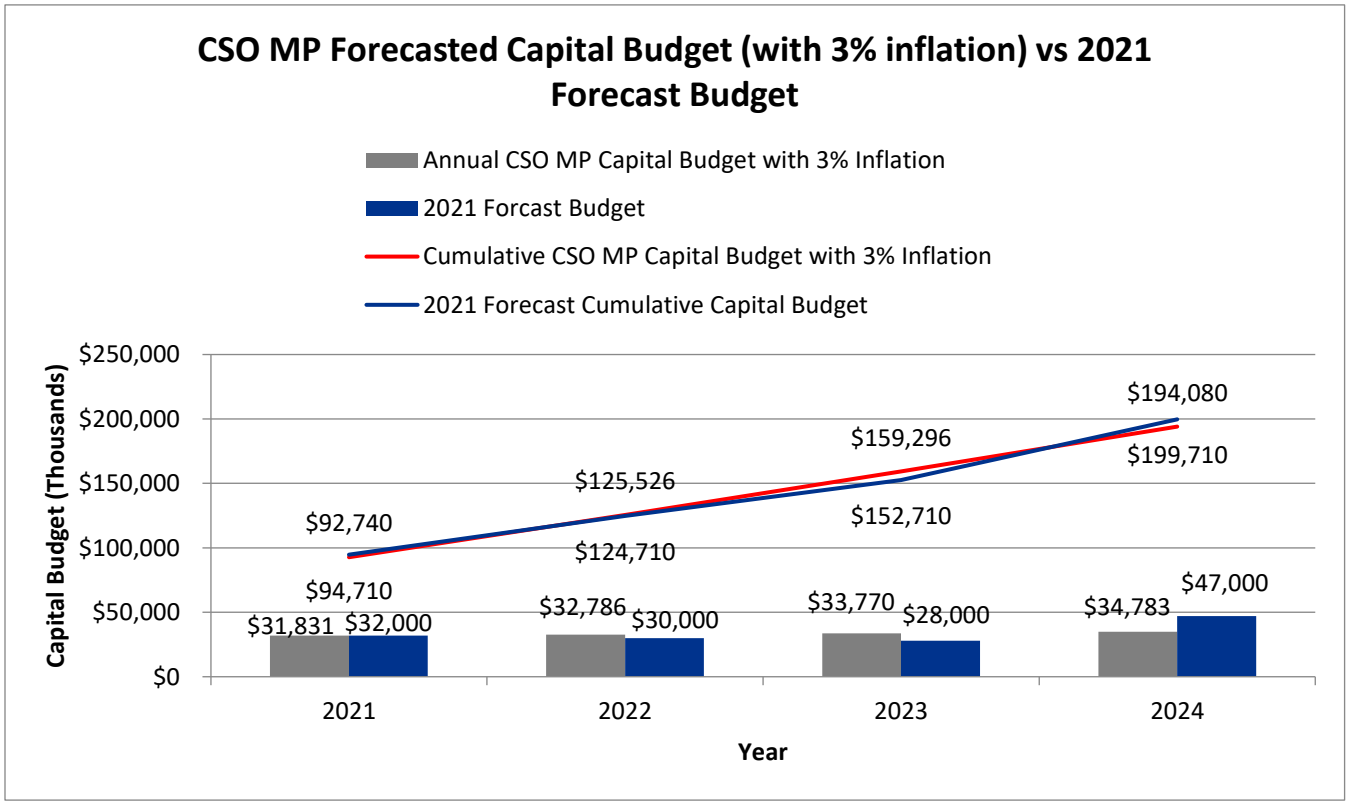


Figure 9 - CSO Master Plan and 2021 Actual and Forecast Capital Budget

4.3 Schedule Tracking

The CSO Master Plan schedule is based on the Program Scenario 1 budget with districts strategically prioritized based on implementation strategy and CSO volume reduction.

The proposed and actual construction implementation schedule for 2021 along with the CSO Master Plan forecast 2022 to 2024 (three-year window) is illustrated in Appendix E.

4.4 Districts Design Status

The design status for each of the combined sewer districts is illustrated in Appendix F. Colored cells represent the design stage status for the specific district as of December 31, 2021.

4.5 Capital Projects Tracking

The list of completed and/or ongoing projects from 2021, with the associated scope, targeted costs, actual cost, and CSO volume reduction are provided in Appendix G.

The list of forecasted work for 2022 and the corresponding capital project's estimated CSO volume reduction are provided in Appendix H.

4.6 Milestones

The 2021 awarded projects and the 2022 planned projects milestones are summarized in Table 8 and Table 9, respectively.

The planned award dates and the actual award dates are compared to demonstrate the project progress. Based on the existing progress and the implementation schedule from the CSO Master Plan, all current projects are on schedule.

In addition to the contract work, any Provincial submissions are also considered as milestones. The milestones for the Provincial submissions are provided in Section 10.

Table 8 - 2021 Past Projects Milestone

2021 Committed Projects	Targeted Award Date	Actual Award Date	Comment
CSO Sewer Relief Projects			
NEWPCC			
Armstrong Consultant Assignment 1	2021	August 2021	-
Jefferson East Consultant Assignment 3	2021	September 2021	-
SEWPCC			
Cockburn / Calrossie Construction Contract 6B	2021	July 2021	-
Cockburn / Calrossie Construction Contract 7	2021	December 2021	This contract includes work initially planned for Contract 10B.
CSO Monitoring Program			
Flow Monitoring Program - Instrumentation Procurement	2021	March 2021	-
Rainfall Monitoring Program	2021	March and May 2021	Two separate contracts: 1) Equipment Supply, Operation and Maintenance Service 2) Data Management Service

Table 9 - 2022 Planned Projects Milestone

2022 Planned Projects	Targeted Award Date	Comment
CSO Sewer Relief Projects		
NEWPCC		
Ferry Road / Riverbed Consultant Assignment 5	2022	-
Jefferson East Construction Contract 6A	2022	-
Jefferson East Construction Contract 6B	2022	
Jefferson East Construction Contract 7	2022	
Hawthorne Consultant Assignment 1	2022	
Hawthorne Construction Contract	2022	Phasing of work is unknown at this time. Risk of delay if Consultant Assignment is not complete
SEWPCC		
Cockburn / Calrossie Consultant Assignment 5 / Over Expenditure	2022	
CSO Monitoring Program		
Rainfall Monitoring Program	2022	-
Real Time Control - Feasibility Study	2022	-
Note: The above status is subject to change pending on available budget and resource.		

4.7 City Investments on CSO Mitigation to Date

The 2021 CSO Master Plan is ongoing and completed contracts are documented in Appendix G. Last year's Annual Report tracked approximately $140.4 million in infrastructure investment since 2013. The budget for the next six years is forecast to be $240 million ($180 million committed and proposed $60 million increase). Please refer to past reports for past project investments.

The 2021 CSO Master Plan investment ($17.5 million) increases the committed infrastructure investment since 2013 to approximately $157.9 million.

5. Current Year 2021

The City reports annually on CSO events and volumes estimates. The amount of rainfall and the level of the river during rainfall events have the most impact on CSO results and sewer network performance.

2021 was comparable in the total annual amount of precipitation in the 1992 Representative Year. There was approximately 2% less rainfall in 2021 than in the representative year.

The 2021 river levels were overall lower than the 1 in 5 year average river levels. Compared to the 1992 Representative Year river levels, the 2021 river levels were lower from April to mid-May and slightly higher for the rest of the recreational season.

In comparison to the 2020 CSO Results, the 2021 CSO Results show a reduction in the number of events but an increase in CSO volume. 2020 and 2021 rainfall years were not that different (roughly 20% more rainfall in 2021) but the river levels were very different. In 2020, the timing of significant rainfall events with river level peaks restricted gravity discharges resulting in more runoff retained in the sewer system and conveyed to treatment. Low river levels in 2021 resulted in much larger volume gravity discharges. In total, 83% of the CSO results values were validated against observed instrumentation data.

5.1 CSO Results 2021

Based on the approach outlined in section 5.6, the 2021 results are provided in Table 10. The location and event volumes are submitted federally and provincially every year on or before February 15 for the proceeding reporting year. The results are also made public on the City webpage by July 31 for the proceeding reporting year.

Table 10 - CSO Overview Results 2021

Source of Data	Number of Combined Sewer Outfalls	Number of events	Volume of events (ML)
CSO Instrumentation & Detailed Hydraulic Model	45	583	8,552
Detailed Hydraulic Model	31	299	1760
Flood Pumped Data	N/A	28	289
Total	76	910	10,601

The number of CSO events for 2021 in total was 910, which is an average of 12 events per outfall (based on 76 outfalls). The total estimated annual sewage discharged from CSOs for 2021 is 10,600 ML.

There are currently 41 flood pump locations. This number includes temporary flood pumps which are installed in specific locations where required based on river levels.

5.2 Rainfall 2021

The 1992 Representative Year and 2021 current year's rainfall events are reviewed and analyzed to understand the impact rainfall events have on CSOs. Table 11 summarizes the amount of precipitation and the number of rainfall events in both 1992 and 2021 based on the single rain gauge at the Forks.

The total amount of rain that fell in 2021 was approximately 2% less than the 1992 Representative Year. The 2021 recreation season was 30% drier than the 1992 Representative Year. The 2021 shoulder season (January through April and October through December) accounted for 36% of the total annual precipitation, which was approximately 2.5 times the precipitation of the shoulder season of the 1992 Representative Year. Eight rainfall events greater than 5 mm were recorded outside of the recreation period.

Table 11 - Single Rain Gauge at the Forks

	1992		2021	
	Annual	Rec Season	Annual	Rec Season
Total precipitation (mm)	478	326	395	227
Estimated rainfall (mm)	362	326	357	227
% deviation from average rainfall			-2%	-30%
Number of Events ≥5mm	22	20	16	8
% deviation from average			-27%	-60%

The comparison between the total annual precipitation and the 1992 Representative Year precipitation over the last several years is illustrated in Figure 10.

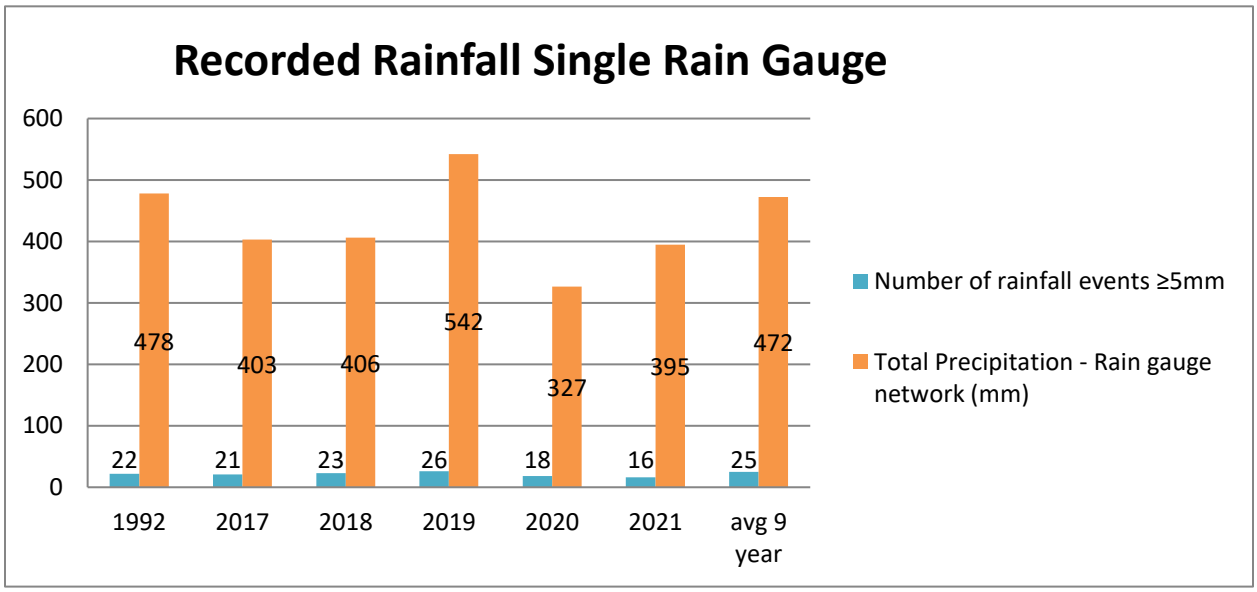


Figure 10 - Total Precipitation Yearly Trend Single Rain Gauge

To capture the spatial variation of the rainfall and further improve CSO event, duration, and volume estimation, the City uses its network of 36 rain gauges.

Instruments are typically operational from May 1 to September 30 but, weather permitting, can be activated as early as March and turned off as late as November. In 2021, there were 16 rain gauges associated with the combined sewer districts. Two Environment Canada rain gauges (the Forks and Airport gauges) are within the combined sewer district and were used to supplement data outside for remaining months of the year.

The average annual rainfall recorded by the City's combined sewer districts' rain gauges was 371 mm. Due to COVID-19 pandemic restrictions, they were unable to be maintained by out-of-province contractors. The Riverbend rain gauge being out of service for the month of March and Westwood rain gauge being out of service from March 1 to May 27 can be attributed to the lack of maintenance. The University of Winnipeg rain gauge was also out of service from September 25 to October 19. Lastly, the Bernie Wolfe rain gauge was unavailable from March 1 to October 31. The missing data from these rain

gauges were supplemented with the rainfall data from the Environment Canada rain gauges. Overall, 2021 had 91% of rain gauges coverage for the recreation season.

5.3 River Elevations 2021

River levels in the recreation season of 2021 overall were lower than the 1 in 5 year average summer river level. The 2021 river levels were significantly lower from April to mid-May but were slightly higher than the 1992 Representative Year river levels for the rest of the recreational season. The river levels of 1992, 2021, and the 1 in 5 year event are illustrated in Figure 11.

As discussed in section 5.2, 2021 had less precipitation during the recreation season but higher precipitation during the shoulder seasons than the 1992 Representative Year. The low river levels in 2021 spring was a result of the low precipitation in winter 2020/2021. During the recreation season, the river levels were overall steady. The Red River remained at winter levels until the levels eventually rose to the normal summer water level set by the control at the St. Andrew's Lock and Dam. The Assiniboine River remained very low upstream of the influence level of the Red River.

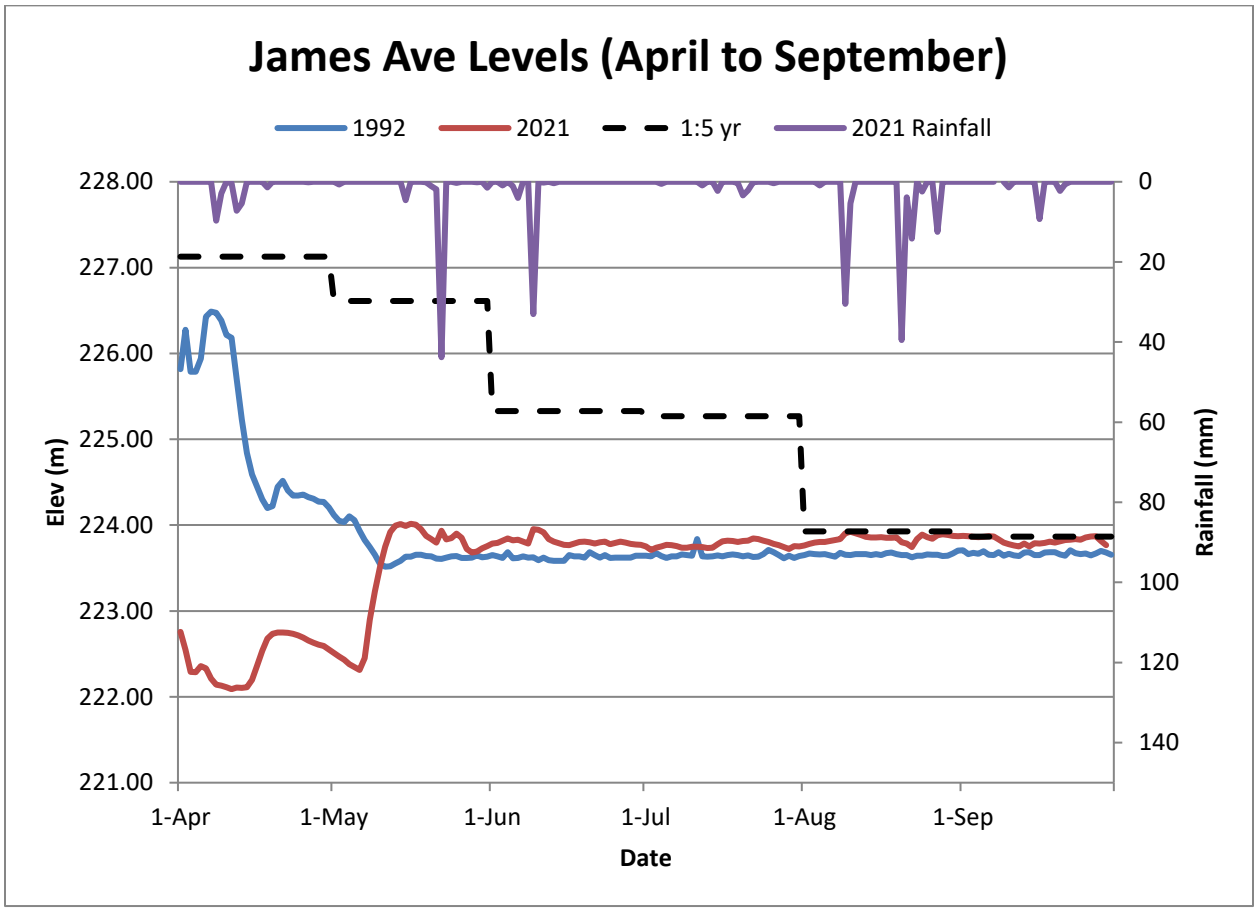


Figure 11 - James Ave River Level Comparison

5.4 Treatment Plant Flows 2021

For 2021, the total citywide treated sewage volume was 82,287 ML which was approximately 5% less than 2020 (86,749 ML). The average annual flows (AAF) distributed between the wastewater treatment plants were as follows:

- North End Sewage Treatment Plant (NEWPCC) - 154 ML/day
- South End Sewage Treatment Plant (SEWPCC) - 51 ML/day

- West End Sewage Treatment Plant (WEWPCC) - 21 ML/day

The distribution of the treated sewage volume at each of the sewage treatment plants was similar to 2020 and past years.

- NEWPCC - 56,124 ML (68%)
- SEWPCC - 18,649 ML (23%)
- WEWPCC - 7,514 ML (9%)

In 2021, approximately 11% of the total annual citywide sewage was lost due to overflows and 89% of the annual sewage flow was captured and sent to sewage treatment plants. The estimated sewage lost from the individual NEWPCC, SEWPCC, and WEWPCC collection systems was 9,999 ML, 358 ML, and 244 ML, respectively.

5.5 Collections System Operational Observations 2021

Infrastructure and outfall monitoring instruments require regular maintenance.

An overview of the 2021 Collections System's maintenance comments is as follows:

- All outfall monitoring instruments were maintained throughout 2021. Non-functional instruments were either recalibrated or replaced as part of the maintenance process.
- The Baltimore force main, which had a leak, has been replaced with a new force main and entered service on December 2, 2021.

The City continues to provide regular maintenance to all monitoring instruments at the CS outfalls to maintain data quality for CSO Reporting. The record of the 2021 operational observations are documented in the Annual CSO Results Report, which was submitted to the Province on February 11, 2022.

5.6 Reporting Process

The 2021 CSO annual reporting process was based on the City Regional Model 2020 network representation. The model was validated using 45 instrumented CSO outfalls.

5.6.1 Hydraulic Model Maintenance

The City model network is continually updated to better represent the current year's performance.

The City will continually work on updating the hydraulic model based on available information, including past studies, field surveys, and record drawings, to reflect on any past and recent sewer infrastructure upgrades. To ensure that the network is representative of its expected performance, during updates, the model is calibrated based on the instrumented data. The level of discrepancy between the predicted model results and the instrumented data is used to validate the model. Upon completion of the model updates, sensitivity checks are undertaken. All changes associated with model maintenance are documented.

5.6.2 CSO Reporting Limitations

Due to the complexities associated with snowmelt, it is not currently possible to numerically model the CSO events as a result of snowmelt at the un-instrumented locations, therefore, CSO analyses of un-instrumented locations is limited to CSO overflows caused by rainfall.

The foregoing calculations of CSO volumes are estimates based on hydraulic model representation of the sewer network based on best available information. The field observed data also has limitations. The estimating process is an engineering estimating process which meets Federal guidance for appropriate estimation and includes processes for addressing assumptions to ensure continuous improvement. Model

results for the current year are based on observed rainfall data and annual results are validated based on overflow detection instrumentation installed at the 45 of the 76 CSO locations.

Annual model updates should to be completed on a regular basis. There will always be network changes or improved data that is not available at the time of the current update but will be included in subsequent updates. The current year network will be the best available representation of the City sewer system and will be constantly improving. The 2020 network is currently the best available representation of the City sewer system.

5.7 Clause 8 Compliance

To comply with the Province's July 8, 2021 request, the estimated increase in volume of CSOs caused by offsetting Clause 8 requirements for small scale developments are outlined below.

The estimated increase in volume to the combined sewer system is approximately 1 m^3 for a 5-year rainfall event for small scale development within a combined sewer area. This was determined based on the actual scenarios below, see Figure 12 to Figure 15 for the estimate increase in CSO volume for each of the development scenarios.

- From a single family dwelling (SFD) to two duplexes,
- From a SFD to two SFDs, and
- From a SFD to two SFDs with secondary suites.

SFD to 2 duplexes

Lot	"C"-value	Existing	Post Lot 2	Post Lot 1	Post Total	Increase
Total Area		557 m²	279 m²	279 m²	557 m²	
Building and Paved Area	0.9	180 m²	120 m²	140 m²	260 m²	
Gravel Area	0.5	0 m²	0 m²	0 m²	0 m²	
Pervious Area	0.1	377 m²	159 m²	139 m²	297 m²	
Weighted C-value		0.36	0.44	0.50	0.47	
Storage		21.7 m3			22.4 m3	0.7 m3
Q_{stm}		**6.1 L/s**	**3.8 L/s**	**4.3 L/s**	**8.0 L/s**	**32.07%**

Note: Q uses t_c of 10 min and intesity of 109.5 mm/hr

Note: Storage is for a 5 year event

Figure 12 – Pre and Post Development CSO Estimate Example 1 for Two Duplexes

SFD to 2 duplexes

Lot	"C"-value	Existing	Post Lot 2	Post Lot 1	Post Total	Increase
Total Area		557 m²	279 m²	279 m²	557 m²	
Building and Paved Area	0.9	130 m²	150 m²	150 m²	300 m²	
Gravel Area	0.5	0 m²	0 m²	0 m²	0 m²	
Pervious Area	0.1	427 m²	129 m²	129 m²	257 m²	
Weighted C-value		0.29	0.53	0.53	0.53	
Storage		21.3 m3			22.8 m3	1.5 m3
Q_{stm}		**4.9 L/s**	**4.5 L/s**	**4.5 L/s**	**9.0 L/s**	**85.18%**

Note: Q uses t_c of 10 min and intesity of 109.5 mm/hr

Note: Storage is for a 5 year event

Figure 13 - Pre and Post Development CSO Estimate Example 2 for Two Duplexes

SFD to 2 SFD						
Lot	**"C"-value**	**Existing**	**Post Lot 2**	**Post Lot 1**	**Post Total**	**Increase**
Total Area		474 m²	238 m²	238 m²	475 m²	
Building and Paved Area	0.9	151 m²	130 m²	130 m²	260 m²	
Gravel Area	0.5	0 m²	0 m²	0 m²		
Pervious Area	0.1	323 m²	108 m²	108 m²	215 m²	
Weighted C-value		0.35	0.54	0.54	0.54	
Storage		18.5 m3			19.5 m3	1.0 m3
Q_{stm}		**5.1 L/s**	**3.9 L/s**	**3.9 L/s**	**7.8 L/s**	**51.94%**

Note: Q uses t_c of 10 min and intensity of 109.5 mm/hr

Note: Storage is for a 5 year event

Figure 14 – Pre and Post development CSO Estimate Example for Two SFDs

SFD to 2 SFD w/ Secondary Suites						
Lot	**"C"-value**	**Existing**	**Post Lot 2**	**Post Lot 1**	**Post Total**	**Increase**
Total Area		557 m²	280 m²	280 m²	559 m²	
Building and Paved Area	0.9	200 m²	138 m²	138 m²	276 m²	
Gravel Area	0.5	0 m²	0 m²	0 m²	0 m²	
Pervious Area	0.1	357 m²	142 m²	142 m²	283 m²	
Weighted C-value		0.39	0.49	0.49	0.5	
Storage		21.9 m3			22.6 m3	0.7 m3
Q_{stm}		**6.6 L/s**	**4.2 L/s**	**4.2 L/s**	**8.4 L/s**	**28.27%**

Note: Q uses t_c of 10 min and intensity of 109.5 mm/hr

Note: Storage is for a 5 year event

Figure 15 – Pre and Post Development CSO Estimate Example for Two SFDs with Secondary Suites

Clause 8 requirements have been offset for 1,169 small scale developments in combined sewer areas in 2021. It is estimated that this results in an increase of 1,169 m^3 in CSO volume for a 5-year rainfall event.

A review of small scale developments since 2014 in combined sewer districts has been conducted and it has been determined that Clause 8 requirements have offset approximately 3,924 properties.

From 2014 to 2021, small scale developments have increased the volume to the combined sewer system by approximately 3,924 m^3 for a 5 year rainfall event.

For context, it is estimated that the sewer separation work completed up to 2020 in the Cockburn Calrossie combined sewer district has decreased the volume of land drainage to the combined sewer system by approximately 57,000 m^3 for a 5 year rainfall event.

6. Water Quality

A water quality objective of the CSO Master Plan is to reduce bacterial loadings to the Red and Assiniboine Rivers by reducing the volume of CSOs discharged. The City is working towards a plan to collect CSO water samples and model river quality data to demonstrate improvements in the river water quality as a result of implementation of Control Option No. 1, per request by the 2019 CSO Master Plan Provincial approval letter.

The water quality monitoring event mean concentration data collected in 2014 and 2015 as described in Section 3.1.7 will be used for the 2021 NPRI reporting and will be continually used until new data becomes available. The City will plan for future targeted river and stream water quality monitoring and will provide the river water quality monitoring report by December 31, 2024.

In addition to the targeted river and stream event water quality monitoring plan, the City is conducting bi-weekly river and stream water quality monitoring for the water quality pollutants of concern (POC), including nutrients, dissolved oxygen, and bacteria. In 2021, monitoring was undertaken at 11 locations along the Red and Assiniboine Rivers and at eight locations on selected small streams. The monitoring data provides an updated characterization of the health of Winnipeg's waterways. The water quality monitoring reports are published on the City of Winnipeg webpage, https://winnipeg.ca/waterandwaste/sewage/monitoring/RiversSmallStreams.stm. The water quality sampling will continue during the execution of the CSO Master Plan.

7. Climate Change

Changes to local precipitation patterns may affect the relative performance of the CSO Master Plan as an increase in duration and/or intensity of rainfall events could lead to an increase in the volume of overflows and the number of overflow events. The CSO Master Plan includes implementation strategies to address the potential impact resulted from climate change.

To provide resilience to the impacts of climate change, the CSO Master Plan incorporates the use of GI and RTC to improve the performance levels. Combined sewer separation work will be prioritized to reduce CSOs from entering rivers and GI will be used to provide the necessary additional performance improvements to mitigate any detrimental impacts from changing precipitation trends. The City has included an allowance of 10 percent of the total CSO Master Plan capital cost estimated for the GI implementation to provide climate change resiliency while meeting compliance with Clause 8 of EA No. 3042.

The City will continue to monitor and track weather patterns to asses any impact to the CSO Master Plan, including the continued use of 1992 as the representative year. The assessment of the impact of climate change on the performance of the CSO program will be provided in the 2030 CSO Master Plan update.

8. Pollution Prevention Plan

The City has a Pollution Prevention Program. Completion of a Pollution Prevention (P2) Plan is part of a comprehensive plan to protect the sewage collection and treatment system, our rivers and lakes, and the environment. This is a process that shifts the focus from municipal wastewater treatment to the control of pollutants at the source by:

- avoiding the use of pollutants wherever possible,
- reducing the amount of pollutants that reach the wastewater system, if avoiding is not possible, and
- eliminating pollutants wherever possible by replacing products with more environmentally friendly products.

In 2021, 600 active businesses were part of the Pollution Prevention Program. Businesses that are a part of the Pollution Prevention Program are required to submit a P2 Plan outlining the source of the pollutants and measures to prevent, eliminate, or reduce the discharge of those pollutions to the wastewater and/or land drainage system. The City performed inspections, collected samples, provided reviews, and approval of the P2 Plans to ensure proper measures are in place to protect the environment.

The purpose of the City of Winnipeg Sewer By-Law is to protect public safety, the environment, and the City infrastructure by setting and regulating sewage discharge limits into the sewer systems and natural water courses.

For further information, refer to the following webpages:

- Winnipeg Pollution Prevention Plan webpage:
  http://www.winnipeg.ca/waterandwaste/sewage/pollutionPrevention/default.stm
- Winnipeg Sewer By-Law webpage:
  https://winnipeg.ca/waterandwaste/sewage/projects/sewerBy-law/default.stm#tab-background

In addition to the Pollution Prevention Program, the City is continually working toward reducing the number of CSOs through:

- Data improvement
- System understanding
- Opportunistic separation
- System optimizations
- Implementing the CSO Master Plan

For further information on the Winnipeg CSO Master Plan, refer to the project development page:

https://wwdengage.winnipeg.ca/cso-mp/

9. Communications

Maintaining an open engagement with stakeholders is essential to the success of the CSO Master Plan. The City will continue to engage with public and the Provincial regulator on progress of the CSO Master Plan execution.

9.1 Public Engagement

The City maintains regular communication with the public during the execution of the CSO Master Plan and will continue as the CSO Master Plan progresses. Prior to the implementation of the sewer relief work, construction notices are issued to residents and property owners to inform them on the background and planned construction work in their neighbourhood.

All City Council and committee meetings are available for viewing on the City website to inform the public of the progress of CSO management work in the city. Agendas are published in advance of the meeting and the public is allowed to present their views as well. In 2021, the Public Service presented an update to the Standing Policy Committee on Water and Waste, Riverbend Management and the Environment, and Council on the 2020 CSO Annual Report on September 13, 2021.

The City will continually maintain an open and transparent engagement program with the public, including regular updates on the City website.

9.1.1 Public Education

The City website contains important information relating to the CSO Master Plan. The website serves as a public education tool to provide Winnipeg residents information on the Master Plan and its benefits. Animated videos and plain language descriptions illustrate and clearly describe the operation of our complex combined sewer systems. The City website also contains information about CSO relief projects and the annual CSO discharge results.

9.1.2 Public Notification System

The City introduced a public notification system called the Sewer Overflow Information System (SOIS) in 2004 to notify the public on the likelihood of overflows as a result of the recommendation from the 2003 Clean Environment Commission hearings. This system provides an indication of the likelihood of overflows into the Red and Assiniboine Rivers based on readings of high-water sensors in the sewers at various overflow locations along with the City's rivers and other monitoring indicators.

In 2013, the City was requested to develop a plan to accommodate a new, enhanced public notification system that would provide a near real-time indication of CSO notifications with overflow occurrences and duration by December 31, 2015 to comply with Clause 10 of EA No. 3042. The CSO Public Notification System Plan, describing the development and implementation plan of the enhanced public notification system, was submitted to the Province on December 15, 2015, and was later approved.

The enhanced public notification system has been in development phase between 2017 and 2021 to test for reliability and accuracy of the CSO notification predictions. It is linked with the most current hydraulic model for the City of Winnipeg CS system, along with rainfall and outfall instrumentation data at each of the 45 of the 76 combined sewer outfalls. The City plans to engage with the Province in 2022 to present the enhanced public notification system.

9.2 Regulatory Engagement

In 2021, the City had a virtual meeting with the province on May 18, 2021 to provide an overview of the 2020 CSO Annual Report. The meeting minutes are provided in Appendix I.

9.3 Other Agencies/Initiatives

Undertaking major sewer infrastructure upgrades in an interconnected sewer network is complex as changes in flow and capacity of one area of the system impacts other areas. During the execution of the CSO Master Plan, it is important to consider all ongoing initiatives. The following section describes the ongoing initiatives that are considered while delivering the CSO Master Plan. Projects related to GI can be found in Section 11.2.1 Green Infrastructure.

9.3.1 OurWinnipeg

OurWinnipeg is the City's 25-year development plan that provides a vision, goals, and policies to increase the quality of life for all residents. It guides growth and change for the City to accommodate future residential growth in a sustainable manner. To support the successful delivery of the vision, Complete Communities was developed.

The Complete Communities is a direction strategy of OurWinnipeg. It is a city-wide secondary plan that guides growth, development, and land use in Winnipeg. With the population increase, the treatment and conveyance demand are also expected to increase. There is a demand for more capacity to service future population growth. The CSO Master Plan incorporates a 35-year design horizon into the design and planning of sewer infrastructure. It uses the City's Planning and Land Use Model (PLUM) forecast data to account for future development and population growth.

10. Compliance

This section provides an overview and summary of the City's compliance with the regulatory requirements.

As discussed in Section 2, combined sewers are regulated by a number of federal and provincial requirements. The City reports on CSO discharge data to NPRI, WSER, and the Province on an annual basis to demonstrate regulatory compliance. Table 12 provides a list of required regulatory deliverables with their associated regulators, deadlines, and submission dates.

Table 12 - Regulatory Submissions

Deliverable	Regulator	Reporting Period	Deliverable Deadline	Submission Date
Federal Submission				
2021 CSO Annual Results	WSER	Jan 1 - Dec 31, 2021	15-Feb-22	11-Feb-22
2021 NPRI CSO Annual Report	Canadian Environmental Protection Act, 1999	Jan 1 - Dec 31, 2021	1-Jun-22	N/A
Provincial Submission				
2021 CSO Annual Results	EA No. 3042 Clause 14	Jan 1 - Dec 31, 2021	15-Feb-22	11-Feb-22
2021 CSO Annual Report	EA No. 3042 Clause 13	Jan 1 - Dec 31, 2021	31-Mar-22	30-Mar-22
CSO Quarterly Results	EA No. 3042 Clause 14	Every Quarter	15th of May, Aug and Nov of the reporting year	May-11, Aug-12, Nov-8 of 2021
Significant CSO Event Reporting	EA No. 3042 Clause 14	Event Dependent - Rainfall Events > 1:10 year	Within 10-days of the event	N/A

Annual CSO Result Submissions

In compliance with both WSER and Clause 14 of EA No. 3042, the City is required to submit the Federal and Provincial CSO Annual Result that consist of CSO outfall data from both the instrumented and non-instrumented locations on or before February 15 for the subsequent year. The non-instrumented locations are supplemented with hydraulic modeling data and rainfall estimations to improve confidence in results.

The 2021 CSO Annual Results were validated, completed, and submitted to both the Province and the Federal on February 11, 2022.

In addition to the Federal and Provincial CSO annual results submission, additional annual submissions include the CSO Annual Report and the NPRI CSO Annual Report, which are due on or before March 31 and June 1 of the preceding year.

Quarterly CSO Result Submissions

The Quarterly CSO Results Reports consist of event, volume, and duration estimation data based on the instrumented outfall sites. The results are not validated and are submitted 45 days after the end of the quarterly reporting period as per Clause 14 of EA No. 3042.

The three 2021 Quarterly CSO Results deliverables were completed and submitted to the Province on May 11, 2021, August 12, 2021, and November 8, 2021, in accordance with the mandated deadline.

Significant Event Report Submissions

In addition to the annual and quarterly CSO results submissions, the City is mandated to report on any significant CSO events that are greater than 1:10 year rainfall event. In 2021, there were no significant CSO events, hence none were reported.

CSO Master Plan Submissions

Additional submissions related to the CSO Master Plan development and implementation is provided in Table 13. This table provides a list of submission milestones pursuant to EA No. 3042.

Table 13 - CSO Master Plan Submission Milestone

Deliverable	Original Targeted Date	Actual Completion Date
Public Education Plan	31-Dec-13	9-Dec-13
Interim Monitoring Plan	31-Jan-14	28-Apr-14
CSO Public Notification Plan	31-Dec-15	15-Dec-15
CSO Preliminary Proposal	31-Dec-15	17-Dec-15
CSO Master Plan	31-Aug-19	28-Aug-19
River Water Quality Report	31-Dec-24	TBD
Percent Capture Assessment for Control Option No. 2	30-April-25	TBD
CSO Master Plan Update	30-April-30	TBD
CSO Master Plan Implementation	31-Dec-45	TBD

The City demonstrates compliance with EA No. 3042 and all CSO federal reporting requirements.

11. Risks and Opportunities

There are a number of risks associated with the CSO Master Plan due to the complexity of the project that need to be tracked and managed (see section 3.9 for other risks associated with the Master Plans). At the same time, there are a number of opportunities to improve and enhance the wastewater collections system.

11.1 Risks

The CSO Master Plan documents a number of program implementation risks, which can affect the budget, capital costs, feasibility, and schedule.

The DEPs comprise of individual conceptual solutions to CSO mitigation for each of the combined sewer districts. Each of the risks and opportunities applicable to the control solutions recommended within each sewer district to meet Control Option No. 1 are documented in the Part 3B – District Engineering Plans of the CSO Master Plan.

Risks are also tracked on a project by project basis. Any changes to the control solution could cascade to a reevaluation of risks associated with each of the specific projects.

11.1.1 Risks Tracking

As part of the Master Plan, initially identified risks as well as new risks that arise will need to be managed. Some significant recent risks which are being tracked and will need to be assessed with regards to their impact on the CSO Master Plan are identified below:

- The November 2019 CSO Master Plan acceptance letter issued by the Province included a requirement for water quality monitoring every 5 years. The resources and funding needed to meet this requirement were not included in the CSO Master Plan.
- In 2021, the City proposed strategic approach to remove the Clause 8 requirements for smaller developments in combined sewer areas. Any increases in CSO volume associated with these developments is to be mitigated by the CSO Master Plan improvements. The cost to offset any increase in discharges to combined sewer to ensure future control targets are met have not yet been included in the CSO Master Plan.
- Additional City resources are required to deliver the CSO Master Plan and for compliance with EA No. 3042 and associated Provincial correspondence requirements (see section 2.3).

11.2 Opportunities

A number of opportunities to improve the volume percent capture during the program were identified during the development of the CSO Master Plan. The following section describes the main areas that the City could benefit from in the coming years in the implementation phase of the program.

11.2.1 Green Infrastructure

Implementation of GI technologies in the design and operation of all new and upgraded infrastructure could promote long term sustainability in CSO volume reduction performance. A budget of 10 percent of the capital program is included in the CSO Master Plan budget for the GI implementation.

The GI pilot projects that have been undertaken to date include the North East Exchange District Engineering Study and aspects of the Cockburn Sewer Separation Project. Pre and post flow monitoring will take place to determine the suitability and performance of GI in Winnipeg's cold climate and heavy clay soils to confirm its benefits to the collections system.

North East Exchange District Engineering Study

The City undertook a pilot study using a soil retention green technology, Strata cells, for the reconstruction of John Hirsh Place in the North East exchange district. Past studies have demonstrated that Strata cells promote tree growth and reduce loading on combined sewers. To demonstrate tangible benefits from the study, the City undertook flow monitoring prior to construction and will complete the post construction flow monitoring to evaluate the environmental benefits.

11.2.2 Floatable Management

Clause 12 of EA No. 3042 requires the Master Plan to demonstrate the prevention of floatable materials in CSO effluent. As described in section 3.9.2, the CSO Master Plan includes the use of end of pipe screening to the primary CS outfall in each CS district where it was determined to be hydraulically feasible and where complete sewer separation of the district was not recommended. In addition to the traditional approach to floatables management, the Master Plan has identified an alternative approach to eliminate the floatables where the floatables will be captured at the surface runoff level before it enters the sewer system.

There are high capital costs, long-term O&M costs, and other risks associated with screen facilities. This alternative floatable management approach will undergo a trial to determine its feasibility as an opportunity for addressing the floatable management requirements at a lower life cycle cost compared to screen facilities currently being recommended. The assessment of the alternative floatables management approach will lead to a better understanding of system floatables and determine the most efficient long term approach to managing floatables. An allowance has been included in the cost estimates to pilot this alternative floatables management approach.

11.2.3 Real Time Control

The incorporation of RTC and monitoring instrumentation will provide an increased understanding of operation and a better control on a real time basis, and the optimization of flows in the system and to the treatment plants. This will also provide opportunities to enhance the public notification system. A feasibility study of the requirements for RTC incorporation is anticipated to take place in the coming years as per the CSO Master Plan's schedule.

12. Record Keeping and Documentation

In compliance with Clause 16 of EA No.3042, the City will comply with sampling record requirements, requirements for summaries of laboratory analytical results of grab samples and CSO event and location records. The City will make records available to an Environment Officer upon request and, within three months of the end of each year (or earlier as directed with regards to the CSO Annual results), the City will post the results on the public webpage as required by Clause 10 of the Licence.

In compliance with subsection 46(8) of The Canadian Environmental Protection Act, City of Winnipeg Water and Waste will retain copies of all information on which reports are based, including any calculations, measurements, and other related data, for a minimum period of three years. This information will currently be kept at City of Winnipeg Water and Waste offices 1199 Pacific Avenue.

13. Next Steps

The next steps are to implement the control technologies recommended as per the CSO Master Plan.

The 2022 planned capital construction projects, preliminary design, and other planned work are provided in Table 9. A summary of the 2022 planned capital projects includes:

- Planning and design of control technologies in Armstrong, Jefferson East, Ferry Road, and Hawthorne districts,
- Construction in Jefferson East and Hawthorne McCleod Creek,
- Review of feasibility on RTC systems in the collections system, and
- Execution of the Rainfall Monitoring Program

The City will continue to explore opportunities to further promote CSO volume reduction, and maintain regular communication with regulatory bodies and the public on the progress of the CSO Master Plan performance.

14. References

CH2M HILL Canada Ltd, XCG Consultants Ltd, Dillon Consulting. 2015. *CSO Master Plan Preliminary Report.* Prepared for: City of Winnipeg, Water and Waste Department. Winnipeg, Manitoba. December 2015.

City of Winnipeg. 2021. *2020 CSO Annual Results Report*. City of Winnipeg. Water and Water Department. February 11, 2021.

Jacobs Engineering Group. 2019. *CSO Master Plan.* Prepared for: City of Winnipeg, Water and Waste Department. Winnipeg, Manitoba. August 2019.

Manitoba Conservation and Water Stewardship (MCWS). 2013. *Environment Act Licence No. 3042.* Client File No.: 3205.00. September 4, 2013.

Wardrop Engineering Inc. (Wardrop), TetrES Consultants Inc., CH2M Hill Canada and EM Services Inc. 2002. *Combined Sewer Overflow Management Study* (2002 CSO Study). Final Report. Prepared for: City of Winnipeg, Water and Waste Department. November 2002.

Appendix A – Manitoba Conservation and Climate - Environmental Licence No. 3042

Appendix B – 2020 CSO Master Plan Provincial Approval Letter

Appendix C – Clause 8 Provincial Approval Letters

Appendix D – District Program Scenario 1 Implementation Schedule

Appendix E - CSO Master Plan Program Scenario 1 Tracked Against Actual Implementation Schedule 3 Year Window

CSO Master Plan (MP) and Actual Implementation Schedule					
		Current Year	Forecasted Schedule		
District	Schedule Type	2021	2022	2023	2024
Ferry Road	MP				
	Actual				
Jefferson East	MP				
	Actual				
Jessie	MP				
	Actual				
Riverbend	MP				
	Actual				
Cockburn	MP				
	Actual				
	Construction implementation to be underway as per CSO Master Plan				
	Actual status as per 2021 Year End Evaluation				

Appendix F - District Plans Design Status

	Completion Progress			
CS Districts	Conceptual Design	Preliminary Design	Detailed Design	Construction
Woodhaven				
Strathmillan				
Moorgate				
Douglas Park				
Ferry Road				
Tuxedo				
Doncaster				
Parkside				
Riverbend				
Tylehurst				
Clifton				
Ash				
Aubrey				
Cornish				
Colony				
River				
Assiniboine				
Cockburn				
Baltimore				
Metcalfe				
Mager				
Jessie				
Marion				
Despins				
Dumoulin				
La Verendrye				
Bannatyne				
Alexander				
Mission				
Roland				
Syndicate				
Selkirk				
Hart				
St John's				
Polson				
Munroe				
Jefferson E				
Jefferson W				
Linden				
Newton				
Armstrong				
Hawthorne				
	Represents progress as of December 31, 2021			

Appendix G – 2021 Ongoing / Completed Capital Projects

2021 Ongoing / Completed Capital Projects

Project Name	District	Contract #	Project Type	Description	Class of Estimate	Baseline Budget	Committed Cost	Targeted Completion Date	Actual Completion Date	Volume Reduction (m3)	Comments
NEWPCC											
Ferry Road / Riverbend - Consultant Assignment 4	Ferry Road / Riverbend	439-2010	Sewer Separation	Phase 4 Works include preliminary design, geotechnical investigation and public engagement, for construction Contract #6. It also includes detailed design and contract administration for Contracts #7A, 7B and 7C as part of the Ferry Road and Riverbend Combined Sewer Relief Works.	Class 3	$1,700,000	$2,000,000	2020	TBD	N/A	Delay caused by constraints related to outfall construction and river levels
Ferry Road / Riverbend - Construction Contract 7A	Ferry Road / Riverbend	840-2019	Sewer Separation	Construction of new land drainage sewers on Assiniboine Avenue from Riveroaks Drive to Ferry Road, and construction of a land drainage sewer on Collegiate Street from Portage Avenue to Assiniboine Avenue.	Class 3	$3,000,000	$2,700,000	2020	2020	10,900	Complete
Ferry Road / Riverbend - Construction Contract 7B	Ferry Road / Riverbend	386-2020	Sewer Separation	Construction of new land drainage sewers along Roseberry Street, Parkview Street and Riveroaks Drive from Portage Avenue to Assiniboine Avenue by a trenchless tunnel method to minimize above ground disruption and impact to local residents and the public at large.	Class 3	$2,000,000	$1,900,000	2020	2020	17,300	Complete
Ferry Road / Riverbend - Construction Contract 7C	Ferry Road / Riverbend	572-2020	Sewer Separation	Construction of land drainage sewer on Ferry Road from Portage Avenue to Assiniboine Avenue and construction of Outfall at Bourkevalle Park.	Class 3	$2,000,000	$2,000,000	2021	2021	15,500	Complete
Jefferson East - Consultant Assignment 2	Jefferson East	440-2010	Sewer Separation	Professional Consulting Services for Detailed Design and Contract Administrator construction Contract #5 for the Jefferson East Combined Sewer District.	Class 3	$2,500,000	$2,600,000	2021	2021	N/A	Complete

Project Name	District	Contract #	Project Type	Description	Class of Estimate	Baseline Budget	Committed Cost	Targeted Completion Date	Actual Completion Date	Volume Reduction (m3)	Comments
Jefferson East - Consultant Assignment 3	Jefferson East	440-2010	Sewer Separation	Professional Consulting Services for Detailed Design and Contract Administrator construction Contracts #6 to #10 for the Jefferson East Combined Sewer District.	Class 3	$2,500,000	$3,500,000	2024	TBD	N/A	Ongoing - the cost estimate cost was updated to reflect on scope changes related to increase in construction and deferred project schedules.
Jefferson East - Construction Contract 5	Jefferson East	1045-2019B	Sewer Separation	Construction of a new land drainage system trunk along Semple Avenue from Scotia Street to the McKenzie Street by a trenchless tunnel method to minimize above ground disruption and impact to local residents and the public at large.	Class 3	$23,000,000	$17,500,000	2021	2021	14,342	Complete
Armstrong - Consultant Assignment 1	Armstrong	943-2020	Sewer Separation	Professional Consulting Services for Armstrong Combined Sewer District Preliminary Design	Class 3	$3,000,000	$1,500,000	2023	TBD	N/A	Ongoing
SEWPCC											
Cockburn / Calrossie - Consultant Assignment 4	Cockburn / Calrossie	441-2010	Sewer Separation	Development of alternative conceptual design separation services for Professional Consulting Services Detailed Design and Contract Administration Services Cockburn and Calrossie Combined Sewer Relief Works	Class 3	$1,000,000	$1,000,000	2022	TBD	N/A	Ongoing
Cockburn / Calrossie - Construction Contract 6A	Cockburn / Calrossie	211-2020	Sewer Separation	New land drainage sewers will be installed in the area between Carter Avenue, Pembina Highway and Stafford Street. The sewers will	Class 3	$6,000,000	$4,800,000	2021	2021	6,504	Complete

Project Name	District	Contract #	Project Type	Description	Class of Estimate	Baseline Budget	Committed Cost	Targeted Completion Date	Actual Completion Date	Volume Reduction (m3)	Comments
				be installed using a trenchless tunnel method to minimize above ground disruption and impact to local residents and the public at large.							
Cockburn / Calrossie - Construction Contract 6B	Cockburn / Calrossie	212-2020	Sewer Separation	Sewer separation and new land drainage system will be installed at Carter and Weatherdon Aves between Stafford Street and Pembina Highway, Wentworth Street, Lilac Street and Arbuthnot Street	Class 3	$9,000,000	$5,300,000	2022	TBD	4,385	Ongoing
Cockburn / Calrossie - Construction Contract 7	Cockburn / Calrossie	537-2021	Sewer Separation	Sewer separation and new land drainage system will be installed at Harrow Street, Grant Avenue, Weatherdon Avenue, Carter Avenue, Hector Avenue, Ebby Avenue, Harrow Street E, and Sparling Avenue	Class 3	$8,500,000	$6,900,000	2022	TBD	9,813	C7 and C10B are now combined into one contract
Cockburn / Calrossie - Construction Contract 10A	Cockburn / Calrossie	166-2020	Sewer Separation	New land drainage sewers will be installed along Stafford Street from Carter Avenue to Pembina Highway. The sewers will be installed using a trenchless tunnel method to minimize above ground disruption and impact to local residents and the public at large.	Class 3	$2,500,000	$1,500,000	2021	2021	1,901	Complete
Overall System											
Flow Monitoring Program Instrumentation Supply	N/A	817-2019	Flow Monitoring Program	Supply and delivery of wireless portable area velocity sewer flow meters	N/A	$250,000	$240,000	2021	2021	N/A	Complete
Flow Monitoring Program Instrumentation Supply	N/A	817-2019 Ext 1	Flow Monitoring Program	Supply and delivery of wireless portable area velocity sewer flow meters from Aug 2021 to 2023	N/A	$80,000	$76,000	2023	TBD	N/A	Ongoing
Rainfall Monitoring Program - Web Based Data Management and Analysis Service	N/A	87-2017 Ext 3	Rainfall Monitoring Program	Web based data management and analysis service for rainfall monitoring network from May 2020 to 2021	N/A	$20,000	$14,000	2021	2021	N/A	Complete
Rainfall Monitoring Program - Supply, Installation and Operation	N/A	86-2017 Ext 3	Rainfall Monitoring Program	Installation, operation and maintenance of rain gauge equipment for Rainfall Monitoring Program from April 2020 to 2021	N/A	$70,000	$67,000	2021	2021	N/A	Complete
Rainfall Monitoring Program - Web Based Data Management and Analysis Service	N/A	87-2017 Ext 4	Rainfall Monitoring Program	Web based data management and analysis service for rainfall monitoring network from May 2021 to May 2021 to 2022	N/A	$20,000	$14,000	2022	TBD	N/A	Ongoing
Rainfall Monitoring Program - Supply, Installation and Operation	N/A	86-2017 Ext 4	Rainfall Monitoring Program	Installation, operation and maintenance of rain gauge equipment for Rainfall Monitoring Program from April 2021 to 2022	N/A	$70,000	$67,000	2022	TBD	N/A	Ongoing

Unvalidated

Project Name	District	Contract #	Project Type	Description	Class of Estimate	Baseline Budget	Committed Cost	Targeted Completion Date	Actual Completion Date	Volume Reduction (m3)	Comments
	Committed costs are subject to change as projects progress										
Note: All costs are rounded to the nearest relevant whole number											

Note: This above table includes the list of projects that were either in progress or completed in the year of 2021. The list of historic projects is referenced in the past CSO Annual Reports.

Appendix H - 2022 Planned Capital Projects

2022 Planned Capital Projects

Project Name	District	Project Type	Class of Estimate	Forecasted Budget	Volume Reduction (m3)
NEWPCC					
Ferry Road / Riverbend Consulting Assignment 5	Ferry Road / Riverbend	Sewer Separation	Class 3	2,500,000	N/A
Jefferson East Construction Contract 6A - Main St *Kingsbury Ave to Jefferson Ave*	Jefferson East	Sewer Separation	Class 3	$3,000,000	32,385
Jefferson East Construction Contract 6B - *Burrin Ave, Belmont Ave, Hartford Ave, Perth Ave – (Salter to Main St)* *Aikens St – (Burrin Ave to Hartford Ave)*	Jefferson East	Sewer Separation	Class 3	$3,000,000	
Jefferson East Construction Contract 7 *Salter St (Royal Ave to St Anthony Ave)* *Royal Ave, Kingsbury Ave, Burrin Ave, Kilbrige Ave,* *Belmont Ave, Hartford Ave, Perth Ave, St Anthony Ave (Powers St to Aikens St)*	Jefferson East	Sewer Separation	Class 3	$7,000,000	27,758
Hawthorne - Consultant Assignment 1	Hawthorne	Basement Flood Relief	Class 3	$1,000,000	N/A
Hawthorne - Construction Contract - phasing of work TBD	Hawthorne	Basement Flood Relief	Class 3	$4,000,000	TBD
SEWPCC					
Cockburn / Calrossie Consultant Assignment 5 / Over Expenditure	Cockburn / Calrossie	Sewer Separation	Class 3	$2,100,000	N/A
Overall System					
Rainfall Monitoring Program – Operation and Maintenance	N/A	Rainfall Monitoring Program	Class 3	$130,000	N/A
Real Time Control Consultant Assignment – Feasibility Study	N/A	Consulting Services	Class 3	$3,000,000	N/A
Note: The status of the planned contracts is subject to change pending on available budget and resource.					
	Unvalidated values				

Appendix I – 2021 Record of Meeting Minutes