Appendix H1

EPCOR WATER SERVICES INC.

List of Drainage Programs and Projects in the 2022-2024 PBR

February 16, 2021

	Program	A Regulatory Category	B 2022-2024 PBR Plan
	Drainage Neighbourhood Renewal		
1	Neighbourhood Renewal Program	Growth / Customer	76.5
2	**Sub-total: Drainage Neighbourhood Renewal**		**76.5**
	Drainage System Expansion		
3	Private Development Construction Coordination Program	Growth / Customer	11.3
4	Yellowhead Trail Freeway	Growth / Customer	9.2
5	Operations Equipment Progam	Growth / Customer	4.5
6	Drainage Facility Upgrades Program	Reliability or Life Cycle	2.3
7	Business Systems Upgrades Program	Reliability or Life Cycle	2.2
8	IT Hardware Program	Reliability or Life Cycle	2.0
9	Servicing for Downtown Intensification (105 Ave)	Growth / Customer	1.3
10	Transportation Construction Coordination Program	Growth / Customer	1.3
11	Construction Equipment Program	Reliability or Life Cycle	1.1
12	Microstation Upgrade/Replacement	Reliability or Life Cycle	1.0
13	Mobile Applications	Reliability or Life Cycle	1.0
14	AssetWise(Ivara) Upgrade	Reliability or Life Cycle	0.6
15	Office Furniture and Equipment Program	Reliability or Life Cycle	0.6
16	Safety Program	Regulatory and HSE	0.3
17	ProjectWise Upgrade	Reliability or Life Cycle	0.1
18	Service Connections Program	Growth / Customer	-
19	**Sub-total: Drainage System Expansion**		**38.8**
	Drainage System Rehabilitation		
20	High Priority Replacement Program	Reliability or Life Cycle	52.1
21	Small Trunk Rehabiliation Program	Reliability or Life Cycle	18.8
22	Pump Station Rehabilitation Program	Reliability or Life Cycle	15.5
23	Fleet and Vehicles Program	Reliability or Life Cycle	13.2
24	Drill Drop Manholes Program	Reliability or Life Cycle	13.1
25	Proactive Service Renewal Program	Reliability or Life Cycle	10.3
26	Manhole Catch Basin Replacement Program	Reliability or Life Cycle	8.7
27	Arterial Roadway Coordination Program	Reliability or Life Cycle	8.7
28	Outfall Rehabilitation Program	Reliability or Life Cycle	8.2
29	New Buena Vista Pump Station Rehabiliation	Reliability or Life Cycle	7.4
30	Electrical Upgrades - Pump Stations Program	Reliability or Life Cycle	2.6
31	Local Sewer Rehabilitation Program	Reliability or Life Cycle	5.4
32	Mechanical Upgrades Pump Stations Program	Reliability or Life Cycle	1.6
33	SCADA Upgrading	Reliability or Life Cycle	0.4
34	**Sub-total: Drainage System Rehabilitation**		**166.0**
	LRT		
35	LRT Relocates Program	Growth / Customer	48.5
36	**Sub-total: LRT**		**48.5**
	SSSF		
37	Sanitary Servicing Strategy Fund Contribution	Growth / Customer	4.5
38	**Sub-total: SSSF**		**4.5**

	Program	A Regulatory Category	B 2022-2024 PBR Plan
	Flood Mitigation		
39	Dry Pond Program - Malcolm Tweddle	Growth / Customer	32.7
40	Rideau Park Empire Park	Growth / Customer	1.1
41	Tweddle Place	Growth / Customer	0.3
42	**Sub-total: Flood Mitigation**		**34.1**
	SIRP		
43	SIRP Dry Pond Program	Growth / Customer	60.4
44	SIRP LID Program	Growth / Customer	53.1
45	SIRP Proactive Pipe Relining Program	Reliability or Life Cycle	22.9
46	SIRP Proactive Manhole Relining Program	Reliability or Life Cycle	18.7
47	SIRP Outfall Gates Program	Growth / Customer	9.6
48	SIRP Emergency Response Equipment Program	Growth / Customer	7.4
49	SIRP Home Flood Proofing Program	Growth / Customer	7.2
50	SIRP Monitoring Program	Efficiency, profit, or	6.5
51	SIRP Imagine Jasper Ave Streetscape	Growth / Customer	4.8
52	SIRP Kinnaird Sewer Separation	Regulatory and HSE	4.1
53	SIRP Storm Water Management Facilities (SWMF) Safety Review	Regulatory and HSE	3.3
54	SIRP Environmental Enhancement Program	Growth / Customer	1.7
55	SIRP Overland Drainage Program	Growth / Customer	1.7
56	SIRP Ermineskin/Steinhauer	Growth / Customer	1.5
57	SIRP Environmental Monitoring Program	Regulatory and HSE	1.3
58	SIRP LID Site and Training Facility	Growth / Customer	0.7
59	SIRP Total Load Reduction Program	Regulatory and HSE	0.5
60	SIRP Automate Multi-Residential Storm Water Entries	Efficiency, profit, or	0.2
61	**Sub-total: SIRP**		**205.6**
	CORE		
62	CORe Large Trunk Rehabilitation Program	Reliability or Life Cycle	79.0
63	CORe Duggan Tunnel Project	Regulatory and HSE	56.3
64	CORe Drop Structure Modification Program	Growth / Customer	22.0
65	CORe Access Manhole Program	Growth / Customer	17.9
66	CORE Pump Station Enhancements Program	Regulatory and HSE	2.7
67	CORE Ventilation Control Program	Growth / Customer	2.2
68	CORe Odour Monitoring Program	Regulatory and HSE	0.3
69	**Sub-total: CORE**		**180.4**
70	**Grand Total**		**754.4**

Appendix H2

EPCOR WATER SERVICES INC.

Drainage Services
CORe Access Manhole Program
Business Case

February 16, 2021

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1.0 OVERVIEW

1. The CORe Access Manhole Program was initiated in 2019 as a critical component of EWSI's Corrosion and Odour Reduction Strategy (CORe) to understand, mitigate and prevent sewer odour issues. The CORe Access Manhole program will include construction of access manholes throughout 80 km of major trunk lines which require safe access for inspections and cleaning. Safe access for inspections and cleaning is critical to identify sources of hydrogen sulfide, concrete corrosion, and sags or deposits of sediment/fat that require cleaning. The CORe Access Manhole Program targets trunk lines with poor existing access availability, where odour causing sediment accumulations are expected and where there is a risk of moderate to severe deterioration of the sewer structure from hydrogen sulfide corrosion.

2. The continuation of the CORe Access Manhole Program is critical for providing safe access to the sanitary system to support EWSI's CORe Strategy. Without safe access to the sanitary system, EWSI cannot inspect or remediate areas where there is an accumulation of odour causing sediments. The odours can impact quality of life for nearby residents and lead to reduced asset service life or unexpected asset failures because the accumulation of hydrogen sulphide causes concrete corrosion. Premature asset failure can result in significant customer service disruptions and will require costly emergency repairs.

3. Without appropriate access there is also a very real risk to human life during human entry inspection, financial and customer service risks for repairs and by-passes and risk to equipment operation due to long distance between access points. Human entry into sewers is often needed to carry out or support inspections, cleaning and repairs. Long stretches of trunk without access reduces communication capacity and complicates rescues by forcing operators to work further away from escape points. Because the risk of a fatality is real and conceivable in such an environment, entry requirements for operators remains very strict. It is only by improving the safety of the existing infrastructure that human entry availability can be extended.

4. The long distance between access points will also make any rehabilitation work difficult. Without sufficient access, inspections may not be feasible and structural deficiencies are only detected when they become major failure events. Additionally, a lack of access requires larger sewerage by-passes in order to complete rehabilitation work on the trunk lines. Bypassing sewage flow over long distances is very complex and can create lots of disturbance to the surrounding area. More access manholes will reduce the size of these bypasses.

5. While the technology supporting robotic sewer inspections has improved dramatically, losing a robot in the sewers is still a very real risk in sewers with limited access and has happened as recently as 2020. Poor access reduces tether control, increases the risk of snares, particularly at bends and the mass of the tether line begins to affect maneuverability at longer deployment lengths. The loss of a robotic inspection platform in a sewer is costly due to the loss of highly specialized equipment but more concerning is the potential for the platform to create a debris pile that blocks or damages the sewer. Access manholes are needed to support robotic deployment, retrieval and tether control.

6. The CORe Access Manhole Program is a new program which was initiated in 2019 as a key CORe deliverable. To date, 6 access manholes have been completed and a further 13 access manhole projects have been initiated and are proceeding towards or undergoing construction at an estimated capital cost of $13.7 million. The scope of this program for the 2022-2024 PBR term is to construct a total of 24 additional access locations on major trunk lines. This program is categorized as an environmental quality enhancement program. EWSI has forecast total program capital expenditures during 2022-2024 at $17.9 million.

2.0 BACKGROUND AND JUSTIFICATION

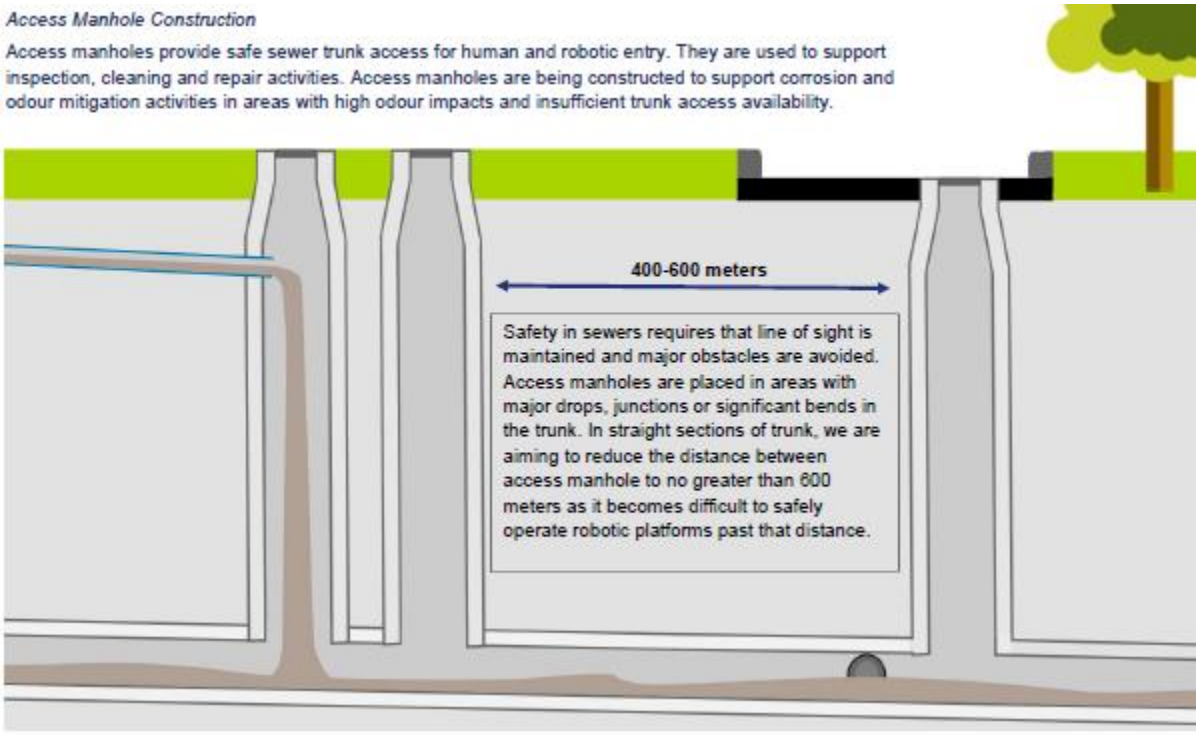
7. EWSI initiated the Corrosion and Odour Reduction (CORe) Strategy in 2019 to understand, mitigate and prevent sewer odour issues across the city of Edmonton using a combination of capital and operational interventions. The CORe Strategy focuses on preventing the formation of H_2S gas, which will reduce community odour impacts and lengthen the life of sewer network assets. Under CORe, EWSI segregates the City into regions with consistent odour issues, those with dynamic odour issues, and those with emerging odour issues. Different approaches have been proposed for each region to ensure that causes of the odour are fully understood and to ensure that capital projects will provide sustainable relief. The capital projects and operating activities in CORe can be classified into four themes of investment: PREVENT, OPTIMIZE, MONITOR and CONTROL.

8. The Access Manhole Program is a critical component of the CORe Strategy under the PREVENT theme. The Access Manhole Program is an annual program that initiates projects to construct access manholes in major trunk lines. The access manholes are used to mitigate health and safety risks, financial risks, environmental risks and risks of customer service disruptions by providing safe access for inspections and cleaning.

9. There are approximately 170 km of sanitary and combined large trunk sewers (1,200 mm diameter and larger) constructed over the past 100 years to varying standards and specifications. Approximately 80 km of the large trunk lines in the City of Edmonton have insufficient access provisions to safely permit either manned or robotic inspections. Safe access for inspections is critical to identify sources of hydrogen sulfide, concrete corrosion, structural failures, and whether the line contains sags or deposits of sediment/fat that requires cleaning. EWSI estimates that fully addressing access needs across Edmonton's combined and sanitary trunk system could require as many as 150 new access manholes. The CORe Access Manhole Program is prioritizing the construction of 24 new access manholes at trunk lines with poor existing access availability, where odour causing sediment accumulations are expected and where there is a risk of moderate to severe deterioration of the sewer structure from hydrogen sulfide corrosion. This program is a critical pre-requisite for completing trunk line inspections and sediment cleaning projects planned under CORe by providing access along trunk lines where there is currently no viable and safe methods of entry either for human or robotic platforms. Additional benefits include the use of the new access for asset management inspections and for future rehabilitation efforts.

10. Figure 2.0-1 shows a graphical image of access manholes, which provide safe sewer trunk access for human and robotic entry and support inspection, cleaning and repairs.

Figure 2.0-1
Access Manhole Construction



11. The CORe Access Manhole Program was initiated in 2019 as a key CORe deliverable. Since 2019, 6 access manholes have been completed and a further 8 access manhole projects have been initiated and are proceeding towards or undergoing construction. The Access Manhole Program has currently enabled the inspection of 400 meters of trunk line in Empire Park and has assisted the completion of 1,000 meters of trunk inspection in Brookside. Trunk cleaning is planned for these locations especially when there are debris in the trunk line.

12. The new access manholes constructed under the CORe program have also been beneficial for trunk rehabilitation and emergency repair activities. The construction of two access manholes in Empire Park not only allowed inspectors to identify structural failures in the connected trunk line prior to trunk line collapse, but are also being used to support the on-going rehabilitation and repair activities. Two access manholes recently completed in Brookside under the CORe program are being used to support emergency repairs to the Whitemud Creek trestle by providing safe access points to the trunk line immediately upstream of the trestle bridge.

13. Significant synergies are expected across EWSI's Drainage Services from the CORe Access Manhole Program beyond the benefits of odour mitigation. Additional access manholes in strategic locations will not only be used to address requirements of EWSI's CORe Strategy, but

can also be used to support inspections and rehabilitation planning activities. EWSI will consider planned inspection and rehabilitation program requirements when selecting locations and timing for each access manhole project in order to maximize potential synergies wherever possible. Some examples of planned synergies for 2021 include:

- Using 4 access manholes in Meadowlark and Jasper Park to support the inspection of the 87th Avenue, 1,200 mm diameter trunk line which is needed prior to Edmonton Valley Line West LRT Expansion.
- Assisting with the re-inspection and repair of multiple non-emergency structural deficiencies on a 1,200 mm diameter trunk line near Jasper Park.
- Supporting rehabilitation planning in Mill Creek by providing access to the 1,500 mm diameter 88th Street trunk line.
- Supporting rehabilitation planning and sewer separation activities for the 1,650 mm double barrel trunk line in Oliver on 116th Street by providing access near its discharge location on 108th Avenue.

14. The continuation of the CORe Access Manhole Program is critical for managing several identified risk factors including the potential for health and safety, financial and customer service disruptions. Without access to the sanitary system, the accumulation of odour causing sediments cannot be safely identified through inspection or remediated using cleaning technologies due to unsafe access. To safely access the major trunk lines, technicians and robotic inspectors require manholes that provide direct line of sight to the trunk, at distance intervals approaching 600 meters and which allow for the safe navigation around major bends, weirs and drops. The CORe Access Manhole Program is designed to provide those conditions at trunks with known odour issues across the city. The odours can impact quality of life for nearby residents and lead to reduced asset service life or unexpected asset failures by causing concrete corrosion. The premature aging of the sewer assets can result in customer service disruptions and require costly emergency repairs. Without appropriate access there is a very real risk of injury and damage/loss of inspection platforms in the sewers.

3.0 PROGRAM DESCRIPTION

15. The scope of the CORe Access Manhole Program includes construction of twenty-four new access manholes across the City of Edmonton in 2022, 2023 and 2024, with 10 completed in 2022 and 7 scheduled for 2023 and 7 scheduled for 2024.

16. The scope of the project is to install access manholes along major trunk lines with poor existing access and are expected to be contributing to downstream sewer odour problems due to excessive sedimentation and debris accumulation. Candidate locations are chosen which satisfy the following criteria:

- The sewer asset has been determined to not having sufficient access for inspections to be completed in a safe manner.
- The asset is a sanitary or combined sewer trunk line of a diameter greater than 650 mm.
- Downstream hydrogen sulfide concentrations exceed an average of 2 ppm over 24 hours or reach a peak concentration above 10 ppm at least once a day or are suspected of reaching such concentrations if access is not available for monitoring. Note that 10 ppm indicates that 0.001% of the sewer air volume is hydrogen sulfide.

17. In addition to the above criteria, the location choice will consider safety of access during construction, ground conditions, potential impacts to traffic and possible conflicts with nearby buried utilities. Additionally, sections of trunk lines with sharp bends, drill drops or flat to negative slopes are given precedence when assigning access manhole locations as the presence of those specific asset features drastically increase access difficulty and are high risk areas for asset deterioration and odour nuisance.

18. Under CORe, the current selection and prioritization process for access manhole construction is driven primarily through public odour reporting and system wide sewer behaviour analysis with additional consideration provided to on-going asset management needs in order to complement rehabilitation and replacement programs.

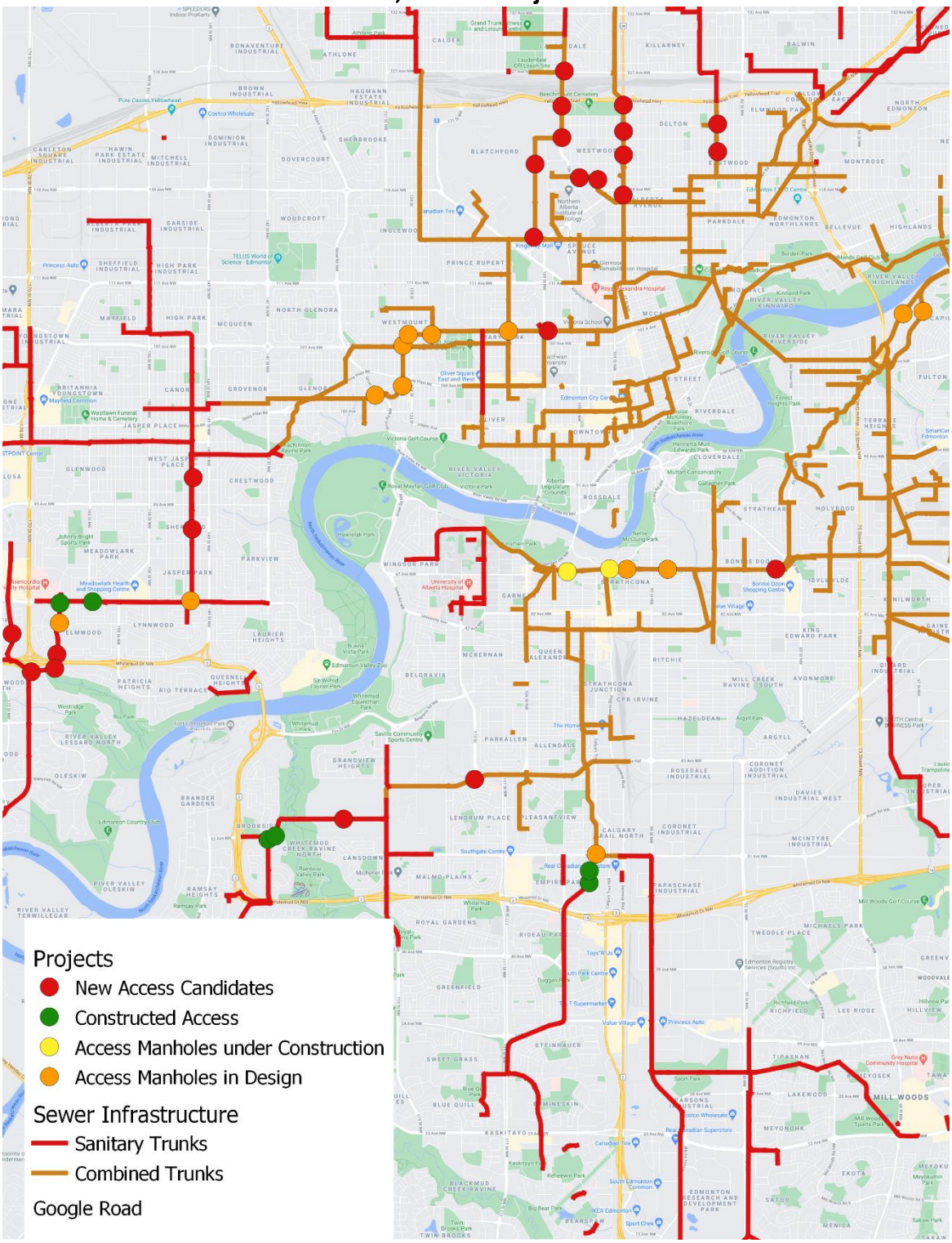
19. While the program has a goal to construct a total of 24 additional access locations during the 2022-2024 PBR term, the timing and location of candidates for access manhole may change as understanding develops but such changes will be subject to the selection criteria. Factors that alter candidate viability include surface access limitations, conflicting construction schedules (LRT, neighborhood renewal) and the presence of nearby buried utilities.

20. Maintenance and repair of the trunk line beyond the tie in location, abandonment of other assets and inspection/cleaning are outside the scope of this program and will be managed and prioritized through appropriate asset programs such as the Large Trunk Rehabilitation Program. Preliminary locations for 20 access manholes have been identified and are shown in the Figure 3.0-1 below. The locations for the remaining 4 access manholes has not been finalized

as we re-evaluate access needs along several major trunks in Capilano, Oliver, Downtown, 151st Street near West Jasper and 61st Avenue near Pleasantview. The final selection is striving to have manholes placed in locations that are beneficial for both odour control and future rehabilitation needs in order to maximize the value of each manhole.

21. The tentative locations of the access manhole projects are identified by the blue circles in Figure 3.0-1 below. The yellow, orange and green circles identify locations that have been or are being completed by 2021.

Figure 3.0-1
Access Manhole Locations, Current Projects and Future Candidates



22. Based on past projects, engineering is expected to take between 2 to 3 months while construction also takes approximately 2 to 3 months. Construction scheduling proceeds based on the utilization of EWSI's construction crews and allowable road detours.

23. Table 3.0-1 provides a schedule for this program over the 2022-2024 PBR term.

Table 3.0-1
CORe Access Manhole Program Schedule
(2022-2024)

Project Phases	A **2021 Q4**	B **2022 Q1**	C **2022 Q2**	D **2022 Q3**	E **2022 Q4**	F **2023 Q1**	G **2023 Q2**	H **2023 Q3**	I **2023 Q4**	J **2024 Q1**	K **2024 Q2**	L **2024 Q3**	M **2024 Q4**
1 Initiation and Approvals	α			β				μ					
2 CCTV & Design	α	α	α	α	β	β	β	β	μ	μ	μ	μ	
3 Procurement		α	α	α	α	β	β	β	β	μ	μ	μ	
4 Construction		α	α	α	α	β	β	β	β	μ	μ	μ	μ
5 Commissioning			α	α	α	β	β	β	β	μ	μ	μ	μ
6 Close-out			α	α	α	β	β	β	β	μ	μ	μ	μ

α: Projects initiated for 2022.
β: Projects initiated for 2023.
μ: Projects initiated for 2024.

4.0 ALTERNATIVES ANALYSIS

24. Current inspection and trunk cleaning technologies cannot effectively address the existing sewer system where long stretches of trunk sewer exist without proper access. Therefore, there are no viable "structural" alternatives for access manholes. Alternative options are limited to:

- No Action (status quo).
- Alternative project locations.
- Project deferral.

25. From the perspective of the overall program, maintaining status quo does not meet the program objectives and is not an acceptable alternative because of the inherent risks that inaccessibility poses to the existing system. The limited access conditions across the city prohibit safe inspection and cleaning activities and severely limits our understanding of the state of the sanitary sewer network. Because of the limited access proper planning to address sewer odour and corrosion issues is difficult especially in areas without easily identifiable point sources for odour, such as pump stations. For example, in communities such as Bonnie Doon, the limited access has made it difficult to identify all of the sources of odour affecting the area. Providing reliable, safe and regular access is a critical requirement for managing our existing system.

5.0 COST FORECAST

26. Costs are estimated based on the reported costing for the most recently completed access manhole projects in 2019 and 2020. Costing is not expected to vary significantly between projects and is mostly determined by shaft depth which is expected to be between 25 to 30 meters for most projects and is not expected to exceed 35 meters.

27. The following assumptions were made to forecast capital expenditures for the CORe Access Manhole Program for the 2022-2024 PBR term:

- 24 access manholes will be constructed with costs per manhole at $0.76 million based on historical costs estimates;
- Construction shaft depths are between 25 to 35 meters;
- Sufficient space is available for construction equipment;
- The roads have moderate to heavy traffic requiring active traffic control provisions;
- The target trunk line requires only standard structural strengthening to support the access manhole; and
- Geotechnical investigations will be completed by external resources.

28. In the CORe strategy that EWSI presented to the City in 2019, access manhole projects were estimated to have a project cost of approximately $1.8 million each. However, due to efficiencies realized by utilizing internal resources, actual project costs have been much lower. For constructing sewer shafts to similar depths as the candidate locations in the 2022-2024 access manhole program, the anticipated cost per location is approximately $0.8 million each. The yearly budgeted forecast has been decreased to reflect the lower costs realized by pivoting from external construction.

29. In 2019, two access manholes were completed at a per manhole cost of approximately $660,000 per manhole. The 2020-2021 access manhole construction program is still on-going and does not have a finalized project cost but was also used to guide the cost estimate for this PBR. During 2020 and 2021, the cost per manhole constructed have ranged from between $600,000 to $850,000, largely depending on shaft depth but also depending on the site conditions (road disturbances, tree interactions, condition of the trunk line).

30. The costing forecasting for access manhole is further reduced from costing presented in the 2019 CORe Strategy by having a lower project contingency of approximately $10,000 per manhole and having reducing external expenses by approximately $5,000 per manhole. The

reductions to contingency and external expenditures are based on experience and feedback from the past and on-going projects.

31. Table 5.0-1 provides the capital expenditure forecast for this program for the 2022-2024 PBR term.

Table 5.0-1
CORe Access Manhole Program
Capital Expenditure Forecast
(2022-2024)
($ millions)

		A **2022**	B **2023**	C **2024**	D **Total**
	Direct Costs:				
1	Contractors	1.79	1.40	1.77	4.96
2	Internal Labour	3.24	2.34	3.23	8.81
3	Vehicles and Equipment	0.58	0.38	0.53	1.48
4	Contingency	0.00	0.46	0.62	1.08
5	**Sub-total Direct Costs**	**5.61**	**4.59**	**6.14**	**16.34**
6	Capital Overhead and AFUDC	0.56	0.41	0.56	1.53
7	**Total Capital Expenditures**	**6.17**	**4.99**	**6.70**	**17.87**

32. EWSI takes a number of steps to minimize the level of these capital expenditures. These include:

- All activities related to project management, design, drafting, construction coordination and inspection, and as-built recording will be undertaken internally by EWSI, eliminating the need for external consultants. The actual construction, including surface restoration, will be completed by using in house construction resources who are skilled and experienced in the construction of these asset types.
- Where necessary, contracted services are performed by pre-qualified external contractors and done on a competitive unit priced basis, using comprehensive engineering packages to ensure cost and scope control. Contracted services will only be used if internal resources are not available due to unforeseen emergency repairs or interventions external to this project.
- The longer term construction contractor relationship allows us to mobilize the contractor efficiently and effectively as they are familiar with our and City's standards and master contractor agreements are in place.
- The installations will be consistent with EWSI's construction standards which will minimize stock requirements and speed up design and construction.

- Where possible, work will be coordinated with other projects or maintenance activities to minimize costs.
- Every project is evaluated individually to determine the appropriate construction method to meet requirements at the lowest cost.
- EWSI will use standard designs to expedite the design phase. Pre-planning of shaft locations minimizes the cost by avoiding utilities (above and below ground), assessing ground conditions to optimize construction methods and ensuring adequate space for materials, equipment and safe operation. Every project scope is evaluated to improve economy of scale.
- All force accounts are documented and reviewed by several EWSI representatives to ensure the additional cost is justified under the terms of the contract.

6.0 RISKS AND MITIGATION PLANS

33. Table 6.0-1 provides key risks and mitigation plans associated with executing this program.

Table 6.0-1
Key Risks and Risk Mitigations

Risk	A Mitigation Plan
1 **Health and Safety Risk** - This project requires heavy construction activities that include, excavations, crane use, confined space entry and working in high traffic areas.	EWSI's construction team will follow EPCORs best practices for ground disturbances and follow all safety procedures and plans. EWSI will ensure that external contractors submit safety plans the meet or exceed EPCOR health, safety and environment (HSE) requirements prior to commencing any work.
2 **Risk of Customer Disruptions** - During construction, the projects can have an impact on the neighborhood by causing disruptions to traffic, releasing sewer gasses and making noise.	EWSI will schedule activities to minimize all impacts and work may need to be adapted if unexpected conditions occur that can worsen impacts on neighbours and residents. EWSI will ensure manholes are designed to not act as egress points for odour, and the project must monitor upstream and downstream impacts.
3 **Financial Risk** – Unknown geotechnical conditions, utility conflicts and poor trunk condition can increase the project cost.	EWSI's design team will conduct desktop geotechnical studies during the design stage and commit to appropriate redesigns in advance when adverse geotechnical condition are anticipated. In the event of poor structural integrity of the trunk, additional project funding has been assigned to allow for moderate structural rehabilitation and support for the interface between the trunk and the new manhole. The project will obtain information on all underground utilities during design stage and conduct hydrovac exposure to confirm utility locations.

Appendix H3

EPCOR WATER SERVICES INC.

Drainage Services
CORe Drop Structure Modification Program
Business Case

February 16, 2021

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1.0 OVERVIEW

1. The CORe Drop Structure Modification Program is a critical component of EWSI's Corrosion and Odour Reduction (CORe) Strategy to understand, mitigate and prevent sewer odour issues. This program initiates projects to construct structures that reduce the downstream air pressurization of a sewer headspace that results from the normal operation of the drop structure. This helps prevent sewer air from exiting the sewer at catch basins and manholes in neighbourhoods.

2. The odours can impact quality of life for nearby residents and lead to reduced asset service life or unexpected asset failures because the accumulation of hydrogen sulphide causes concrete corrosion. Premature asset failure can result in significant customer service disruptions and will require costly emergency repairs.

3. This program is categorized as environmental quality enhancement program. This program started in 2019 as part of the CORe strategy. Since then, EWSI has initiated six drop structure modification projects which are currently under design and construction. During the 2022-2024 PBR term, this program will complete construction of 21 drop shaft air recirculation structures. EWSI has forecast total program capital expenditures during 2022-2024 at $22.0 million.

2.0 BACKGROUND/JUSTIFICATION

4. EWSI initiated the Corrosion and Odour Reduction (CORe) Strategy in 2019 to understand, mitigate and prevent sewer odour issues across the city of Edmonton using a combination of capital and operational interventions. The CORe Strategy focuses on preventing the formation of H2S gas, which will reduce community odour impacts and lengthen the life of sewer network assets. Under CORe, EWSI segregates the City into regions with consistent odour issues, those with dynamic odour issues, and those with emerging odour issues. Different approaches have been proposed for each region to ensure that causes of the odour are fully understood and to ensure that capital projects will provide sustainable relief. The capital projects and operating activities in CORe can be classified into four themes of investment: PREVENT, OPTIMIZE, MONITOR and CONTROL.

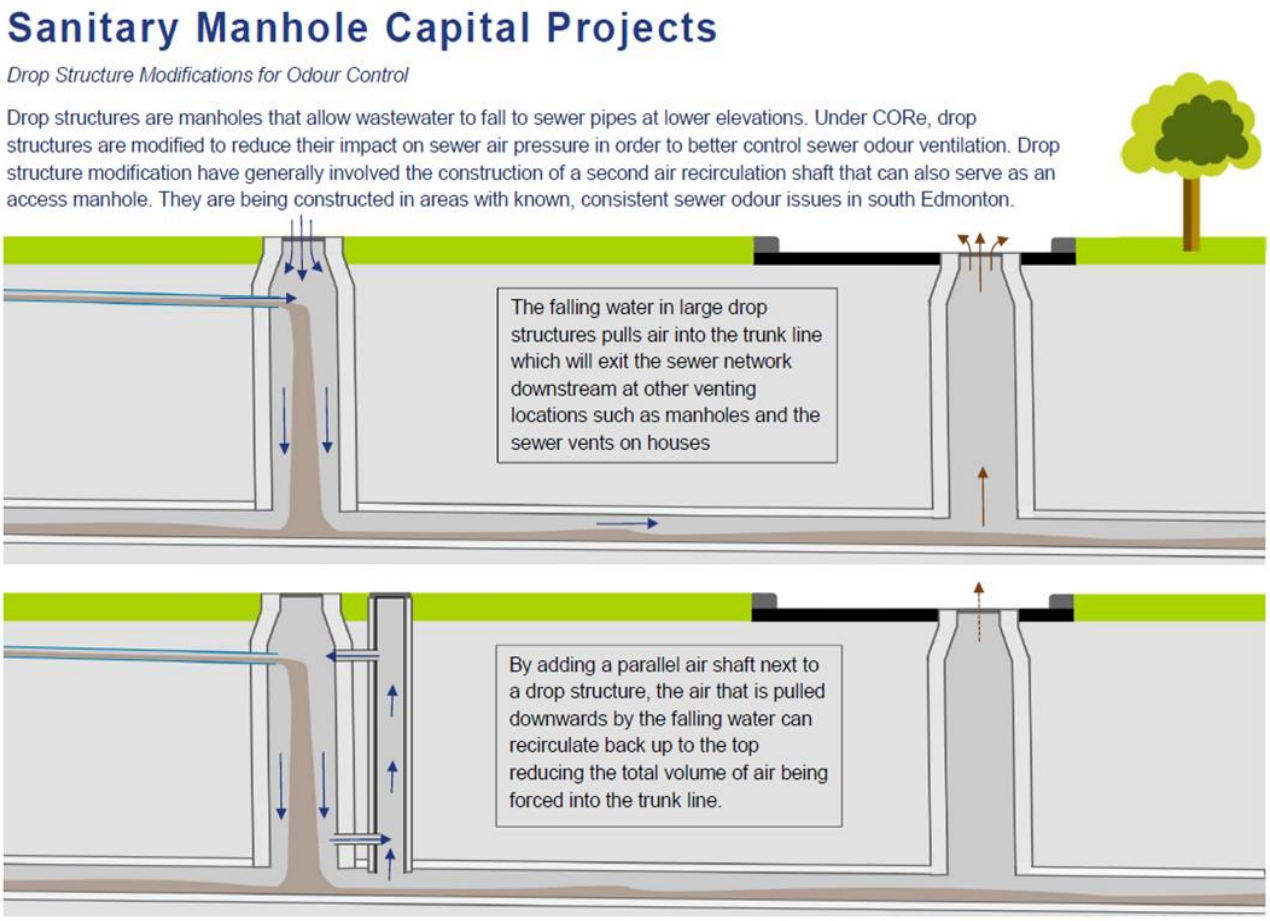
5. The Drop Structure Modification Program is a critical component of the Corrosion and Odour Reduction Strategy (CORe) under the CONTROL theme. A drop structure is a location where wastewater is allowed to fall from a more elevated sewer into a deeper trunk line.

However as the water falls in the drop structure it drags air along with it, acting like an air pump and pressurizing the receiving trunk line. If left unabated, the resulting high air pressure in the trunk lines will force air out of the sewer at other locations often creating odour and/or corrosion problems far away from the sources of sewer odour. High air pressure in trunk lines is one of the main factors for the perception of sewer odours around catch basins and manholes.

6. The CORe Drop Structure Modification program is an annual program that constructs structures that reduce the downstream air pressurization of a sewer headspace that results from the normal operation of the drop structure. This helps prevent sewer air from exiting the sewer at catch basins and manholes in neighbourhoods.

7. The approach being employed by the CORe program to reduce air pressurization involves modification of drop structures through installation of several horizontal pipes between the drop structure and a newly constructed air re-circulation shaft (refer to Figure 2.0-1). The principle is that the air entrained due to the falling effect of the wastewater is recirculated through the connection pipes between the drop shaft and the air re-circulation shaft. This re-circulation configuration prevents the entrained air from pressurizing the downstream trunk system and escaping into the environment. The modified drop shaft can also be adapted to incorporate accessibility improvements for the trunk line.

Figure 2.0-1
Drop Structure Modifications – Air Re-Circulation Shaft Method



8. During the 2022-2024 PBR term, the Drop Structure Modification Program will include the construction of 21 additional drop structure modifications

9. Approximately 80 of 170 kilometers of deep trunk lines lack appropriate access provisions for safe entry. 17 of the candidate project locations in this program lie along trunks with poor accessibility and where there is value in incorporating accessibility improvements into the drop modification shafts. A decision to incorporate accessibility improvements into the drop structure modification design will be based on the requirements of the location. Additional access will not be added if there is already access available at alternative locations within the same area.

3.0 PROGRAM DESCRIPTION

10. The scope of this program is to modify drop structures to reduce downstream headspace pressure in major trunk lines. A secondary goal of this project is to provide additional trunk access. Candidate locations should satisfy the following conditions:

- The asset must serve an upstream area with an average dry weather flow greater than 300 m^3/day;
- The asset must result in a height drop greater than 8 meters for a trunk line or 10 meters for a sewer lateral;
- Downstream hydrogen sulfide concentrations exceed an average of 2 ppm over 24 hours or reach a peak concentration above 10 ppm at least once a day. (Note that 10 ppm indicates that 0.001% of the sewer air volume is hydrogen sulfide.);
- The asset is demonstrated to increase downstream air pressure by 20 Pascal or more; and
- The location choice consider access safety during construction, potential impacts to traffic and not conflict with nearby buried utilities.

11. With the above criteria in place, the current selection and prioritization process for the construction of drop shaft modifications is driven primarily through public odour reporting and system wide sewer behaviour analysis.

12. Maintenance and repair of the trunk line beyond the tie in location, abandonment of other assets and inspection/cleaning are beyond the scope of this program and will be prioritized and managed in the CORe Large Trunk Rehabilitation Program.

13. Based on past projects, engineering is expected to take between 2 to 3 months while construction also takes approximately 2 to 3 months. Construction scheduling proceeds based on the utilization of in-house construction crews. As shown in Table 3.0-1, the schedule for this program for 2022-2024 will include 5 to 10 drop structure modification projects completed per year, for a total of 21 projects completed in the PBR term.

Table 3.0-1
CORe Drop Structure Modifications Schedule
(2022-2024)

		A **2022**	B **2023**	C **2024**	D **Total**
1	# Drop Structure Modifications With Access	4	8	5	17
2	# Drop Structure Modifications Without Access	1	2	1	4
3	**Total**	**5**	**10**	**6**	**21**

14. Table 3.0-2 provides the annual schedule for the Drop Structure Modification Program for the 2022-2024 PBR term.

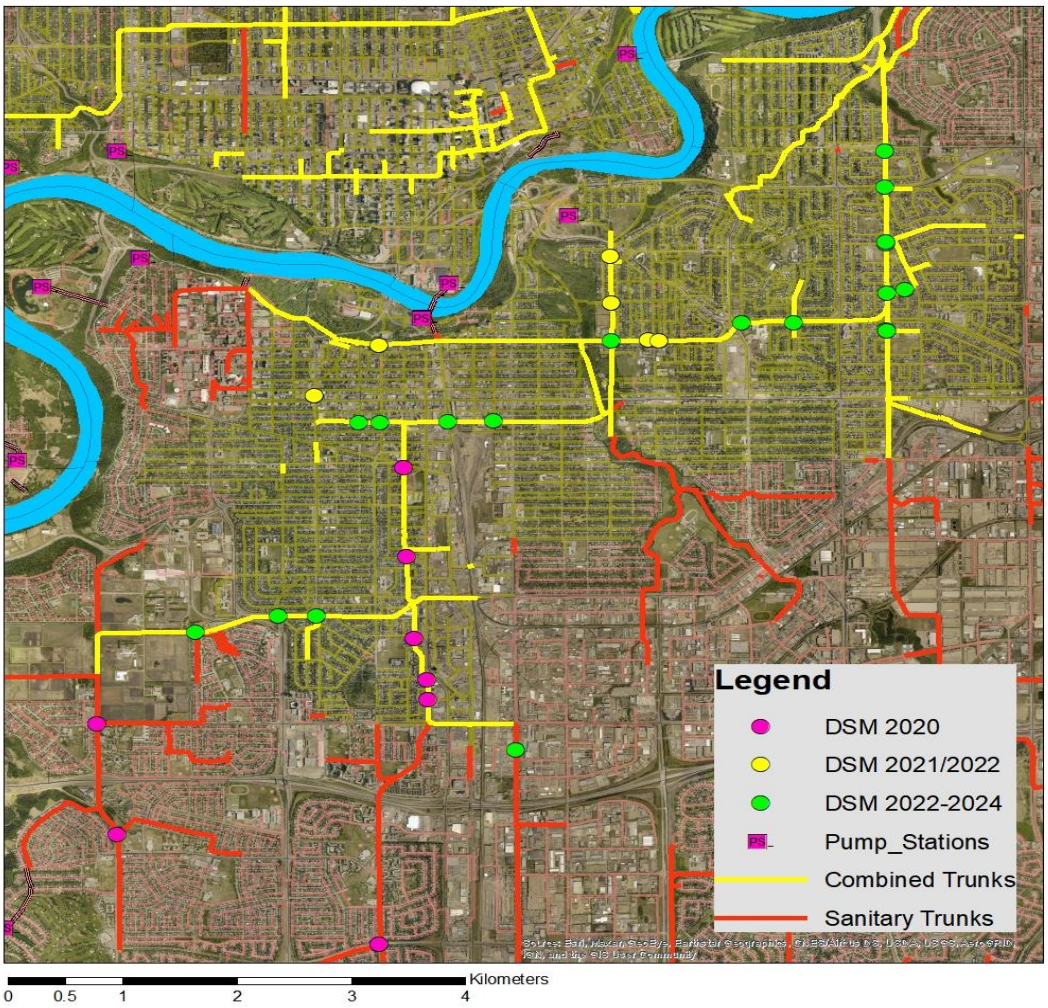
Table 3.0-2
Drop Structure Modification Program Schedule
(2022-2024)

Project Phases	A 2021 Q4	B 2022 Q1	C 2022 Q2	D 2022 Q3	E 2022 Q4	F 2023 Q1	G 2023 Q2	H 2023 Q3	I 2023 Q4	J 2024 Q1	K 2024 Q2	L 2024 Q3	M 2024 Q4
1 Initiation and Approvals	α			β				μ					
2 CCTV & Design	α	α	α	α	β	β	β	β	μ	μ	μ	μ	
3 Procurement		α	α	α	α	β	β	β	β	μ	μ	μ	
4 Construction		α	α	α	α	β	β	β	β	μ	μ	μ	μ
5 Commissioning			α	α	α	β	β	β	β	μ	μ	μ	μ
6 Close-out			α	α	α	β	β	β	β	μ	μ	μ	μ

α: Projects initiated for 2022.
β: Projects initiated for 2023.
μ: Projects initiated for 2024.

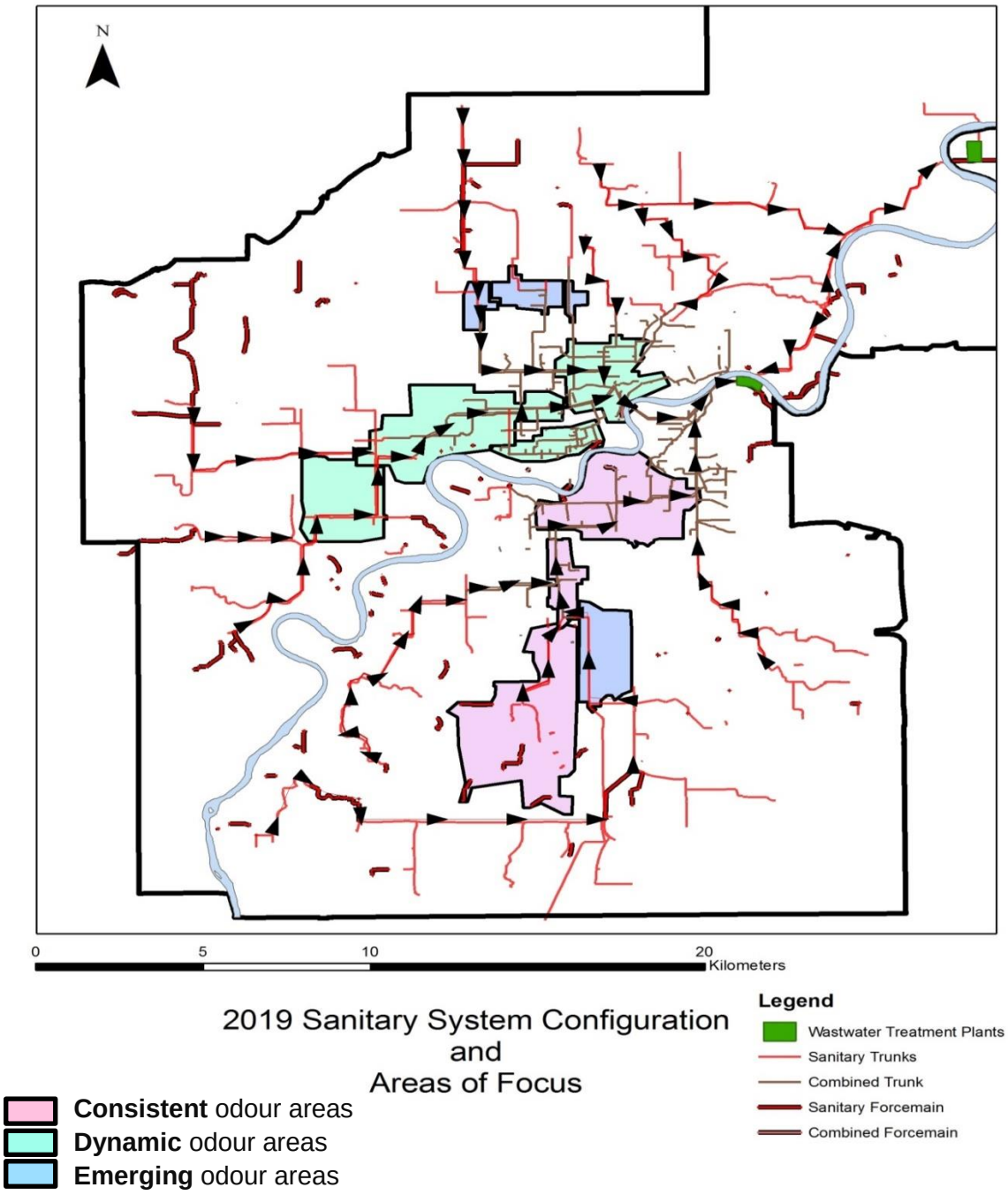
15. The tentative locations of the drop structure modification projects are identified by the green circles in Figure 3.0-1 below. The yellow and pink circles identify locations that are being completed by 2021.

Figure 3.0-1
Drop Structure Modification Program Current Projects and Future Candidates (2022-2024)



16. The selected locations will target the consistent odour area in the City as shown in Figure 3.0-2 and will benefit neighbourhoods such as Boonie Doon and Strathcona.

Figure 3.0-2
Edmonton Sanitary System
Odour Areas of Focus



4.0 ALTERNATIVES ANALYSIS

17. A number of alternative approaches have been considered in lieu of modifying drop structures. The purpose of modifying drop structures is to reduce odours from leaving the sewer

system by decreasing trunk line air pressure in the sewer headspace. However, reducing odour emissions can also be accomplished through: i) containment; ii) forced removal; or iii) source treatment.

18. Containment has proven to be a viable and versatile mitigation approach for small local applications but does not scale up effectively and may increase corrosion risks. It becomes prohibitively expensive if used as a primary odour control approach. Using containment structures, such as one-way flaps, air curtains and manhole seals has a much smaller benefit area and often still requires accompanying drop structure modifications in order to mitigate sewer odours without increasing the risk of transferring the odour and corrosion issues to another area in the sewer network. Therefore this method is not a viable alternative for drop structure modifications on its own and several air containment structures are being deployed selectively across the sewer system, often in close proximity to proposed drop structure modification locations.

19. The forced air removal alternative uses vent stacks or odour control facilities. Under this approach, the benefits generally do not extend beyond their immediate locality even when large volumes of air are extracted. These type of facilities require high initial investment for construction, high cost of operation and maintenance and have had larger spatial foot-prints in the past. These facilities also have poor performance in combined sewer systems like those in Bonnie Doon and Strathcona. Therefore this method is not a viable alternative for drop structure modifications.

20. Source treatment is a very effective alternative and one that is being pursued heavily in CORe using the pump station treatment/optimization and trunk line cleaning programs. However, in several communities fully treating odour at every odour generating point source has been determined to be cost prohibitive. While the main point sources of sewer odors are being targeted for treatment across the city, drop structure modifications and other forms of ventilation control remain cost competitive in sections of the sewer network with many small, distributed, point sources of sewer odour as well as in areas where the volume of waste water carried by the sewer infrastructure makes treatment by chemical injection cost prohibitive or technically untenable.

21. On a project by project basis, drop structure modifications are deemed non-viable when there are too many utility conflicts near original drop structure or when construction cannot be completed in a manner that is not too disruptive to local traffic.

5.0 COST FORECAST

22. Costs are estimated based on on-going projects of a similar type and scope. Currently 6 drop shaft modifications are at various stages of design and construction across the city as part of the 2019 and 2020 CORe Drop Shaft Modification Program. Of those, 4 are drop shaft modifications with access provisions and two are being constructed without access provisions. All of the projects are being constructed using internal resources. The construction costs of two drop shaft modification structures in the Jasper Place community in 2014/2015 were also considered when developing costing.

23. The following assumptions were made in this cost estimate:

- Construction shaft depths are between 25 to 35 meters.
- Sufficient space is available for construction equipment.
- Shafts are constructed using in house resources.
- The roads have moderate to heavy traffic requiring active traffic control provisions.
- The target trunk line requires only standard structural strengthening to support a re-circulation shaft.
- Geotechnical investigations will be completed by external resources.
- Contingency.

24. In the CORe strategy, drop structure modification projects were estimated to have a project cost of approximately $2.2 million each. However, due to efficiencies realized by utilizing internal resources, actual project costs have been much lower. For constructing sewer shafts to similar depths as the candidate locations in the 2022-2024 drop structure program, the anticipated cost per location is approximately $1.3 million each. The yearly budgeted forecast has been decreased to reflect the lower costs realized by pivoting from external construction.

25. The program cost estimates for the 2022-2024 PBR term are shown in Table 5.0-1.

Table 5.0-1
CORe Drop Structure Modifications Program
Capital Expenditure Forecast
(2022-2024)
($ millions)

		A **2022**	B **2023**	C **2024**	D **Total**
	Direct Costs:				
1	Contractors	2.65	3.19	2.04	7.88
2	Internal Labour	2.54	2.92	2.70	8.16
3	Vehicles and Equipment	0.48	0.55	0.56	1.58
4	Contingency	0.00	1.61	1.08	2.69
5	**Sub-total Direct Costs**	**5.66**	**8.26**	**6.38**	**20.31**
6	Capital Overhead and AFUDC	0.44	0.66	0.59	1.68
7	**Total Capital Expenditures**	**6.10**	**8.92**	**6.97**	**21.99**

26. EWSI takes a number of steps to minimize the level of these capital expenditures. These include:

- All activities related to project management, design, drafting, construction coordination and inspection, and as-built recording will be undertaken internally by EWSI, eliminating the need for external consultants. The actual construction, including surface restoration, will be completed using in house construction resources who are skilled and experienced in the construction of these asset types
- EWSI uses standard designs to expedite the design phase. Pre-planning of shaft locations minimizes the cost by avoiding utilities (above and below ground), assessing ground conditions to optimize construction methods and ensuring adequate space for materials, equipment and safe operation.
- EWSI has taken advantage of longer-term contracts with vendors to effectively manage the supply, quality and construction of required equipment. As such, EWSI has minimized the need to stock much of the required equipment reducing the overall costs of all installations and upgrades. Also the longer term construction contractor relationship allows us to mobilize the contractor efficiently and effectively as they are familiar with our and City's standards and master contractor agreements are in place. The use of external contractors is being limited to geotechnical assessments and in scenarios where internal resources are not available due to emergency interventions.
- Contracted services are performed by pre-qualified external contractors and done on a competitive unit priced basis, using comprehensive engineering packages to ensure cost and scope control.

- The installations will be consistent with EWSI's construction standards which will minimize stock requirements and speed up design and construction.
- Where possible, work will be coordinated with other projects or maintenance activities to minimize costs.
- Every project is evaluated individually to determine the appropriate construction method to meet requirements at the lowest cost.
- Every project scope is evaluated to improve economy of scale.
- All force accounts are documented and reviewed by several EWSI representatives to ensure the additional cost is justified under the terms of the contract.

6.0 RISKS AND MITIGATION PLANS

27. Table 6.0-1 provides key risks and mitigation plans associated with this program.

Table 6.0-1
Key Risks and Risk Mitigations

	Risk	A Mitigation Plan
1	**Health and Safety Risk** - This project requires heavy construction activities that include, excavations, crane use, confined space entry and working in high traffic areas.	The construction team will follow EPCORs best practices for ground disturbances and follow all safety procedures and plans. External contractors will be expected to submit safety plans the meet or exceed EPCOR health, safety and environment (HSE) requirements prior to commencing any work.
2	**Risk of Customer Disruptions** - During construction, the projects can have an impact on the neighbourhood by causing disruptions to traffic, releasing sewer gasses and making noise.	Activities should be scheduled to minimize all impacts and work may need to be adapted if unexpected conditions occur that can worsen impacts on neighbours and residents. Design must ensure manhole are designed to not act as egress points for odour, and the project must monitor upstream and downstream impacts.
3	**Financial Risk** - Unknown geotechnical conditions, utility conflicts and poor trunk condition can increase the project cost.	The design team will conduct desktop geotechnical studies during design stage and commit to appropriate redesigns in advance when adverse geotechnical condition are anticipated. In the event of poor structural integrity of the trunk, additional project funding has been assigned to allow for moderate structural rehabilitation and support for the interface between the trunk and the new manhole. The project will obtain information on all utilities during design stage and conduct hydrovac exposure to confirm the location of utilities.

Appendix H4

EPCOR WATER SERVICES INC.

Drainage Services
CORe Duggan Tunnel Project
Business Case

February 16, 2021

Table of Contents

1.0 OVERVIEW

1. The Duggan Tunnel is a key project proposed under EWSI's Corrosion and Odour Mitigation (CORe) Strategy. The CORe Strategy proposes to reduce the odour impact both in Duggan and the downstream communities through operational changes and active odour treatment of the wastewater. One of the key strategies is to limit the release of hydrogen sulfide gas (H_2S gas) and reduce the pressurization within the Duggan Tunnel through structural upgrades to the sewer.

2. The Duggan Tunnel Project is essential for addressing sewer corrosion and odour issues in the Steinhauer-Duggan area. The Steinhauer-Duggan sewer corridor is an area that suffers from chronic, intense sewer odours and rapid asset corrosion. The area has accounted for one out of every ten sewer odour complaints received in the City of Edmonton over the past 20 years. The issues are attributed to the premature corrosion of downstream sewers. The odour complaints center on a single common sewer asset, the Duggan deep sanitary/combined sewer trunk (the "Duggan Tunnel"). The sewer's design and operation create ideal conditions for both, the creation of gases causing odours, and for allowing the release of sewer air into the Duggan Tunnel surrounding communities.

3. The creation of sewer odour within the Steinhauer-Duggan sewer corridor also has severe impacts on downstream communities as the corridor discharges septic and odour laden wastewater into the communities of Allendale and Bonnie Doon. The H_2S gas produced in the Duggan Tunnel has significantly contributed to the observed concrete corrosion of sewer crowns and manholes shafts in the downstream drainage network. The corrosion has been sufficiently advanced in many locations to necessitate a number of planned and emergency rehabilitation projects. The proposed upgrades will address the sewer odour in this area and greatly reduce downstream sewer corrosion.

4. The Duggan Tunnel Project includes the abandonment of the existing Duggan Tunnel and Duggan Pump Station and the construction of a new, shallower sewer trunk. The proposed new sewer will create a gravity-flow system that eliminates the need to operate the existing Duggan pump station. The Duggan Tunnel Project was initiated in 2019 to provide timely odour mitigation in the community. Construction start is planned for late 2021, and the project is expected to be completed and placed in service in mid-2025. Total capital expenditures for this project are forecast at $85.89 million.

5. The CORe Duggan Tunnel Project will address health and safety risks associated with H_2S gas along the Steinhauer-Duggan sanitary service area. It will also mitigate the risks of customer service disruptions from the existing tunnel failure that could affect residents in multiple neighbourhoods for months. Financial risks associated with costly emergency repairs or replacement from tunnel or pump station failures, as well as potential environmental risks associated with sewer and pump station deterioration, will also be addressed.

6. EWSI conducted an alternative analysis comparing this project with other odour containment options. Following the financial and risk analysis of the alternatives, this tunnel bypass solution is recommended. Although this project is not included in EWSI's revenue requirement for sanitary utility until the project goes into service in 2025, this business case is provided in the Application because of the significant capital expenditures that will be incurred in the 2022-2024 period.

2.0 BACKGROUND AND JUSTIFICATION

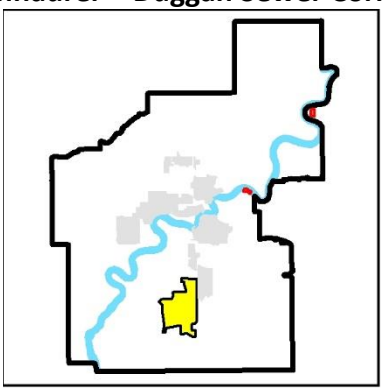
7. EWSI initiated the Corrosion and Odour Reduction (CORe) Strategy in 2019 to understand, mitigate and prevent sewer odour issues across the city of Edmonton using a combination of capital and operational interventions. The CORe Strategy focuses on preventing the formation of H_2S gas, which will reduce community odour impacts and lengthen the life of sewer network assets. Under CORe, EWSI segregates the City into regions with consistent odour issues, those with dynamic odour issues, and those with emerging odour issues. Different approaches have been proposed for each region to ensure that causes of the odour are fully understood and to ensure that capital projects will provide sustainable relief. The capital projects and operating activities in CORe can be classified into four themes of investment: PREVENT, OPTIMIZE, MONITOR and CONTROL. The CORe Duggan Tunnel Project is a critical component of the CORe Strategy under the PREVENT theme.

8. The CORe Strategy places significant emphasis on consistent odour areas due to the impact on customers and communities to provide rapid relief within these service areas. Since significant research and analysis has already been completed in these areas, the capital projects and operating activities required to address corrosion and odour issues are well understood. The CORe strategy identified Steinhauer–Duggan Sanitary Service area as a consistent odour area. Steinhauer-Duggan is the first sanitary service area to be targeted under the CORe Strategy.

9. The Steinhauer–Duggan sanitary service area (shown in Figure 2.0-1) is located in south-west Edmonton, has a 14.5 hectare service area and serves more than 7,500 customers.

Communities within the Steinhauer-Duggan sewer corridor include Bearspaw, Blackburne, Blue Quill, Calgary Trail South, Duggan, Ermineskin, Keheewin, Rideau Park, Skyrattler, Steinhauer, Sweet Grass and Twin Brooks.

Figure 2.0-1
Steinhaurer – Duggan Sewer Corridor



10. The Steinhauer-Duggan sanitary service area suffers from chronic and intense sewer odours. The area has accounted for 1 out of every 10 of the sewer odour complaints received in the City of Edmonton over the past 20 years. The odour complaints center on a single common sewer asset, the Duggan Tunnel. The design and operation of the Duggan Tunnel creates conditions that are ideal for both the creation of sewer odours as well promoting their release into the communities surrounding the tunnel. The sewer odours within the Steinhauer-Duggan sanitary service area also has severe impacts in downstream communities as the corridor discharges septic and odour laden wastewater into the communities of Allendale and Bonnie Doon.

11. The CORe Strategy determined that odour issues along the length of the tunnel are caused by multiple compounding structural and operational issues:

- The presence of three major upstream pump stations which contribute septic wastewater into the system.
- A major 35 meter vertical drop structure on Saddleback Road and 111 Street NW that agitates the wastewater significantly, causing the localized release of H_2S gas.
- The Duggan Pump Station at the terminus of the Duggan Tunnel which causes wastewater to stagnate and limits air flow in the sanitary system causing odorous air discharges to occur upstream of the pump station and contributes septic wastewater downstream of the Duggan Pump Station.

12. The CORe Duggan Tunnel Project will address a number of risks:

- **Health & Safety Risks** – The odours can impact quality of life for nearby residents. The Duggan Tunnel Project will eliminate the main source of H_2S gas creation along the Steinhauer Duggan area.
- **Risk of Customer Service Disruptions** - High concentrations of H_2S gas causes concrete corrosion and can lead to reduced asset service life or unexpected asset failures. There is a high risk of structural failure in the tunnel that could result in service interruption affecting a significant part of Edmonton for a few weeks or multiple neighbourhoods for a few months. The proposed Duggan Tunnel project will lower the risks of sewer tunnel and pump station failures and service interruptions.
- **Financial Risks** – The potential of Duggan Tunnel and Duggan Pump Station failure could result in more costly emergency replacement. The proposed bypass tunnel and Duggan Pump Station abandonment will lower the risks of sewer tunnel and pump station failure and, therefore, reduce the emergency replacement costs.
- **Environmental Risks** - Risk of sewage leakage and spills associated with Duggan Tunnel and pump station failure can result in violation of environmental compliance and potential fines. Replacing the Duggan Tunnel and Duggan Pump Station will lower the risks of Duggan Tunnel and pump station failure.

The Duggan Tunnel Line

13. The Duggan Tunnel begins at Saddleback Road and 111 Street NW with a 35 meter vertical drop structure where wastewater falls from three incoming community sewers into the deeper Duggan Tunnel. The wastewater then travels through a 1,500 mm diameter sewer tunnel for 1,620 meters and then enters a smaller 1,200 mm diameter sewer for the remaining 1,390 meters. The entire tunnel is 3,212 meters long. There are five locations along the Duggan Tunnel line with service tie-ins, all of them are along 106th Street between 34th Avenue and 43rd Avenue.

14. The Duggan Tunnel then continues northward without any further sanitary tie-ins. Before reaching its terminus, the tunnel passes beneath multiple multi-unit residential buildings. The Duggan Tunnel terminates at the Duggan Pump Station at 45th Avenue and 105th Street. The pump station lifts the wastewater from 39 meters below grade to 21 meters below grade (18 meters). The wastewater is immediately discharged into a 1,650 mm diameter sewer main that continues into the community of Allendale. The pump station is located on 45th Avenue and 105th Street in the front drop off area for the L.Y. Cairns Public School. The pump station has

traditionally used the upstream Duggan Tunnel for wet weather storage and for wastewater storage in the winter. However, in the past 10 years, due to aging of the pump station and inadequate flow capacity, the Duggan tunnel has had to store wastewater in the Duggan Tunnel continuously. The wastewater is held in storage for so long that it becomes extremely septic and accumulates considerable volumes of solids and sediments creating sewer odours. Additionally, with the tunnel fully filled with wastewater, air that has been driven into the Dugan Tunnel by the upstream drop structures is forced to exit through the connected community sewers ultimately driving sewer odours directly into the residential neighborhoods.

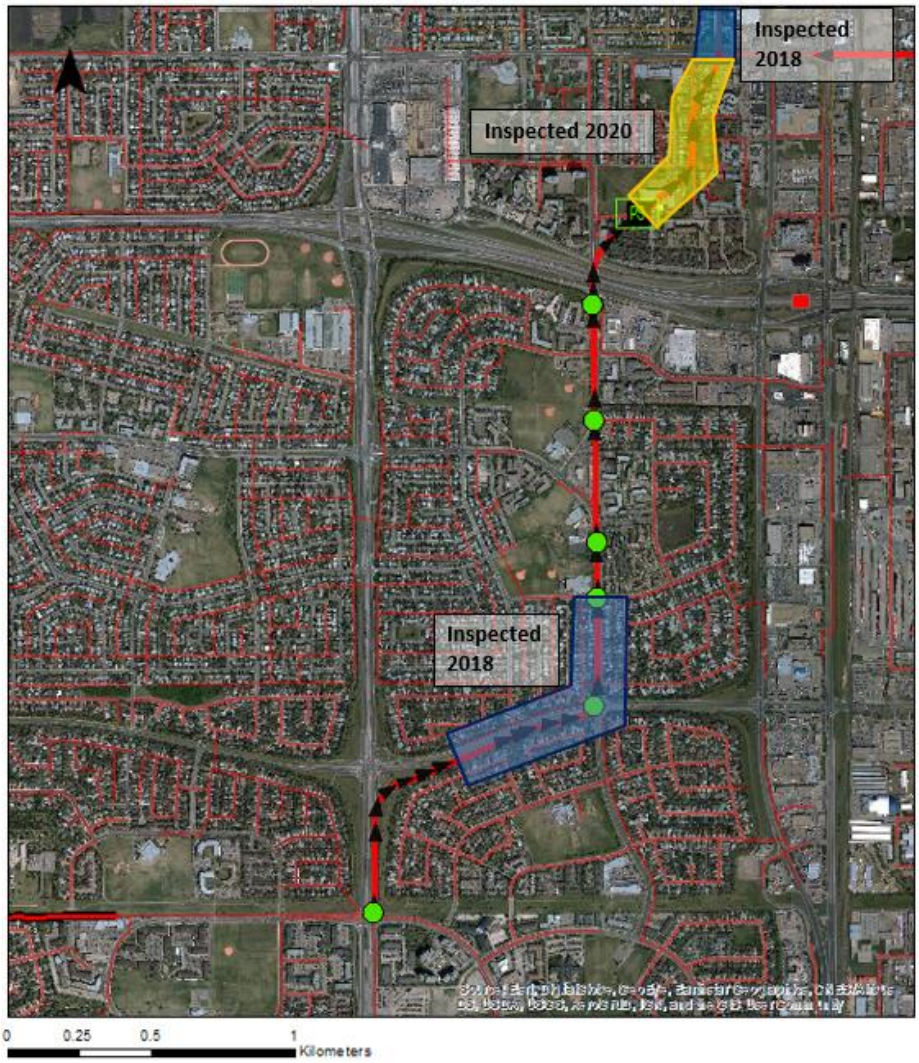
15. The specific design of the existing Duggan Tunnel is not ideal from the perspective of wastewater conveyance. At the commencement of its construction in 1970, the technology available was not sufficiently advanced to provide the tunneling capabilities required to pass through sections of sand and glacial deposits located closer to the surface. As a result, to avoid a large section of sand near Whitemud drive, the tunnel depth was increased substantially. This required the construction of the existing Duggan Pump Station to lift wastewater. Today, technology exists to tunnel through the varied geotechnical conditions present along the current tunnel alignment. The modern tunneling technology allows for a shallower tunnel depth through the sand layer to create a gravity flow system. The proposed gravity flow system would eliminate the need for large drop structures and the need of a pump station in front of L.Y. Cairns school.

16. The Duggan Tunnel has been a source of odour throughout most of its length. Odour complaints primarily center around the first drop structure and then further downstream along 106th street where there are multiple sanitary tie-ins. H_2S gas monitoring along the length of tunnel measured high concentrations H_2S gas in the air of the sewers and in manholes at multiple locations, corresponding closely with the locations with higher numbers of public odour complaints. In several locations peak H_2S gas concentrations were measured at levels that can be expected to cause major odour nuisance and cause severe sewer corrosion.

17. In 2018, EWSI inspected an 800 meter stretch of the trunk line between manholes along 34th Avenue (Figure 2.0-2). Measurements of H_2S gas were similar to those previously recording for that location and did not at any time exceed 4 ppm. The section that was inspected showed only minor corrosion and limited asset damage. Further inspection of the Duggan Tunnel, particularly in the areas with high H_2S gas, could not be completed due to insufficient access and the presence of large amounts of sediment accumulation near the north most section where the inspection was occurring. EWSI completed additional inspections in late 2018 north of 51st Avenue and in 2020 immediately north of the Duggan Pump Station and found significant

concrete corrosion that required immediate corrective action. Measured H_2S gas concentrations were in the same range as observed in manholes connected to sections of the Duggan Tunnel that were not successfully inspected indicating that there is a credible risk of severe concrete corrosion along the northern stretch of that trunk line.

Figure 2.0-2
Duggan Tunnel Configuration and Inspection Areas



The Duggan Pump Station

18. The Duggan Pump Station is recognized as one of the largest odour contributors in the sanitary network and is designated as a high risk asset by EWSI asset management system. The building of the Duggan Pump Station as seen on the surface is shown in Figure 2.0-3. The current Duggan Pump Station is required because the existing Duggan Tunnel is more than 20 meters

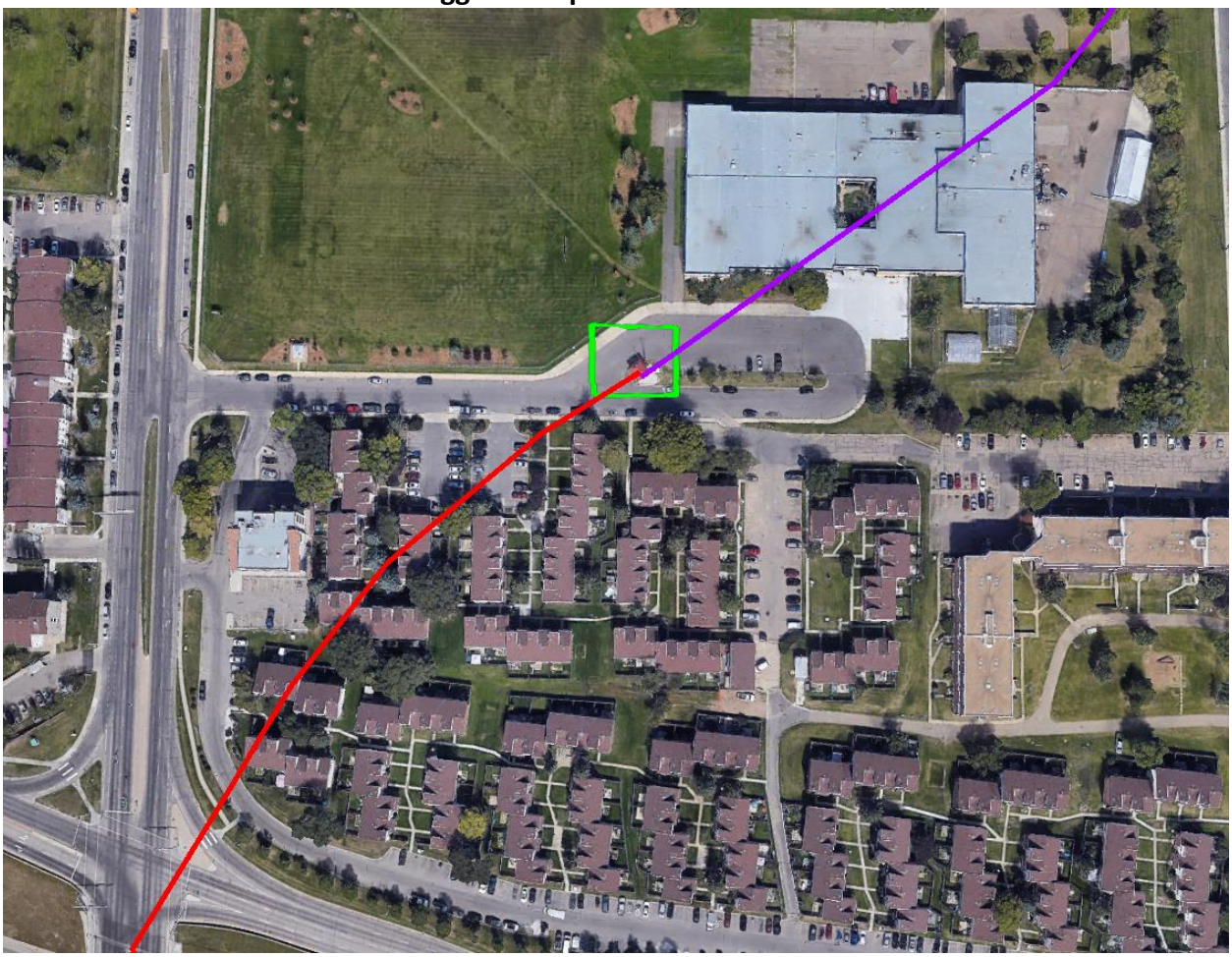
lower than the downstream sewers that receives its wastewater. The pump station's main purpose is to lift the wastewater to the higher elevation so that it can then continue to flow, naturally, towards the Gold Bar Wastewater Treatment Plant.

19. The proposed Duggan bypass tunnel will create a gravity system and eliminate the need for a pump station at this location.

Figure 2.0-3
Duggan Pump Station

20. As shown in Figure 2.0-4, the Duggan Pump Station is located in the main drop-off area south of the L.Y. Cairns School. The red and purple lines in the photo indicate the tunnel alignment.

Figure 2.0-4
Duggan Pump Station Ariel View



21. The existing Duggan Pump Station suffers from a combination of capacity limitations and aged assets that limits its ability to effectively pump wastewater. Wastewater now primarily enters the downstream tunnel by overflowing through the pump station wet well. As a result, wastewater is continuously stored in the Duggan Tunnel for a longer duration (upwards of 18 days). With such long storage times time, the amount of H_2S gas generated is significant. Based on the past dry weather flows and previous H_2S gas monitoring in that area, the pump station is likely discharging more than 2 tons of H_2S gas into the downstream sanitary network each day.

22. The immediate effect on concrete sewer infrastructure is substantial. Inspections of the Duggan Tunnel have been limited due to a lack of access along both the upper and lower sanitary reaches, however a photo taken in 2016 (refer to Figure 2.0-5) from the pump station wet well at its point of discharge showed substantial corrosion to the point of exposing rebar in the 1,650 mm tunnel roof. Further inspection in 2020 was completed after the construction of two

new access manholes. The inspection revealed that several sections of the sewer tunnel downstream of the Duggan pump station had deteriorated sufficiently to require immediate repairs.

Figure 2.0-5
Duggan Pump Station Wet Well Point of Discharge

3.0 PROJECT DESCRIPTION

23. The Duggan Tunnel project proposes to reduce the creation and release of H_2S gas along the Duggan Tunnel by eliminating the need for the sewer assets responsible for odour creation. To mitigate odours in the Steinhauer-Duggan service area, the Duggan Tunnel Project will construct a new sanitary tunnel bypass that follows the same path as the original tunnel but will be placed 20 meters higher. Raising the sewer tunnel to this higher elevation eliminates several large drops encountered by the wastewater and removes the need for a lift station permitting the permanent abandonment of the Duggan Pump Station. The removal of the pump station, in particular, will greatly reduce sewer odours by eliminating wastewater storage, wastewater stagnation and the accumulation of sediments and debris. With the elevated tunnel bypass, wastewater will flow freely and without obstruction. The proposed tunnel bypass and abandonment activities are expected to significantly reduce odour issues locally and as far downstream as Bonnie Doon. Several major structural, mechanical and capacity deficiencies are present at the Duggan Pump Station that severely limit its capacity to operate.

24. EWSI's other CORe capital programs are providing additional reductions to sewer odour nuisance in the Steinhauer Duggan area. The CORe Ventilation Program is installing air flaps and

manhole seals at locations where odours are known to escape from the sewer system in the Duggan Area. The flaps prevent sewer air from entering into community level sewers while the manhole seals prevent odours from leaving street level manholes. The devices are being installed along the length of 111th Street, 34th Avenue and 106 Street at assets that have been inspected and verified to be contributing to localized odour issues. Most of the installations were completed in early 2020 with only a few locations remaining to be addressed. The CORe Pump Station Treatment Program is investing in odour control and treatment systems at pump stations upstream of the Duggan Tunnel. These stations have been confirmed to be operating in a manner that creates sufficient H_2S gas to contribute to the odour issues experienced along the Duggan Tunnel. Through the application of operational design changes or the addition of chemical odour treatment units, the creation of H_2S gas at those locations will be significantly reduced. Odour benefits from these improvements will extend to the area served by the Duggan Tunnel. The pump station treatment projects are currently in the detailed design phase and will begin construction early 2021.

25. Replacing the Duggan Tunnel will involve the construction of the 3,400 meter long 1,500 mm pipe bypass tunnel completed by micro-tunneling. The bypass tunnel will approximately follow the same alignment as the existing Duggan tunnel. It will discharge into an existing 1,650 mm sewer at 105A Street and 45th Avenue NW just south of the L.Y. Cairns School. At its tie-in, the sewer will be 21 meters below grade. The pipe will have a steep enough slope that is more than sufficient to provide self-cleaning of the sewer tunnel and meet design standards for 1,500 mm sanitary pipe. This will ensure that sediment and debris does not accumulate in the tunnel, minimizing the need for operational intervention and cleaning in the future. The proposed bypass tunnel alignment is shown in Figure 3.0-1.

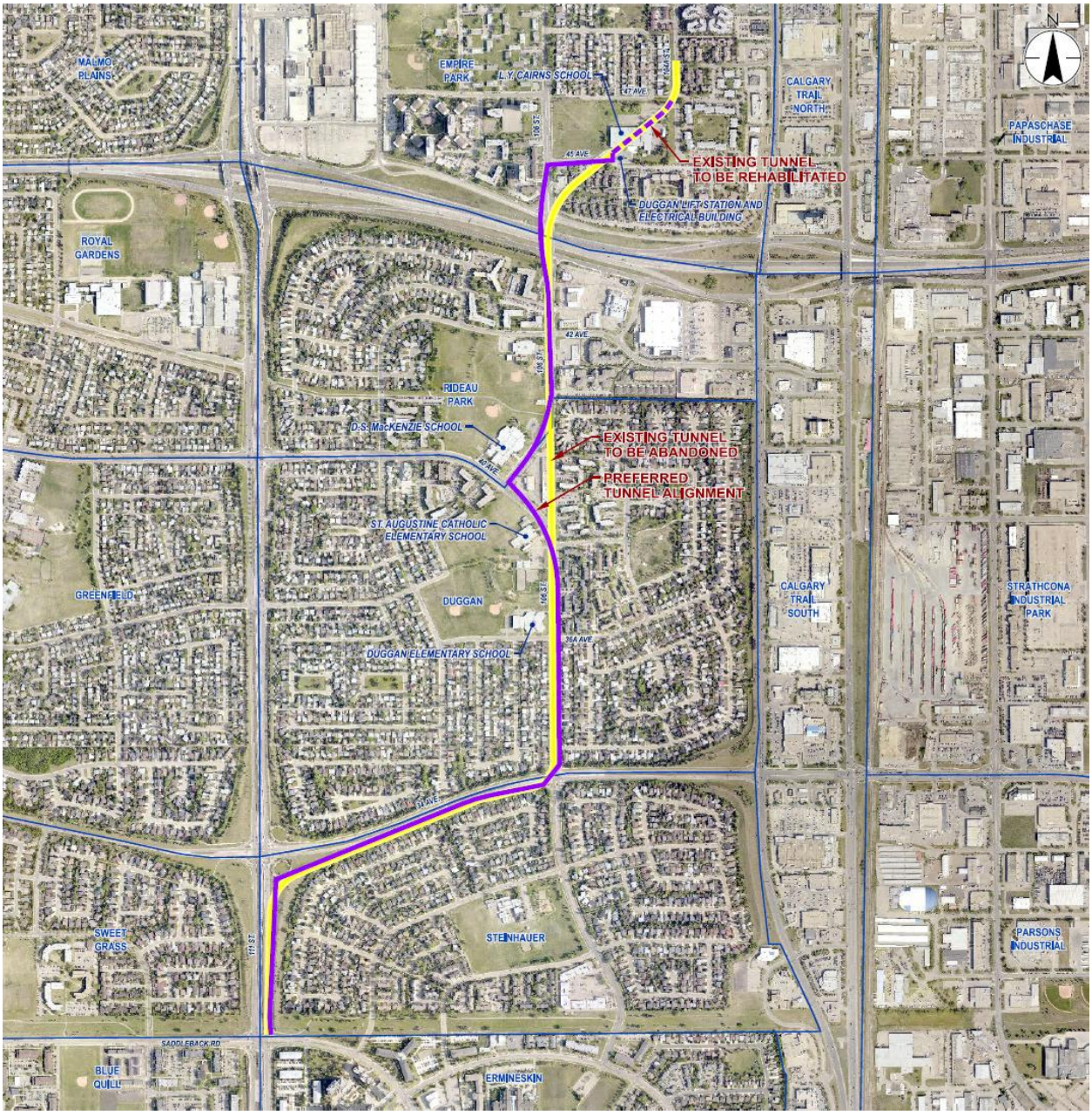
26. As part of the tunnel costing the following assets and activities were added and accounted for:

- 3,400 meter long 1,500 mm pipe bypass tunnel completed by micro-tunneling
- five 20 meter deep working shafts to permit boring machine access and alignment changes;
- eight 20 meter deep access shafts for future inspection and cleaning activities;
- installation of a corrosion resistant liner over the entire 3,212 meters of the tunnel; and
- installation of one sewer air vent to provide pressurization relief along the tunnel bypass.

27. Additionally this project includes a total of 6 tie-ins with existing sanitary assets at:

- A manhole at 106th Street and 34th Avenue
- A drill drop manhole at 106th Street and 36A Avenue
- A manhole at 106th Street and 38th Avenue
- A drill drop manhole at 106th Street and 40A Avenue
- A manhole at 106th Street just south of Whitemud Drive
- A drill drop manhole on 106th Street and 45th Avenue

Figure 3.0-1
Proposed Tunnel Alignment



28. Preliminary design and detailed geotechnical assessment began in 2019 and was completed in mid-2020. Detailed design will be completed in late 2020 to early 2021, followed by procurement with an anticipated construction start in fall 2021. The remainder of the project timeline will depend on tunneling speed and the contractor's chosen methodology of shaft construction and tunnel construction sequence. For costing, a tunneling speed of 2 meters per day was assumed, requiring a total of 1,715 tunneling days to complete the full 3,400 meters of

proposed tunnel. Based on the assumed tunneling rate and no more than 350 tunneling days per year, EWSI anticipates that the tunnel component will be completed mid to late 2025.

29. The bypass tunnel will be constructed with a corrosion resistant material or a corrosion resistant liner. The ventilation unit can be installed prior to the completion of the tunnel, particularly if its installation can be used to depressurize the existing Duggan tunnel until construction of the new tunnel is completed. Access shafts and working shaft placement will depend on the contractor's construction technology and sequencing strategy.

30. Table 3.0-1 provides the Duggan Tunnel Project Schedule.

Table 3.0-1
Duggan Tunnel
Project Schedule

	Activity	A 2020	B 2021	C 2022	D 2023	E 2024	F 2025	G 2026
1	Preliminary Design and Geotechnical Investigation	X						
2	Detailed Design	X	X					
3	Procurement		X					
4	Construction		X	X	X	X	X	X
5	Commissioning							X

4.0 ALTERNATIVES ANALYSIS

31. EWSI investigated three solution pathways to mitigate sewer odour at the Duggan Tunnel for both local and downstream benefits.

- **Alternative 1, the Tunnel Bypass Solution:** involves completely replacing the Duggan Tunnel with a new, elevated tunnel, and abandoning the existing pump station.
- **Alternative 2, the Active Treatment Solution:** involves installing odour containment, control and treatment infrastructure along the existing tunnel along with odour control through long-term operational management (Air extraction and treatment facilities, modifying drop structures, sewer vents, manhole seals, a new higher capacity pump station).
- **Alterative 3 New Pump Station and Bypass:** Involves constructing a new pump station at 111 Street and 29A Avenue and bypassing the existing deep tunnel with a shallow force main. Alternative 3 was rejected prior to proceeding to a detailed financial analysis due to early indications that it will substantially increase project capital costs

and annual operating costs while not providing the same level of service as the other two solutions.

32. Alternative 1 -Tunnel Bypass Solution and Alternative 2- The Active Treatment Solution provide similar reductions to odour intensity surrounding the Duggan Tunnel. Additionally, both of the proposed alternatives are expected to significantly decrease the prevalence of sewer odours in Allendale and are expected to have beneficial impacts as far away as Bonnie Doon, however the tunnel bypass solution is expected to result in greater reductions to downstream odour and corrosion overall.

Alternative 2 - Active Treatment Solution

33. This solution proposes the addition of several assets to decrease H_2S gas creation and control the release of sewer air in the community. It consists of the following:

- Modifications to the drop structures to reduce air circulation. These asset modifications have been deployed in the City previously. The modifications to the drop structure reduce the amount of air that is pumped into the lower tunnel as water falls through the drop. Without the modifications to the drops, the air is often released in large quantities from downstream manholes and household sewer vents and can cause odour problems across the entire community.
- The construction of an odour control unit (OCU) directly attached to the Duggan Tunnel at 34th Avenue and 111th street. The OCU uses high capacity air extraction fans to withdraw sewer air from the tunnel and then passes the air through an air treatment system before discharging the air into the atmosphere. The OCU will further reduce the sewer headspace pressure as well as remove H_2S gas and other sewer odours from the tunnel.
- The abandonment of Duggan Pump Station and construction of a new higher capacity pump station. The station will not include a chemical treatment system for odour control as it has been determined to be cost prohibitive. Instead the new pump station will reduce odour by greatly decreasing wastewater retention time as a result of its increased capacity. Unlike the tunnel bypass solution, the need for a pump station will remain necessary in this alternative because the wastewater will still need to be lifted up 20 meters in order to enter the higher, downstream sewer network. Identified structural, mechanical and capacity limitations require that a new pump station will need to be constructed if the need to lift the wastewater remains.

- The rehabilitation of at least 1.5 Km of the Duggan Tunnel upstream of the Duggan pump station. This will include repairs to the structure of the sewer, construction of additional access manholes and lining the tunnel with a corrosion resistant liner or sealant.
- The sealing of several manholes and isolation of all incoming sewer pipes from the air in the deep tunnel using sealing caps and one-way flaps.

4.1 Performance Analysis of Alternatives

34. EWSI has evaluated the expected performance of the two alternatives and have determined that in most cases both alternatives perform similarly in terms of odour reductions locally and downstream (both options decrease odour at locations where wastewater is dropped into the main Duggan tunnel). However, there are a few additional benefits realized from the tunnel bypass solution:

- Because the Tunnel Bypass Solution greatly reduces the size of the drops or removes them entirely, less H_2S gas is expected to be present in the headspace of the sewer immediately adjacent to the drops. This is expected to reduce localized sewer corrosion even further.
- While the Active Treatment Solution alternative will significantly reduce wastewater storage times in the Duggan Tunnel by building a larger capacity pump station, some storage will still be necessary and this will ultimately produce some septic conditions.
- The Tunnel Bypass Solution removes the need for any impediments to flow and so is very unlikely to develop septic wastewater. It is likely that the fresher wastewater will be less likely to contribute to odour issues further downstream as a result.
- The Tunnel Bypass Solution is significantly less likely to accumulate sediment and debris accumulations. If a pump station is maintained, sediment will accumulate in the storage areas and require regular cleaning in order to not become an odour and corrosion issue.

4.2 Financial Analysis of Alternatives

35. EWSI evaluated the cost of Alternative 1 and 2 on a net present value (NPV) basis. EWSI calculated the NPV of the revenue requirement associated with these two alternatives for the expected tunnel bypass service life of 75 years. EWSI assumed a discount rate of 6.17% and annual inflation rate of 2%. Tables 4.2-1 and 4.2-2 summarize the results of this analysis. The

net present value of the cost to ratepayers (total revenue requirement) is $67.7 million for the Tunnel Bypass alternative compared to $81.1 million for the Active Treatment Solution. Although the Tunnel Bypass Solution has a higher initial capital expenditure, the Active Treatment Solution has higher ongoing operational costs which offset the benefit of lower capital expenditures. Based on both the financial and qualitative considerations, EWSI selected the Tunnel Bypass as the proposed alternative.

Table 4.2-1
NPV of Revenue Requirement
Alternative 1 - Tunnel Bypass Solution
($ millions)

		A	B	C	D	E	F	G	H	I	J
		NPV	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**Terminal Value**
1	Operating Expenses	$0.91	$0.13	$0.01	$0.02	$0.02	$0.03	$0.03	$0.04	$0.05	
2	Depreciation	$13.20	$0.00	$1.15	$1.15	$1.15	$1.15	$1.15	$1.15	$1.15	
3	Cost of Debt	$16.96	$0.00	$1.74	$1.49	$1.24	$0.99	$0.75	$0.50	$0.25	
4	Return on Equity	$31.24	$0.00	$3.21	$2.75	$2.29	$1.83	$1.37	$0.92	$0.46	
5	Franchise Fees	$5.42	$0.01	$0.53	$0.47	$0.41	$0.35	$0.29	$0.23	$0.17	
6	Terminal Value	$0.01	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1.15
7	**Revenue Requirement**	**$67.73**	**$0.14**	**$6.64**	**$5.87**	**$5.11**	**$4.35**	**$3.59**	**$2.82**	**$2.07**	

Table 4.2-2
NPV of Revenue Requirement
Alternative 2 - Active Treatment Solution
($ millions)

		A	B	C	D	E	F	G	H	I	J
		NPV	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**Terminal Value**
1	Operating Expenses	$8.91	$0.13	$0.35	$0.42	$0.51	$0.63	$0.76	$0.93	$1.13	
2	Depreciation	$19.98	$0.00	$1.42	$1.42	$1.78	$1.78	$2.05	$2.64	$2.64	
3	Cost of Debt	$15.92	$0.00	$1.36	$1.05	$1.23	$0.84	$0.90	$1.18	$0.61	
4	Return on Equity	$29.31	$0.00	$2.51	$1.94	$2.26	$1.55	$1.66	$2.18	$1.13	
5	Franchise Fees	$6.45	$0.01	$0.49	$0.42	$0.50	$0.42	$0.47	$0.60	$0.48	
6	Terminal Value	$0.53	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$64.12
7	**Revenue Requirement**	**$81.10**	**$0.14**	**$6.12**	**$5.25**	**$6.28**	**$5.21**	**$5.85**	**$7.54**	**$5.99**	

4.3 Tunnel Bypass Solution Financial Assumptions

36. The Tunnel Bypass Solution included at total of $85.9 million in capital additions being completed by 2025. A yearly operational expense of $116,200 (uninflated) is incurred until the abandonment of the Duggan Pump Station in 2026 with subsequent yearly operational expense of $12,000 (uninflated) being incurred there after. Costing for the tunnel bypass solution was first estimated through internal costing unit rates and was subsequently updated as part of the

preliminary design process completed by an external consultant. Costing for the tunnel bypass option is expanded upon in Section 5.0.

4.4 Active Treatment Solution Financial Assumptions

37. The Active Treatment Solution included a forecast of $70.6 million in capital additions. This includes: (i) rehabilitation of approximately 1.5 km of the existing deep tunnel ($18.3 million); abandonment of the Duggan pump station ($2.0 million); (iii) construction of a new pump station ($12.5 million); (iv) two drop structure modifications ($4.4 million); (v) one odour control/air extraction facility ($0.95 million); and (vi) relining of 3.1 km of the existing tunnel ($9.7 million).

38. The assumed capital costs were based on recent experience with similar projects in Edmonton. Pump station costing was updated based on the detailed costing analysis completed for the SA6 pump station and recent costing for a Buena Vista pump station replacement alternative. Drop structure modification and access manhole costing was updated based on recent costing for completed projects in the CORe strategy. Slip lining costs were updated based on experiences with the recent relining project on the South Edmonton Sanitary System Storage Tunnel. The rehabilitation costs were estimated assuming that only 50% (or 1.5 kilometers) of the existing Duggan tunnel requires rehabilitation. Costing for rehabilitation was reduced partially based on updated condition information and recent experience within CORe for costs associated with providing access provisions.

39. The cost analysis for the Active Treatment Solution excluded the potential costs of trunk replacement or rehabilitation at the current end of service date for the existing deep tunnel (2040), as the full scope of such activities could not be easily defined at this time. The costing also does not include provisions for future cleaning and removing of sediments in the Duggan Tunnel beyond 2022 as the frequency and scope of future cleaning operations has not been established. Even with these conservative assumptions, this is still the higher cost solution on a NPV basis.

40. Operating cost assumptions include $3.0 million in cleaning and inspection costs in 2022 and annual operating expenses of $278 thousand being incurred thereafter. Operating expenditures for the present and future operation of a pump station were based on the current yearly operational expense of the existing Duggan Pump Station. Operational costs for an OCU were estimated by an external consultant but based on past experience with the Kenilworth and King Edward Park OCUs. Inspection and cleaning costs were based on recent experience with tunnel cleaning operations at two locations along the North Edmonton Sanitary Storage Tunnel

where sediment accumulation is expected to be equivalent to the conditions in the Duggan Tunnel immediately upstream of the Duggan Pump Station.

4.5 Risks and Qualitative Considerations

41. For the Tunnel Bypass Alternative, risks and qualitative considerations include:

- while the wet weather storage capacity remains constant, there is an identified loss of wet weather storage control resulting from the abandonment of the Duggan Pump Station; and
- preliminary modelling indicates that the downstream impact remains manageable but there remains the risk that additional infiltration and inflow control measures, such as manhole sealing, may need to be implemented in the upstream sanitary catchment.

42. For the Active Treatment Alterative, risks and qualitative considerations include:

- risks associated with potential failure of the Duggan Tunnel or Duggan Pump Station;
- the potential for regular tunnel cleaning and sediment removal in the storage portions of the Duggan Tunnel;
- increased tunnel entry requirements;
- uncertainty in the long term viability of a new Odour Control Unit based on the historical performance of the Kenilworth and King Edward Park stations; and
- technical viability remains uncertain for rehabilitating and relining the tunnel when flow bypassing is required.

5.0 COST FORECAST

43. Total project costs are calculated based on the assumption of a bid-design-build project rollout for tunneling, tie-ins and the installation of the single odour ventilation unit. Costs for access manholes and working shaft construction were estimated assuming that in-house resource allocation is used. Table 5.0-1 provides the total forecast capital expenditures for this project.

Table 5.0-1
Duggan Tunnel Project
Capital Expenditure Forecast
($ millions)

		A	B	C	D	E	F
		Pre-2022	**2022**	**2023**	**2024**	**Post 2024**	**Total**
	Direct Costs						
1	Contractors	4.59	10.88	14.80	16.63	12.89	59.80
2	Internal Labour	0.29	0.14	0.14	0.14	0.12	0.83
3	Vehicles and Equipment	0.01	0.01	0.01	0.01	0.00	0.03
4	Abandonments	0.00	0.00	0.00	0.00	5.01	5.01
5	Contingency	0.07	0.00	2.72	5.83	2.26	10.89
6	Risk Allowance	0.00	0.00	0.00	0.00	0.00	0.00
7	**Sub-total Direct Costs**	4.96	11.03	17.67	22.62	20.28	**76.56**
8	Indirect Costs	0.15	0.65	1.52	2.80	4.21	9.33
9	**Total Capital Expenditures**	5.11	11.67	19.19	25.41	24.49	**85.89**

44. The capital cost estimates are based on unit rates provided by internal estimators and are as follows:

- $9,000 / meter of installed 1,500 mm tunnel installed via micro-tunneling
- $2,200 / meter of installed corrosion liner over the 3,202 meters of tunnel
- $24,000 / meter of depth for the five 20 meter deep working shafts
- $18,000 / meter of depth for the eight 20 meter deep access shafts
- $440,000 for one sewer air vent to provide pressurization relief
- $60,500 for the installation of one-way flaps and manhole sealing

45. Cost estimate unit rates are based on cost information from the City-Wide Flood Mitigation Strategy (pipes and tunnels) and the City-wide Odour Strategy. A further $400,000 has been allocated as an expenditure to support a detailed geotechnical study. The shaft installation unit costs assume labour and capital burden costs of 45% and 80% respectively. The ventilation unit cost is provided by an external estimator. The unit costs for the tunnel and liner are an estimate based on the internal expertise in the cost estimation group based on past projects. A 45% contingency has been applied. The unit rates together with the contingency costs also account for the miscellaneous works such as the tie-ins required for the new tunnel construction. It should be noted that construction costs associated with tunneling are highly volatile due the relatively small pool of contractor availability in this area, as well subject to market fluctuations influenced by the general construction activity in Alberta oil sands.

46. The project also incurs several operational expenses including tunnel and abandonment costs ($5 million), temporary pump station repairs ($0.9 million) and other costs for public consultations and odour venting. Estimated total operation expenditures by project completion are $6 million with an annual expenditure of $20,000 per year thereafter.

47. EWSI takes a number of steps to minimize the level of these capital expenditures. These include:

- constructability and risk assessment to understand risks associated with tunnel construction and carry out additional due diligence such as a detailed geotechnical assessment;
- part of the tendering strategy, identify a risk allocation strategy that provides more visibility to bidders to provide competitive pricing;
- a two stage tendering process to screen and identify competent tunneling contactors;
- project management during construction to include dedicated schedule and cost control personnel; and
- a rigorous scope change process.

6.0 RISKS AND MITIGATION PLANS

48. Key risks associated with executing this project along with EWSI's mitigation plans are summarized in Table 6.0-1.

Table 6.0-1
Key Risks and Risk Mitigations

	Risk	A Mitigation Plan
1	**Health & Safety Risks** - Covid 19 risks to project team and construction crews.	EWSI will develop pandemic response plan and contingency measures to minimize transmission of Covid 19 in line with ongoing Provincial /City recommendations.
2	**Customer Service Disruptions -** Traffic impacts resulting in customer complaints; the proposed tunnel pass through several schools in neighborhood with a potential to impact on school operations; and construction noise and vibration complaints along the tunnel alignment.	EWSI will design access shaft in location where traffic impact is minimized and will work with the City traffic operations and the contractor to develop traffic accommodation plans. Where possible, EWSI will avoid locating access/retrieval shafts near schools. Work with schools to identify access requirements and develop strategy to minimize disruption to school. EWSI will include noise and vibration monitoring at key locations in the contract.
3	**Financial Risks -** There is limited availability of tunneling contractors in Alberta resulting in cost escalation due to market conditions.	EWSI will ensure early engagement with potential contractors and will utilize a two stage tendering strategy to prequalify contractors.
4	**Environmental Risks** – There could be unexpected environment issues are encountered during construction at the shafts (e.g., contaminated soils). Potential sewage spill during construction and tie in.	EWSI will carry out Environmental Site Assessment and soil testing to identify potential contamination along the trunk line, design shaft locations accordingly and develop contingency plan for removal and remediation. EWSI will develop environmental management plan and commissioning plan to include spill contingency measures and bypass pumping plan as required.
5	**Execution Risks -** Changing geotechnical condition could add uncertainty to the proposed construction method. Utility conflicts resulting in construction delays and cost escalations	ESWI will conduct geotechnical investigations to confirm ground condition and engage experienced contractors for constructability review in advance. EWSI will identify utilities and carry out hydrovac excavations to confirm utility locations, design shaft structures to minimize utility conflicts and work with utility companies in advance of construction to relocate utility where required.

Appendix H5

EPCOR WATER SERVICES INC.

Drainage Services
CORe Large Trunk Rehabilitation Program
Business Case

February 16, 2021

Table of Contents

1.0 OVERVIEW

1. EWSI has initiated a Corrosion and Odour Reduction (CORe) Strategy that focuses on preventing the formation of hydrogen sulphide (H_2S) gas, which will reduce community odour impacts and lengthen the life of sewer network assets. Starting with the 2022-2024 PBR, the CORe strategy also includes the rehabilitation projects required due to H_2S induced corrosion are categorized as part of CORe PREVENT programs. These rehabilitation projects are included in the CORe strategy as the large trunk rehabilitation which are required primarily to prevent further corrosion to the system and lengthen the life of the assets damaged due to the corrosive gases in the drainage system.

2. The CORe Large Trunk Rehabilitation Program focuses on the rehabilitation of large trunk sewers greater than or equal to 1,200 mm in diameter. There are approximately 630 km of sanitary, storm, and combined large trunk sewers constructed over the past 100 years to varying standards and specifications. Currently, approximately 60 km large trunk sewers are rated in poor and very poor condition.

3. There are several risks associated with the deterioration and failure of large trunks including health and safety risks to the public associated with potential subsidence on high traffic roadways (e.g., the subsidence at 109 Street and 61 Avenue found in October 2020) or structural stability issues; environmental risks associated with failures of large trunks causing sewage spills to the environment; risk of significant customer service disruptions and traffic disruptions associated with large trunk failures; and financial risks associated with costly emergency repairs. Deterioration and failure of large trunks is largely due to corrosion and, as such, this program should be a key component of EWSI's CORe Strategy. The high number of odour reports and direct measurements of sewer gas surrounding certain assets is an indicator that sewer corrosion is a major risk factor in many trunk lines.

4. Rehabilitating these trunk lines can reduce the number of odour reports from the area because the same solids build-up in the area which promoted the formation of H_2S and corroded the trunk lines is being addressed while the trunk lines are fixed. Another example is the rehabilitation work in West Jasper Place where odour concerns led to an inspection that revealed an asset failure. In fixing the corroded assets in West Jasper Place, many components of the CORe Strategy such as cleaning out the debris, adding access points, and modifying the drop structures were implemented. Therefore, adding this rehabilitation program to CORe Strategy is consistent with the objectives of the strategy.

5. The CORe Large Trunk Rehabilitation Program will focus on the rehabilitation either through relining or spot repairs of trunk lines and/or replacement of longer lengths of large trunks rated as poor and very poor. The program will contribute to an improvement in the asset conditions and a reduction in risk. For the 2022-2024 PBR term approximately 4.9 km of large trunk rehabilitation is planned. The most cost effective solution will be developed and they could include relining, lining, spot repair, full replacement or bypass tunnel. For the 2022-2024 PBR, EWSI has forecast 2.4 km of rehabilitation in place (lining, relining, spot repairs) with costs in the range of $5,000/m to $10,000/meter and 2.5 km of full replacement (or bypass tunnel) with construction costs ranging form $10,000/m to $20,000/m. Based on recent inspections, EWSI has identified trunk sewers that are prioritized for rehabilitation or replacement during 2022-2024. These trunk sewers are described in detail below. The scope of work under this program includes inspection, rehabilitation or replacement of large trunk sewers.

6. The CORe Large Trunk Rehabilitation Program is a new program which will be initiated in 2022 which is categorized as reliability / life cycle replacement and is a key component of CORe Strategy. Prior to initiating this program, the large trunk rehabilitation works were conducted as discrete projects as needed. The total spending on the discrete large trunk rehabilitation projects from 2018 to 2020 was approximately $69.8 million which includes approximately $12 million in unplanned large trunk failures.

7. As EWSI continues to install access manholes as another component of the CORe strategy (through the CORe Access Manholes Program), it expects to be able to identify additional large trunks requiring immediate rehabilitation work at critical locations. EWSI has forecast total program capital expenditures during 2022-2024 at $79.0 million. This includes both new projects in the program and completion of some discrete large trunk rehabilitation projects which extend to the 2022-2024 PBR term. This reflects an increase in average annual spending on the large trunk rehabilitation works from $23.3 million per year to $26.3 million per year. The increase is required to mitigate the increased risk of failure of large trunks due to corrosion and deterioration.

2.0 BACKGROUND/JUSTIFICATION

8. EWSI initiated the CORe Strategy in 2019 to understand, mitigate and prevent sewer corrosion and odour issues across the City of Edmonton using a combination of capital and operational interventions. The CORe Strategy focuses on preventing the formation of H_2S gas, which will reduce community odour impacts and lengthen the life of sewer network assets. Under CORe, EWSI segregates the City into regions with consistent odour issues, those with dynamic odour issues, and those with emerging odour issues. Different approaches have been proposed for each region to ensure that causes of the odour are fully understood and to ensure that capital projects will provide sustainable relief. The capital projects and operating activities in CORe can be classified into four themes of investment: PREVENT, OPTIMIZE, MONITOR and CONTROL.

9. The Large Trunk Rehabilitation Program is a critical component of the CORe Strategy under the PREVENT theme. The CORe Large Trunk Rehabilitation Program focuses on the rehabilitation of large trunk sewers greater than or equal to 1,200 mm in diameter. There are approximately 630 km of sanitary, storm, and combined large trunk sewers constructed over the past 100 years to varying standards and specifications. The average ages for sanitary, storm and combined trunk sewers are 35, 38 and 62 years, respectively. Some of the trunk sewers are close to or beyond their design life of 75 years. H_2S induced corrosion has also caused trunk premature deterioration. Currently, approximately 60 km large trunk sewers are rated in poor and very poor condition. The definition of poor and very poor condition is as follows:

- **Poor condition** – major deterioration evident, extensive ongoing maintenance and/or operational "prop up" actions are required to keep the element operational.
- **Very poor condition** – element deteriorated to such an extent that it is generally inoperable or unsafe, history of failures, immediate need to replace most or all of the element.

10. According to the current system wide deterioration model, the large trunk sewers in poor and very poor conditions have an estimated replacement cost of $520 million. With the aging and deterioration of large trunk sewers, the risk of failure and collapse of these sewers will continue to increase. The subsidence at 109 Street and 61 Avenue and the subsidence at Whitemud Drive and 170 Street found recently are the result of the large trunk failure due to H_2S corrosion deterioration. Not completing the rehabilitation for the large trunks in poor or very poor condition could result in unexpected large trunk failures that have potential to affect large

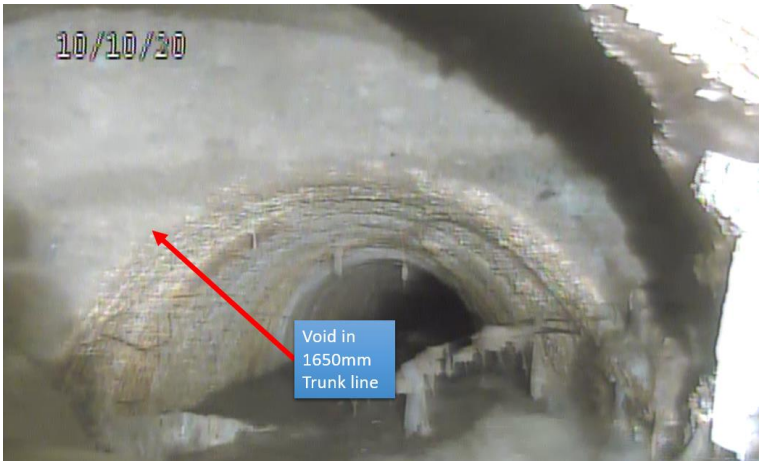
service areas and population. There are several risks associated with the deterioration and failure of large trunks:

- **Health and Safety Risk** – Failure of a large trunk could cause a subsidence on high traffic roadways or structural stability issues for infrastructures which poses a safety risk to the public. Figures 2.0-1, 2.0-2 and 2.0-3 show examples of severe deterioration and voids inside the 61 avenue trunk line which caused roadway subsidence. Replacing or rehabilitating pipe, manhole and chamber will extend the life of the trunk and lower the risks of trunk failure.

Figure 2.0-1
Severe Deterioration of 61 Avenue Trunk

Figure 2.0-2
Severe Deterioration of 61 Avenue Trunk

Figure 2.0-3
Void Inside 61 Avenue Trunk



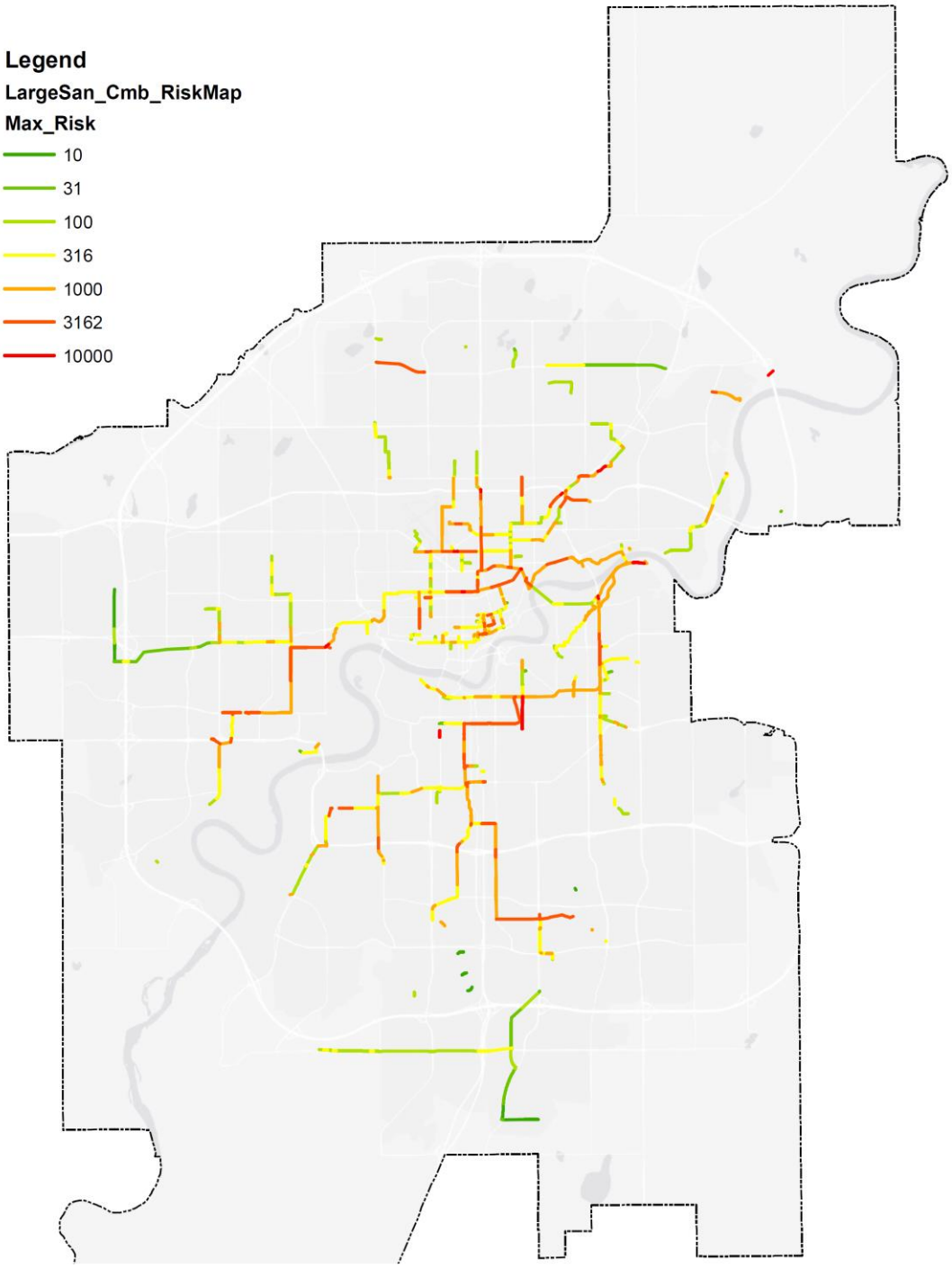
- **Environmental Risk** – Failure of a sanitary or combined large trunk could cause a sewage spill to environment or water bodies (river, creeks, storm water management facilities, etc.) and potential fines. Replacing or rehabilitating pipe, manhole and chamber will extend the life of the trunk and lower the risks of failure.
- **Customer Disruption Risk** – Failure of large trunks can cause disruption to large service areas impacting many customers and businesses for a few weeks or months and can cause sewer backups into customer's basements. Failed trunks also lead to emergency repairs which are more disruptive to high traffic roadways and therefore to the public. The odour reports and direct measurements of sewer gas surrounding certain assets is an indicator that sewer corrosion is a major risk factor in many trunk lines. Finding the affected trunk lines and implementing appropriate trunk rehabilitation will lower the risks of trunk failure and service interruption.
- **Financial Risk –** Emergency repairs of failed large trunks are more costly. Depending on the location and consequence of the failure, it could cost $1 million more to repair a failed trunk than repairing the trunk through more proactive rehabilitation. The proposed large trunk rehabilitation will lower the risks of trunk failure and, therefore, reduce the emergency replacement costs.

11. As the large trunk's conditions deteriorate it is important to prioritize inspections and rehabilitation works to deal with structural condition issues of large trunks and to mitigate the risks identified above. The CORe Large Trunk Rehabilitation Program aims to improve the conditions of the asset, which will therefore reduce the risk of failure for these assets. This program supports EWSI's asset management objectives by identifying emerging asset risks,

managing them appropriately, and reducing risk exposure. Risk prioritization will be used to prioritize trunk lines for inspection and for completion of the required rehabilitation work based on different perspectives including health and safety, environment, social impacts and financial.

12. EWSI has recently developed risk ranking for large trunk sewers based on their likelihood and consequence of failure. Figure 2.0-4 shows the risk ranking of the sanitary and combined trunks. The risk of each trunk was ranked based on the impacts on Health and Safety, Environmental, Regulatory, Customer Servicing, and Financial aspects in addition to the risk of trunk line failures.

Figure 2.0-4
Large Trunk Risk Ranking



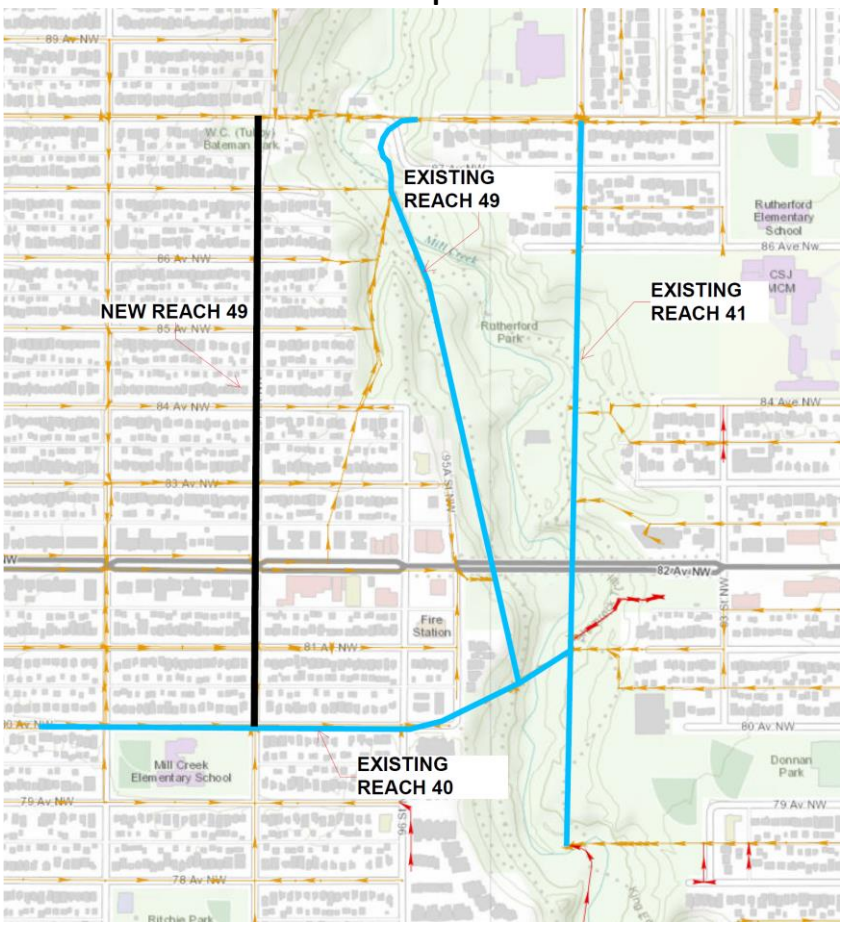
13. Through this program the following large trunk rehabilitation projects have been identified as the priority projects during the 2022-2024 PBR term. The CORe Duggan Tunnel Project is submitted as a separate business case as it was identified in the original CORe business

case focused on the priority odour area and is a new bypass tunnel project as opposed to rehabilitation of the existing deep trunk tunnel.

2.1 Mill Creek Combined Trunk Reach 49 Replacement

14. Reach 49 (built in 1960) provides drainage service to an area of Edmonton over 8,000 Ha in South Edmonton affecting a population of 300,000. The trunk reach is 800 m long 1,200 mm diameter combined bypass trunk in Mill Creek Ravine running from 80 Avenue to 88 Avenue. The trunk is in an environmentally sensitive area and contributes to the odour issues seen in this region due to its configuration with the adjacent trunk lines. Due to location there are limitations in the ability to complete full rehabilitation in its current alignment. It is proposed to build a new trunk along 97 Street and convert the existing Reach 49 to a local sewer trunk for the neighbourhood immediately to the west of the pipe. The portion of trunk line between this new location and Reach 41 will be abandoned. This reconfiguration will also increase the trunk line capacity available in Reach 41 to provide additional sewer capacity for the growth node east of Mill Creek identified through City Plan and the Transportation Orientated Development in this region. Figure 2.1-1 shows the trunk alignments.

Figure 2.1-1
Reach 49 Replacement



15. A large hole was found in Reach 49. Multi-sensor inspections (MSI) completed provided more information on the trunk condition including identification of another large hole in Reach 41. To reduce the risk of imminent trunk failure, local repair of the two large hole locations (at Reaches 41 and 49) was completed in early 2020 to avoid trunk failure Figures 2.1-2 and 2.1-3 show the poor to very poor conditions at the junction of Reaches 40 and 49.

Figure 2.1-2
Large Void Upstream of Reach 49

Figure 2.1-3
Severe Corrosion in Manhole 246631 and Junction of Reach 40 and 49

16. While no immediate work is required for the remaining segment of Reach 49, rehabilitation is required within the next few years to avoid trunk failure that would result in:

- danger to the public due to trunk failure that could result in settlement and/or collapse on trails and roads;
- loss of service for an area of 8,000 ha in south Edmonton affecting a population of 300,000 for months;

- possible raw sewage spill into the Mill Creek and downstream water courses, impacting the public health and with serious environmental regulatory implications; and
- more costly emergency replacement.

2.2 99 Avenue and 151 Street Trunk Sewer Rehabilitation

17. The 99 Avenue and 151 St Trunk Sewer Rehabilitation Project is one of the ongoing discrete large trunk rehabilitation projects which will extend into the 2022-2024 PBR term. The existing 99 Avenue sanitary trunk was constructed in 1972. This trunk system is part of the West Edmonton Sanitary Sewer (WESS) system which services over 117,000 customers in west Edmonton. The existing 99 Avenue sanitary trunk has been identified as having sections in very poor condition as shown in Figure 2.2-1 below.

Figure 2.2-1
Photo Condition of 99 Avenue Trunk

18. The deterioration was caused by hydrogen sulphide gas, which if present, reduces the thickness and strength of the concrete wall and increases the risk of collapses. As a result, approximately 1,080 m of the trunk is currently in poor to very poor conditions and in need of rehabilitation.

2.3 Other Large Trunk Rehabilitation

19. There are some known issues in some other large trunk sewers where rehabilitation is required within the 2022-2024 PBR term to avoid trunk failure.

20. One identified location has significant evidence of corrosion and other structural defects were found in in Area C-2 which is located adjacent to downtown in the McCauley, Parkdale, and Alberta Avenue neighbourhoods. Based on the findings from MSI conducted in 2019, portions of trunk sewers are in poor or very poor condition. In addition, a chamber in Combined Trunk Sewer No. 94 (Cmb_94) is located in a men's washroom at Commonwealth Stadium. It is extremely difficult to perform any operation and maintenance activities and it poses high risk for public safety as well. Therefore, Cmb_94 is recommended to be rehabilitated with a high priority.

21. Another location is the 151 Street south trunk, which is running beneath 151 Street from 93 Avenue to 99 Avenue. It is a 1,676 mm deep and 1,200 mm wide arch-shaped sanitary trunk and was constructed in the late 1960s. This tunnel section is approximately 1,035 m long and is located approximately 30 m beneath the ground surface. Inspection of this trunk was completed. The results of the inspection indicate that the trunk is in fair-to-poor to poor condition, with the furthest downstream section rated as very poor. There are numerous instances of material loss throughout the tunnel, and four holes identified in the crown region of the tunnel. Therefore, local area rehabilitation is required within the PBR term to prevent trunk failure at the worst sections.

22. Sanitary Trunk Sewer No 11 (SAN-11) Double Barrel (DB) pipe along east side of 116 Street from 102 Avenue to 108 Avenue is another identified location for this upcoming PBR. The total length of the DB pipe is about 1.12 km. According to the preliminary inspection results, portions of the divider wall (membrane) in the 1,650 mm diameter DB pipe were missing or deteriorated. The membrane was designed to separate storm and sanitary flows in the DB pipe. The compromised membrane has allowed untreated wastewater from the sanitary collection system to flow into the storm system which discharges to the North Saskatchewan River. This could result in serious environmental regulatory issues. The inspection also found voids around the sanitary drop pipe connection located at 116 Street and 108 Avenue. Further deterioration could result in trunk failure. Therefore, it is planned to complete the SAN-11 DB pipe rehabilitation by 2024.

23. In addition to the trunk sewers with known issues due to aging and deterioration of large trunk infrastructure, unexpected large trunk failures may also occur. The unexpected failures can

cause sink holes on high traffic roadways or structural stability issues for the infrastructure. In the past two years several unexpected large trunk failures have caused subsidence at 109 Street and 61 Avenue, Whitemud Drive and 170 Street, and Allendale. For the 2022-2024 PBR term, EWSI will accommodate trunk repairs after inspections identify an imminent risk of failure of the trunk line by prioritizing the projects based on the risks.

3.0 PROGRAM DESCRIPTION

24. The Large Trunk Rehabilitation Program will focus on the rehabilitation and/or replacement of large combined and sanitary trunks rated as poor and very poor. Rehabilitation to respond to the large trunk sewer failures or imminent failures are part of this program as well. For the 2022-2024 PBR term, EWSI plans to complete approximately 4.9 km of rehabilitation or replacement over the three years.

25. The scope of work for this program will include inspection, rehabilitation, or replacement of large trunk sewers. In some cases it may also include construction of new small trunks when required to accommodate growth. Trunk condition inspection, including MSI and physical invasive inspections may be required depending on the location, access, depth, and flow. Inspection results will be reviewed and rated based on the Pipe Assessment Certification Program (PACP) Ranking System as shown in Table 3.0-1 and the Large Trunk Condition Rating Scales as shown in Table 3.0-2 to determine the rehabilitation priority.

Table 3.0-1
PACP Condition Grading

Grade		A Definition
1	5	Most significant defects
2	4	Significant defects
3	3	Moderate defects
4	2	Minor to moderate defects
5	1	Minor defects

Table 3.0-2
Large Trunk Condition Rating Scales

Rating		A Category	B Descriptions
1	I	Good	– Concrete wall loss greater than and equal to 5% of the design thickness. – No evidence of active surface corrosion/leaching or areas of exposed aggregates – Surface pH > 6. – Re-inspection within 10 years.
2	II	Fair	– Concrete wall loss greater than 5% to less than and equal to 15% of the design thickness at multiple locations. – Scattered areas of active surface corrosion/leaching and / or areas of exposed aggregates. – Surface pH > 5 and less than or equal to 6. – Re-inspection within 10 years.
3	III	Fair to Poor	– Concrete wall loss greater than 15% to less than and equal to 30% of the design thickness at multiple locations. – Scattered areas of active infiltration. – Continuous exposed aggregates throughout. – Surface pH > 3 and less than or equal to 5. – Re-inspection within 5 years.
4	IV	Poor	– Scattered exposed reinforcement steel. – Concrete wall loss greater than 30% to less than and equal to 50% of the design thickness at multiple locations. – Intermittent sections of surface corrosion above water level. – Continuous infiltration throughout the joints and wall. – Surface pH > 2 and less than or equal to 3. – Mitigation action is needed.
5	V	Very Poor	– Exposed ribs. – Concrete wall loss greater than or equal to 50% of the design thickness at multiple locations. – Exposed wood lagging. – Continuous sections of surface corrosion above water surface. – Surface pH < 2. – Immediate mitigation action is needed.

26. The selection criteria for large trunk rehabilitation are shown in Table 3.0-3.

Table 3.0-3
Selection Criteria for Large Trunk Rehabilitation

	Selection Criteria for Rehabilitation	A Definition
1	Pipe Sizes	Equal or greater than 1,200 mm in diameter
2	Non-linear Assets	Manholes, Chamber Structures
3	Drainage Asset Condition	Pipes and manholes/chambers having defects of Grade 4 or 5 as per PACP, or
		Rating IV and V (Poor and Very Poor) as per Large Trunk Condition Rating Scales, or
		Other known issues
4	Operational Issues	Sags, excessive inflow/infiltration, excessive sediment, encrustation
5	Risk Level	High, Medium-High
6	Synergy with Other Projects	Coordination potential with other EPCOR projects
7	Implementation Priority	High operational impacts and high environmental risks.

27. Due to the complexity of the large trunk rehabilitation work, it can take multiple years from inspection to design and completion of construction for each trunk rehabilitation project depending on the scope and site-specific constraints. As such, there are multiple large trunk rehabilitation projects underway within the 2022 to 2024 PBR term and some projects may carry over from the previous years or span beyond 2024 into the next PBR term. The 2022-2024 PBR term projects are in different stages from inspection and concept development to construction. Based on the selection criteria for Large Trunk Rehabilitation Program and the known issues, it is estimated that rehabilitation of 4.9 km large trunks and associated manholes/chambers would be completed between 2022 and 2024. The most cost effective solution will be developed and they could include relining, lining, spot repair, full replacement or bypass tunnel. The scope of some of the identified large trunk rehabilitation projects are described below:

3.1 Mill Creek Combined Trunk Reach 49 Replacement

28. Mill Creek Combined Trunk Reach 49 provides drainage services to an area of over 8,000 ha in south Edmonton. After completing detailed trunk condition assessments, Reach 49 was determined to require high priority attention. After completing a thorough evaluation on the potential rehabilitation and replacement options, a new trunk is proposed along 97 Street to replace the existing Reach 49.

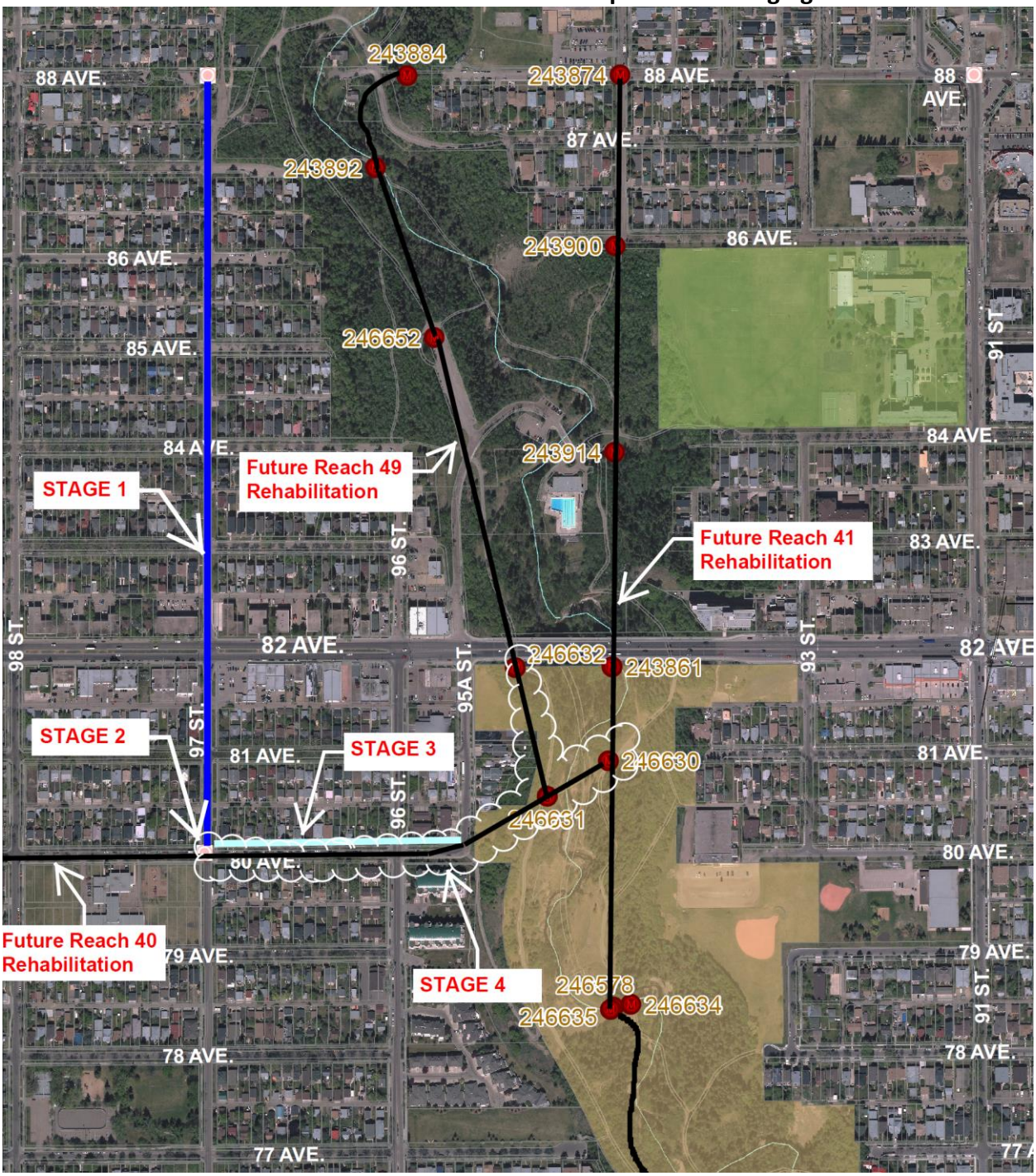
29. The project will be completed in several stages. See Figure 3.0-1.

- Stage 1: Construct a new 2100 mm trunk along 97 Street (approximately 820 meter long), and connect it to the 1500 mm combined trunk at 88 Avenue.

- Stage 2: Connect the new trunk to Reach 40 at 80 Avenue to intercept the flow from Reach 40.
- Stage 3: Relocate the local sewer at 80 Avenue which currently drains to Reach 40 at 96 Street to direct the local flow to the new trunk.
- Stage 4: Abandon Reach 40 east of 97 Street and upstream of Reach 49 with the very poor segments.

30. The cost from 2022 to 2024 for the Mill Creek Combined Trunk Reach 49 Replacement is estimated to be $27.6 million which includes the costs of 820 m replacement trunk, approximately 200 m local sewer relocation and 500 m abandonment of existing trunk which is in very poor condition. The existing Reach 49 will be converted to a local sewer to convey existing local flows.

Figure 3.0-1
Mill Creek Combined Trunk Reach 49 Replacement Staging Plan



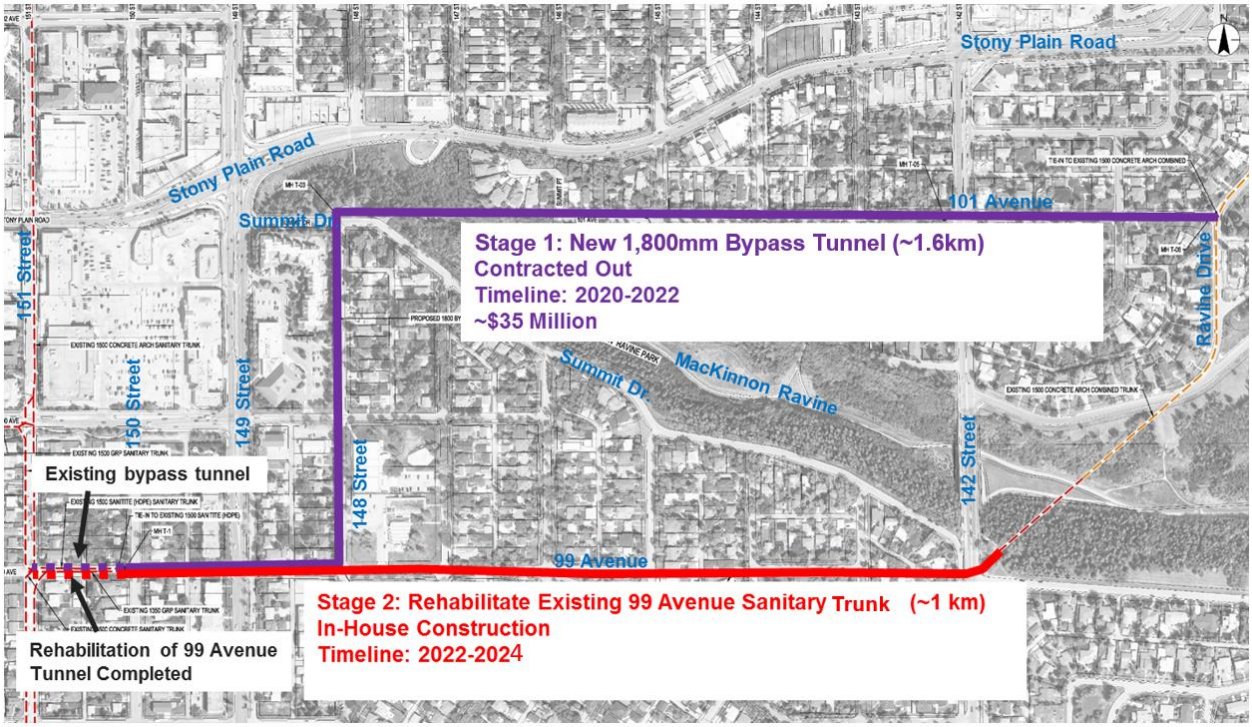
3.2 99 Avenue and 151 St Trunk Sewer Rehabilitation

31. As one of the ongoing discrete large trunk rehabilitation projects, this project is being completed in two stages. The first stage started in 2020 and is expected to be completed in

mid-2022. This stage aims to construct a new tunnel (approximately 1,636 m of 1800 mm diameter bypass tunnel) which will allow for the flows in the existing trunk to be diverted into the new tunnel to facilitate the rehabilitation of the existing trunk. The bypass tunnel will also provide benefit to protect the downstream sanitary and combined trunks from surcharging during wet weather flow conditions. The second stage of the project is planned to start in 2022 and to be complete in 2024. The aim of the second phase is to rehabilitation of 1,080 m of existing trunk along 99 avenue.

32. In addition to meeting the requirements to rehabilitate the existing tunnel, the construction of the proposed bypass tunnel, will provide additional storage capacity upstream of the W3, W4 and W5 section to protect the sanitary and combined trunks from excessive surcharging during wet weather flow conditions. Figure 3.0-2 shows the 99 avenue and 151 street Trunk Rehabilitation Staging Plan.

Figure 3.0-2
99 Avenue and 151 Street Trunk Rehabilitation Staging Plan



33. The project cost from 2022 to 2024 is estimated to be $29.7 million which include the costs of the remaining construction for the 1,636 m bypass tunnel and 1,080 m of existing trunk rehabilitation.

3.3 Other Large Trunk Rehabilitations

34. Due to aging and deterioration of the existing large trunk sewers, there are some known and emerging issues in some large trunk sewers. Based on the selection criteria for the CORe Large Trunk Rehabilitation Program, it is estimated that $21.75 million is required during the 2022-2024 PBR term to complete approximately 1.3 km of required large trunk rehabilitation works in addition to the Mill Creek Combined Trunk Reach 49 Replacement and the 99 Avenue and 151 Avenue Trunk Rehabilitation. The priority of the other large trunk rehabilitations will be determined based on the trunk conditions after the inspections are completed. Due to aging and deterioration of large trunk infrastructure, unexpected large trunk failures may occur. The unexpected failures would need to be addressed as a high priority. EWSI will prioritize the projects in the CORe Large Trunk Rehabilitation Program based on the urgency and overall risk.

4.0 ALTERNATIVES ANALYSIS

35. An alternative to the large trunks program is to do nothing and not rehabilitate any large trunks. Risks associated with leaving the trunks as status quo include:

- Health and Safety risks - leaving large trunks in poor or very poor condition in the drainage system could result in settlement and collapse on roads causing potential risks to public safety.
- Environmental and Regulatory risks - trunk failures could result in raw sewage spilling into watercourses which could impact public health, environmental compliance, and may result in potential fines to EWSI.
- Services Disruption risks - trunk failures could result in service interruptions affecting a significant part of Edmonton for a few weeks to a few months.
- Financial risks - trunk failures could result in more costly emergency replacement.

36. The status quo option does not align with EWSI's objectives and commitments to the City to mitigate these risks and is therefore not an acceptable option. Due to the complexity of the large trunk rehabilitation projects, a variety of alternatives on the trunk rehabilitation and replacement for each project is explored to determine the optimal solution. The alternatives will be developed with the consideration of the project specific conditions, criteria and constraints. The potential alternatives include trunk line replacement, trunk rehabilitation in place, (e.g., relining or spot repair), and combination of replacement and rehabilitation. These alternatives have been included in this program to achieve the most cost efficient option

wherever possible. Alternatives considered for the two identified large trunk rehabilitation projects are described below:

4.1 Mill Creek Combined Trunk Reach 49 Replacement

Alternative 1: Replace Trunk Reach 41 and 49 with New Tunnels

37. This option requires both existing Trunk Reach 41 and 49 to be abandoned and replaced with new trunks adjacent to Mill Creek Ravine. The new trunk Reach 49 consists of a 2100 mm tunnel to connect Trunk Reach 40 at 80 Avenue and the downstream trunk line at 88 Avenue. The new Trunk Reach 41 is proposed to consist of a 900 mm pipe to connect the existing 600 mm sewer south of 76 Avenue to the 88 Avenue trunk line. This option was eliminated due to the requirement of significant local sewer reconstruction which would cause surface disturbance, drainage service interruption, and significant adverse traffic impacts in multiple neighbourhoods for multiple years.

Alternative 2: Rehabilitate all Three Trunk Reaches in Place

38. This option proposes all three existing trunks to be rehabilitated in place. Several challenges have been identified associated with the trunk rehabilitation, including limited construction access, significant adverse environmental impacts, geotechnical conditions within the ravine, and a high cost for temporary flow bypass during trunk rehabilitation. It could result in a project cost of $48 million which would be approximately $20 million higher than the recommended alternative.

Alternative 3 (proposed): Rehabilitation and Replacement in Staging

39. Rehabilitation and replacement in staging was considered in this option. This option was refined and recommended as the preferred option to proceed.

4.2 99 Avenue 151 St Trunk Sewer Rehabilitation

40. A series of workshops were conducted in 2016 and 2017 to develop a concept design to address the deterioration in the pipe. The workshops explored various potential solutions and assessed their feasibility and suitability. The following nine options were initially developed for consideration:

Alternative 1: New Tunnel Parallel Alignment

41. This alternative was considered to align a new trunk underneath four residential properties. Attempts to secure additional strata easements was not successful and therefore it was eliminated.

Alternative 2: New Tunnel South Alignment

42. This alternative was not deemed technically viable as the length of this alignment, combined with minimum pipe slope, would result in tying into the existing trunk below its existing elevation which is not acceptable.

Alternative 3: New Tunnel North Alignment

43. This alignment would take the trunk along Stony Plain Road, which was not technically viable due to conflicts with other planned projects.

Alternative 4 (proposed): Rehabilitation in Dry Conditions with Bypass Tunnel Parallel Alignment

44. This alternative involves completing the project in two stages. The first stage is the construction to construct a new tunnel which will allow for the flows in the existing trunk to be diverted into the new tunnel to facilitate the rehabilitation of the existing trunk. The second stage of the project is planned to rehabilitate the existing trunk. At the end of the project, both tunnels will be put into service. This alternative will provide additional storage capacity upstream of the W3, W4 and W5 section to protect the sanitary and combined trunks from excessive surcharging. This is the proposed alternative.

Alternative 5: Rehabilitation in Dry Conditions with Shallow Bypass Pipe and Pumping

45. This alternative will involve installing a temporary lift station to bypass the flows to allow rehabilitate of the existing tunnel. This was not considered viable given the potential high risk of significant tunnel surcharge and the need to build a significant temporary bypass pumping system which would not provide any hydraulic capacity benefits.

Alternative 6: Rehabilitation in Dry Conditions with Deep Bypass (Upper) Tunnel and Pumping

46. This alternative was similar to Alternative 5, though with different bypass pumping configuration. This was not considered viable as the same reasons as Alternative 5.

Alternative 7: Rehabilitation in Dry Conditions with Inline Storage and Pump Bypass

47. This option was similar to Option 5, though with different bypass pumping configuration. This alternative was not considered viable given the risks presented by relying on storage inside the trunk to reduce bypass pumping costs.

Alternative 8: Rehabilitation in Wet Conditions with Sliplining

48. This alternative involves sliplining, pushing a new pipe inside the old pipe, while the sewer is in operation. While this is technically feasible, EWSI determined that there were no contractors available in Canada and that the overall risk of the methodology is high. For these reasons this alternative was rejected.

Alternative 9: Partial Wet Rehabilitation and Chemical Injection (20 Year Horizon)

49. This alternative required patching the worst areas to reduce the further deterioration and reassess in the future. This alternative was rejected because it does not address the long-term risks associated with the deteriorated trunk condition.

5.0 COST FORECAST

50. The program cost estimates for the 2022 to 2024 PBR term are shown in Table 5.0-1 and are based on costs of trunk rehabilitation from previous projects with the similar scope. The assumptions are as follows:

- 2.4 km of rehabilitation in place and 2.5 km of replacement over the PBR period;
- The unit construction costs of trunk replacement range from $10,000/m to $20,000/m depending on the size, depth, and alignments;
- The unit construction costs of rehabilitation in place range from $5,000/m to $10,000/m depending on the size, depth, and locations;
- Except for Mill Creek Combined Trunk Reach 49 Replacement Project where a new replacement trunk is to be installed in a new alignment, all other trunk rehabilitation works are assumed to be rehabilitated in place and the cost forecast was estimated accordingly. In the case that trunk rehabilitation in place is not feasible and the trunk has to be replaced, the cost of replacement may be higher than the forecast cost;
- Trunk rehabilitation construction can be completed by either internal or external resources depending on the scope of work and the availability of in-house construction resources;

- Trunk replacement construction will be completed by external resources;
- The construction costs are based on the unit rate estimate for trunk rehabilitation and trunk replacement from the previous projects with of similar scope;
- An overall contingency of 10% to 30% has been included in the estimates based on the maturity level of each project;
- Geotechnical investigations, environmental assessments and other engineering services as needed will be completed by external engineering consultants;
- MSI inspections will be completed by external contractors;
- The in-house resource will perform: trunk replacement and rehabilitation design, project coordination and management, general engineering during construction, construction completion certification (CCC) inspection, etc.; and
- Based on the project maturity level, contingencies of 30% have been included with the consideration of project uncertainties.

Table 5.0-1
Large Trunk Rehabilitation Program
Capital Expenditure Forecast (2022-2024)
($ millions)

		A **2022**	B **2023**	C **2024**	D **Total**
	Direct Costs				
1	Contractors	15.82	21.81	12.62	50.25
2	Internal Labour	1.68	1.40	2.51	5.60
3	Vehicles and Equipment	0.57	0.59	0.27	1.44
4	Abandonments	0.00	0.00	0.75	0.75
5	Contingency	0.64	6.67	7.16	14.47
6	Risk Allowance	1.50	0.73	0.00	2.23
7	**Sub-total Direct Costs**	**20.21**	**31.21**	**23.31**	**74.74**
8	Capital Overhead and AFUDC	0.85	1.47	1.95	4.27
9	**Total Capital Expenditures**	**21.06**	**32.68**	**25.26**	**79.01**

51. The Large Trunk Rehabiliation Program cost estimates broken down into the major projects are shown in Table 5.0-2.

Table 5.0-2
Large Trunk Rehabilitation Program by Project
Capital Expenditure Forecast (2022-2024)
($ millions)

		A	B	C	D
		2022	**2023**	**2024**	**Total**
1	Mill Creek Combined Trunk Reach 49 Replacement	4.53	10.18	12.85	27.56
2	99 Avenue and 151 St Trunk Sewer Rehabilitation	13.21	14.45	2.01	29.67
3	Other Large Trunk Rehabilitation	3.32	8.05	10.4	21.75
4	**Total Program Costs**	**21.06**	**32.68**	**25.26**	**79.01**

52. EWSI takes a number of steps to minimize the level of these capital expenditures. These include:

- EWSI has taken advantage of longer-term contracts with vendors to effectively manage the supply, quality and construction of required equipment. As such, EWSI has minimized the need to stock much of the required equipment reducing the overall costs of all installations and upgrades. Also the longer term construction contractor relationship allows us to mobilize the contractor efficiently and effectively as they are familiar with our and City's standards and master contractor agreements are in place.
- All activities related to project management, design, drafting, construction coordination and inspection, and as-built recording will be undertaken internally by EWSI, eliminating the need for external consultants. The actual construction, including surface restoration, will be completed by one of EWSI's long term construction contractors.
- Contracted services are performed by pre-qualified external contractors and done on a competitive unit priced basis, using comprehensive engineering packages to ensure cost and scope control.
- The installations will be consistent with EWSI's construction standards which will minimize stock requirements and speed up design and construction.
- Where possible, work will be coordinated with other projects or maintenance activities to minimize costs.
- Every project is evaluated individually to determine the appropriate construction method to meet requirements at the lowest cost.
- Every project scope is evaluated to improve economy of scale.
- All force accounts are documented and reviewed by several EWSI representatives to ensure the additional cost is justified under the terms of the contract.

6.0 RISKS AND MITIGATION PLANS

53. Completion of the large trunk rehabilitation/replacement work would lower the risks associated with the potential trunk failure. The risks associated with execution of the work have also been identified and summarized in Table 6.0-1.

Table 6.0-1
Program Risks and Mitigations

	Risk Area	A Risks	B Mitigations
1	Health and Safety	Working in confined space without proper training or permit results in injuries and potential fine from OH&S during construction.	EWSI will ensure that contractors have a safe work plan, emergency response plan and other plans to ensure that it meets EPCOR standards.
2	Environmental	Risk of sewage leakage associated with flow bypass methods during construction results in environmental incompliance and potential fines of several million dollars.	EWSI will develop detailed flow monitoring and bypass plan with sufficient standby capacity to reduce the risk of bypass leakage.
3	Customer Impacts	Stakeholder communication issue/concern during construction results in business, resident and councilor inquiries.	EWSI will prepare a stakeholder communication plan.
		Construction on congested road will disrupt traffic.	EWSI will engage experienced construction manager, and project manager to develop an optimal construction staging plan and coordinate with the City to obtain OSCAM permits.
4	Execution Risk	Limited access to perform the rehabilitation work may result in construction delays and construction cost increase.	EWSI will develop rehabilitation or replacement alternatives to select the most cost effective option to perform the work.
5	Financial	Limited access to the trunk to perform the rehabilitation work may result in construction delays and construction cost increase.	EWSI will develop rehabilitation or replacement alternatives to obtain/construct the required access to perform the work.

Appendix H6

EPCOR WATER SERVICES INC.

Drainage Services
Drill Drop Manholes Program
Business Case

February 16, 2021

Table of Contents

1.0 OVERVIEW

1. The Drill Drop Manhole (DDMH) Renewal Program is an annual program that includes costs to inspect and systematically rehabilitate or replace failing DDMHs which are small diameter shafts extending from the ground surface into the trunk sewer. These were built using corrugated metal pipes (CMP) which are highly susceptible to corrosion. Many of the DDMHs are beyond their expected life. The DDMH Renewal Program was initiated in 2006 to address risk of failure of these manholes. Prior to 2006, a high number of emergency DDMH repairs heightened awareness of this issue and the need for a proactive response. EWSI estimates approximately 300 DDMHs exist in the drainage system and this program has renewed or abandoned approximately 66 since its inception. During the 2022-2024 PBR term, this program is forecast to complete 110 DDMH inspections, 12 DDMH full replacements and 30 DDMH rehabilitations (relining). By the end of 2022-2024 PBR term, EWSI expects that through this program and other capital and operational programs it will have determined baseline conditions for all of the DDMHs through these inspections which will aid in reducing the overall risk of significant failures of these structures.

2. Failure of these manholes may cause road subsidence or sinkhole formation. Risks of failure include health and safety risks to the public and traffic impacts associated with road subsidence/sinkhole formation and financial risks associated with costly emergency repairs and flooding. The most notable recent example of a failure was at a location on Allendale Road and Calgary trail. Upon inspection, it was determined that from 16 m below ground to the trunk sewer, 7 m of the corrugated metal pipe manhole was missing and a large void had formed. Where the DDMH previously connected to the trunk sewer, a hole remained and within several days, settlement of the road surface was seen in the wheel path of vehicles. The location is a very busy intersection and therefore a high safety risk to the public, and has also caused major traffic disruption in the area. As this DDMH is part of the combined system, the failure allowed for flow of untreated wastewater to the soil in the surrounding area. The total cost of emergency repairs were $3.5 million and the work took 16 months to complete. If the trunk sewer had collapsed, EWSI estimates this would have impacted over 200 businesses and a 37 hectare area.

3. Selection of DDMHs for renewal will be based on those identified as requiring immediate rehabilitation or replacement to prevent voids, collapses or sinkholes. Following inspections, EWSI has established criteria to risk rank DDMHs in order to prioritize for rehabilitation or replacement. The criteria includes condition assessment based on the Closed Circuit Televising

(CCTV) inspection, number of inlets/functionality, depth of the trunk, road classification/location and synergy with other projects.

4. This program is categorized as reliability / life cycle replacement and is one of the Drainage System Rehabilitation programs. The scope of this program includes annual inspection of approximately 35 DDMHs, assessment and prioritization of inspected DDMHs and design and construction of approximately 3 to 4 DDMH replacements and 10 DDMH rehabilitations annually. EWSI has forecast total program capital expenditures during 2022-2024 at $13.11 million. This reflects an increase in average annual spending on this program from $2.3 million per year to $4.3 million per year. The increase is required to address the higher frequency of emergency projects emerging from deficient DDMHs in the last few years. More investment is needed to address the DDMHs in the system before they become emergency projects because of the inherent risks of these DDMHs. These system failures present a high safety risk for EWSI employees and the public.

2.0 BACKGROUND/JUSTIFICATION

5. Drill Drop Manholes (DDMHs) were constructed as equipment or emergency access points during tunnel construction of many of Edmonton's deep combined, storm and sanitary trunk sewers. They are small diameter shafts extending from the ground surface into the trunk sewer, and housed power cables, lighting and ventilation systems during construction of the sewer. They are generally constructed of corrugated metal pipe (CMP) or cast iron (CI) pipe. Many of these DDMHs were left in place following completion of the trunk, instead of being properly abandoned at the end of the tunnel construction. Subsequently, numerous DDMHs were utilized as receiving manholes for local sewers. During the connection of local sewers to DDMHs, many of them were modified by replacing the top section of the DDMH (about 5m to 9m deep from ground surface) with standard size manholes to accommodate the sewer connection. Corrugated metal pipe and cast iron are prone to corrosion, and have a typical lifespan of only 30-40 years when used in conditions found in the trunk sewers. Consequently, many of the DDMHs are beyond their expected life span.

6. Records indicate approximately 300 DDMHs existed in the drainage system when the DDMH Renewal program was first initiated. Since its inception, this program has rehabilitated 43 DDMHs and abandoned 23 DDMHs. When DDMH structures are abandoned, the piping must be reconfigured to eliminate the need for the DDMH at that location. Table 2.0-1 provides the

historical data on DDMHs in terms of number within each age range and the number rehabilitated and abandoned since inception of this program.

Table 2.0-1
Historical Drill Drop Manholes Age and # Rehabilitated or Abandoned
(2020 Data)

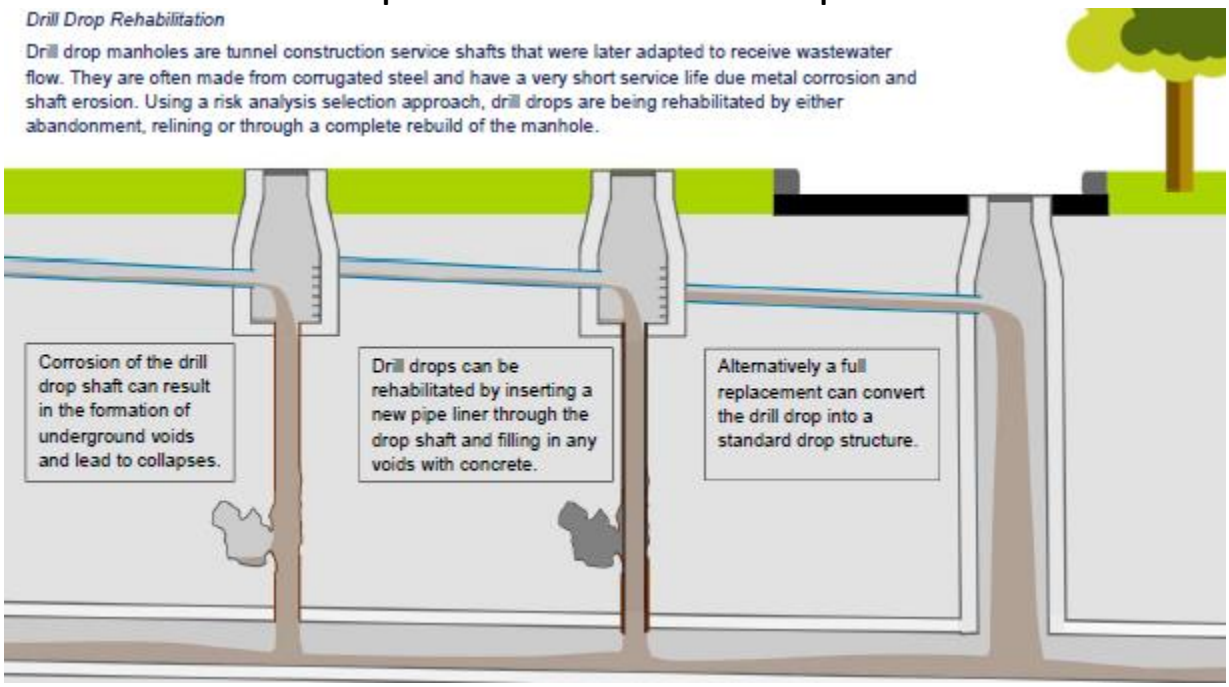
		A	B	C	D	E
	Age of DDMH	**Quantity**	**Percentage**	**Number of Rehabilitated DDMHs**	**Number of Abandoned DDMHs**	**Total Number of DDMHs Abandoned or Rehabilitated**
1	>100 years	3	1.0%			
2	80 - 100 years	6	2.0%			
3	60 - 80 years	8	2.7%			
4	40 - 60 years	224	75.7%	39	20	59
5	30-40 years	43	14.5%	3		3
6	20 - 30 years	12	4.1%	1	3	4
7	< 20 Years	0	0.0%			
8	**Total**	**296**	**100%**	**43**	**23**	**66**

7. There are several alternatives for the renewal methods for DDMHs. The method for each DDMH will be selected based on its structural integrity, connection type to the trunk, access points, and other engineering considerations.

1) Full Replacement – This method must be used where the DDMH is in such poor condition and no viable rehabilitation option is available. Functionality can also be the driver for full replacement if there are a number of sewer connections present, and if there is a risk of back-ups or inability to remove an obstruction.
2) Rehabilitation (Relining) – This includes options such as slip lining or cured in place pipe, and cannot be used where there are side connections to the trunk or if the DDMH is corroded away. This method reduces the hydraulic capacity of the DDMH.

8. Once the condition of the DDMHs are determined through inspection, the best method of remedying any issues found will be explored and documented. Figure 2.0-1 shows both the rehabilitation and full replacement options for renewing DDMHs.

Figure 2.0-1
Drill Drop Manhole Rehabilitation and Replacement

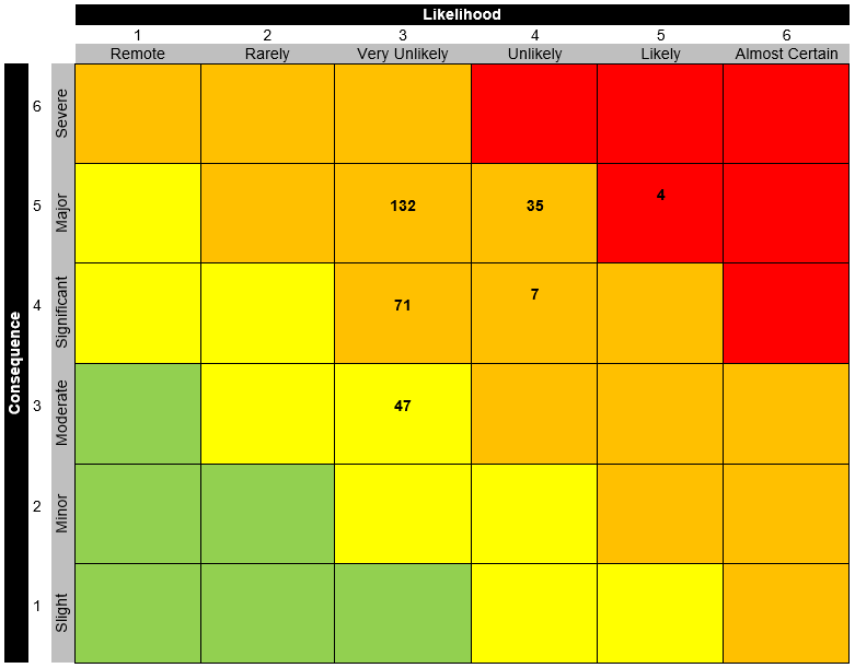


9. The DDMH Renewal Program was initiated in 2006 as a proactive response to concerns about the risk of failure of these manholes, especially as about 40% or 120 of these were approaching or well past their design life of 35 years. Several emergency repairs of failed DDMHs prior to 2006 also heightened awareness of this issue and elevated the need for the program. The potential consequences of failure of these assets include road subsidence or sinkhole formation, resulting in public safety and traffic impacts, flooding and costly emergency repairs.

10. Historically DDMH's selected for inspection were based on the risk ranking using methodologies that were developed prior to the transfer of Drainage from the City of Edmonton to EPCOR. Moving forward, the selection of DDMHs will continue to be risk-based using the EPCOR Risk Matrix and Risk Assessment Standards which continue to take into account age, waste type, proximity to environmentally sensitive areas, number of lateral connections, depth, roadway classification, previous inspection information, etc. The EPCOR Risk Matrix also expands this assessment to consider customer impacts of pipe and roadway failures in addition to these physical risk considerations. Once the program has identified a high priority location, the DDMH is inspected to determine its current condition, and confirm the number of connections into the manhole and type of connection into the trunk, etc.

11. Utilizing the EPCOR Risk Matrix and Risk Assessment Standards, preliminary DDMH results are displayed below in Figure 2.0-2.

Figure 2.0-2
Preliminary DDMH EPCOR Risk Matrix Results



12. The four DDMHs in the red box in Figure 2.0-2 are planned to be completed before the start of the 2022-2024 PBR term. During the 2022-2024 PBR term, EWSI plans to complete the highest risk DDMHs in the orange boxes depending on what is found during inspections. Of the total 296 DDMH's, 249 rank either High or Medium-High risk, due in part to the consequence characteristics noted below:

- located on Arterial or Collector roadways;
- more than 2 incoming lateral connections;
- depth is greater than 20m and are constructed on large sanitary and combined trunks;
- located in close proximity to an extremely high value environmentally sensitive area; or
- financial costs to deal with emergency repair, initial response, etc. is higher due to depth, and by-pass needs.

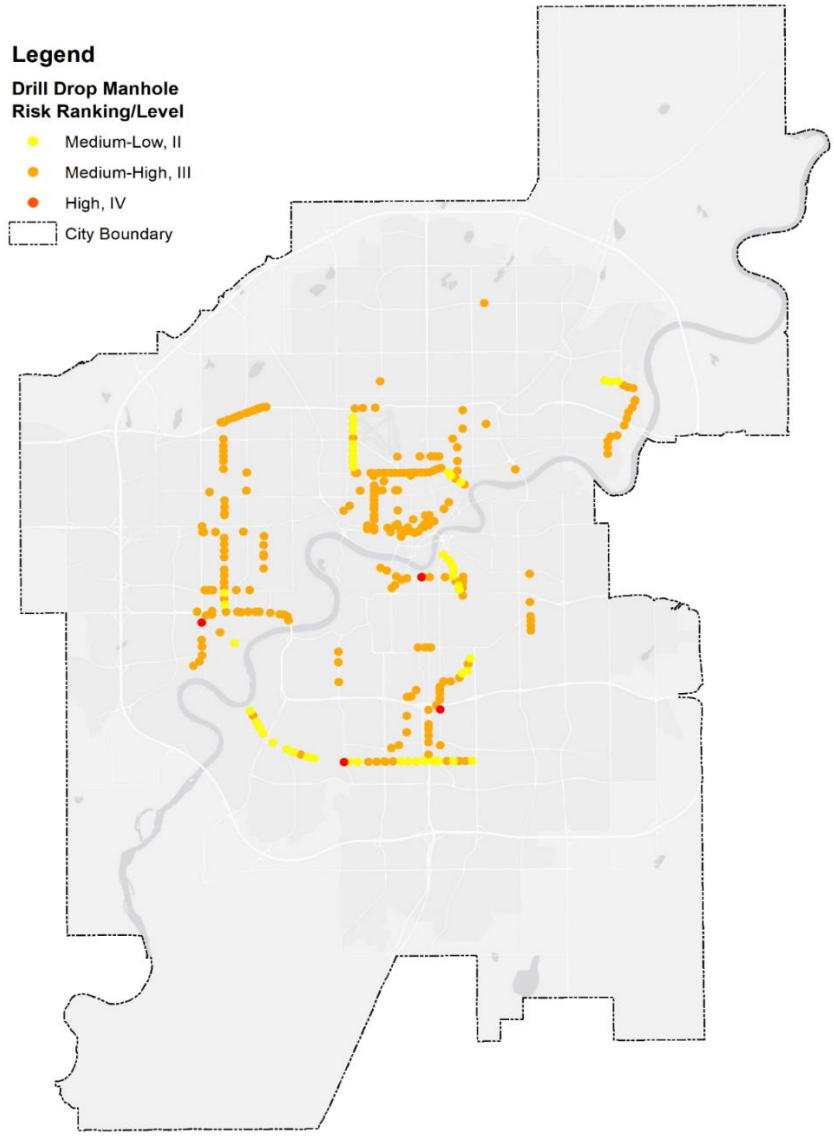
13. The criteria used for selecting a DDMH for rehabilitation or replacement for this program after inspections have been completed are shown below in Table 2.0-2.

Table 2.0-2
Selection Criteria for Renewal

	Selection Criteria for Renewal	A Definition
1	Post Inspection Risk Ranking	CCTV result analysis – significant or very significant defects
2	Synergy with other projects	Rehabilitation, replacement or abandonment could be driven by the presence of other projects in the vicinity of the DDMHs (e.g., CORe projects)

14. A map showing all DDMH locations by risk ranking and level are shown in Figure 2.0-3.

Figure 2.0-3
Drill Drop Manhole Risk Ranking/Level



15. CCTV is used to inspect these DDMHs. High flows in the DDMH can result in unclear CCTV images that are difficult to interpret. In locations where the trunk is deep and flows are high, televising the line may become a significant project itself, requiring flow bypass, road closure and removal of a "wagon wheel" like structure that is used to prevent potential obstructions from falling into the smaller diameter section of the DDMH.

16. Several DDMH failures have occurred in the recent past, most notable near Calgary Trail and Allendale Road, which created a large underground void. The inspection of DDMHs is very important to identify those that require immediate rehabilitation or replacement in order to prevent voids, collapses or sinkholes and proactively manage risk of emergency repairs. This is an ongoing program to systematically renew failing DDMHs which aligns with EPCOR's objectives to identify and manage risk appropriately to reduce risk exposure, and to reduce the negative impacts of assets on the environment.

3.0 PROGRAM DESCRIPTION

17. The scope of renewal for DDMHs will be either rehabilitation or full replacement depending on the physical condition and functional aspects of the DDMH. If there are significant holes or large pieces of the DDMH missing, a full replacement will be required.

18. This program proposes that each year, inspections on an average of 25 DDMHs will be completed as part of the concept development for the DDMH program. The scope for concept development will include inspections, assessment and review of the videos, defining replacement and rehabilitation needs, and prioritization of the DDMHs. Based on past experience, whenever 20 or more DDMHs are inspected, about 50% usually require rehabilitation, while between 10% to 15% would require replacement. EWSI anticipates that about 10 DDMHs would require rehabilitation and 3 to 4 DDMHs would require replacements. Once a prioritized list has been determined, the program will move forward with design and construction.

19. The program will include the following scope of work on an annual basis:

- Inspection of approximately 25 DDMHs
- Assessment and prioritization of inspected DDMHs
- Design of 3-4 DDMHs going forward for replacement
- Design of 10 DDMHs going forward for rehabilitation
- Geotechnical investigation
- Construction of 3-4 DDMH replacements

- Construction of 10 DDMH rehabilitations
- Assets placed into service

20. Inspections, design and construction will take place each year as shown in the Table 3.0-1 below. If possible, the approvals, concept development and inspections will begin in the year prior to construction to ensure there is sufficient time to complete all the renewal work.

Table 3.0-1
Program Phases

	A **2021 Q3**	B **2021 Q4**	C **2022 Q1**	D **2022 Q2**	E **2022 Q3**	F **2022 Q4**	G **2023 Q1**	H **2023 Q2**	I **2023 Q3**	J **2023 Q4**	K **2024 Q1**	L **2024 Q2**	M **2024 Q3**	N **2024 Q4**
1 Initiation/Approvals	x				x				x				x	
2 Inspections		x	x			x	x			x	x			x
3 Preliminary Design			x	x			x	x			x	x		
4 Detail Design				x				x				x		
5 Procurement				x	x			x	x			x	x	
6 Construction						x	x	x	x	x	x	x	x	x
7 Commissioning										x				x
8 Close-out										x				x

4.0 ALTERNATIVES ANALYSIS

21. The alternative to the program is to leave the DDMHs and deal with them reactively instead of proactively. However, if this program is not continued and existing deterioration in the DDMHs remains unaddressed, failures are likely to occur potentially causing underground voids. This could lead to sink holes in the middle of high traffic arterial roadways where many DDMHs are located. This is a significant safety concern. Other considerations are environmental impacts from holes in sanitary or combined DDMHs which could cause soil contamination, interruption of service to residents and high costs of unplanned emergency repairs. The advantage to this alternative is that there may be lower upfront costs, however if more emergencies continue to occur such as the Allendale Road DDMH failure, the costs in the long term will be increased.

5.0 COST FORECAST

22. The program cost estimates for the 2022-2024 PBR term shown in Table 5.0-1 is based on historical information such as past inspection costs, past design costs and past construction costs of similar DDMH projects that occurred within the last few years.

23. Underlying assumptions are as follows:

- 25 CCTV inspections per year will be completed by internal resources

- 4 replacements will be required each year
- 10 rehabilitations will be required each year
- Replacements will be completed by internal resources
- Rehabilitation (relining) will be completed by external resources
- Geotechnical investigations will be completed by external resources
- Replacements are assumed to cost approximately $900,000 per location
- Rehabilitations are assumed to cost approximately $100,000 per location
- Project cost estimates are based on costs incurred for inspection, design and construction of similar projects that occurred in the past few years

Table 5.0-1
Program Cost Summary
($ millions)

		A	B	C	D
		2022	**2023**	**2024**	**Total**
	Direct Costs				
1	Contractors	3.90	3.48	2.53	9.91
2	Internal Labour	0.50	0.55	1.08	2.13
3	Vehicles and Equipment	0.02	0.16	0.43	0.61
4	Contingency	0.00	0.02	0.06	0.09
5	**Sub-total Direct Costs**	**4.42**	**4.22**	**4.11**	**12.74**
6	Capital Overhead & AFUDC	0.09	0.10	0.19	0.37
7	**Total Capital Expenditures**	**4.50**	**4.31**	**4.29**	**13.11**

24. EWSI takes a number of steps to minimize the level of these capital expenditures. These include:

- EWSI has taken advantage of longer-term contracts with vendors to effectively manage the supply, quality and construction of required equipment. As such, EWSI has minimized the need to stock much of the required equipment reducing the overall costs of all installations and upgrades. Also the longer term construction contractor relationship allows us to mobilize the contractor efficiently and effectively as they are familiar with our and City's standards and master contractor agreements are in place.
- All activities related to project management, design, drafting, construction coordination and inspection, and as-built recording will be undertaken internally by EWSI, eliminating the need for external consultants. Construction of DDMHs will be completed by internal construction resources. Any DDMH relining will be completed by specialized external contractors.

- Contracted services are performed by pre-qualified external contractors and done on a competitive unit priced basis, using comprehensive engineering packages to ensure cost and scope control.
- The installations will be consistent with EWSI's construction standards which will minimize stock requirements and speed up design and construction.
- Where possible, work will be coordinated with other projects or maintenance activities to minimize costs.
- Every project is evaluated individually to determine the appropriate construction method to meet requirements at the lowest cost.
- Every project scope is evaluated to improve economy of scale and to eliminate future throw-away of infrastructure.
- All force accounts are documented and reviewed by several EWSI representatives to ensure the additional cost is justified under the terms of the contract.

6.0 RISKS AND MITIGATION PLANS

25. Table 6.0-1 provides the key risks and mitigations associated with executing this program.

Table 6.0-1
Key Risks and Risk Mitigations

	Risk	A Mitigation Plan
1	**Health and Safety**: • There is a risk that DDMH failure could result in a big void and road settlement which poses as a safety risk to the public and traffic. • Another key risk is that construction on a busy roadway can pose a higher safety concern for the workers on site.	Replacing or rehabilitating DDMH would reduce the risks of asset failure. Ensuring that the contractor and all on site workers follow proper safety procedures will help to mitigate the safety risk.
2	**Financial**: The potential DDMH failure could result in more costly emergency replacement.	The proposed DDMH replacement or rehabilitation program would lower the risks of asset failure and, therefore, reduce the cost.
3	**Customer Impacts**: Road user impacts: construction will cause significant traffic disruption on high traffic roadways Service impacts: incoming connections to DDMH	EWSI will engage experienced construction manager, and project manager to develop an optimal construction staging plan and coordinate with the City to obtain OSCAM permits. Bypass will be required during construction to maintain service to all incoming laterals.
4	**Execution Risk**: There is a high risk that rehabilitation of the DDMHs will be difficult to execute. Rehabilitation of DDMHs must be completed by external resources as EWSI does not currently have the ability to do this type of work. However, there are not many external contractors that willing to do the work due to specialized skill and low profit margin. In 2019, a tender was released for the rehabilitation of several DDMHs and there were no bids received. DDMHs requiring rehabilitation that are not able to be completed will remain in their current condition and will eventually need to be dealt with through a full replacement.	One way to mitigate this risk is to offer contractors several DDMH rehabilitations as one package, or to offer long term contracts that would guarantee them work over a specified number of years. EWSI will undertake project related activities including inspection, project management, design, construction coordination and survey as well as as-built recording. These locations will be risk ranked and prioritized with all other replacement priorities.
5	**Environmental**: Risk of sewage leakage and spills associated with DDMH failure can result in environmental incompliance and potential fines	Replacing or rehabilitating DDMH would reduce the risks of failure for the asset.

Appendix H7

EPCOR WATER SERVICES INC.

Drainage Services
Fleet and Vehicles Program
Business Case

February 16, 2021

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1.0 OVERVIEW

1. The Fleet and Vehicles Program is an annual capital program to upgrade, replace and purchase new vehicles and equipment. This program consists of the purchase of life cycle replacement for existing essential vehicles, as well as additional new vehicle types to support the sanitary and stormwater system as Edmonton continues to grow. This program ensures that EWSI's operations and construction staff are equipped with the appropriate and properly functioning vehicles and mobile equipment to safely and efficiently complete their work to ensure the sanitary and stormwater systems are maintained in a reliable manner.

2. This program is categorized as reliability / life cycle replacement and is one of the Drainage System Rehabilitation programs. EWSI has forecast total program capital expenditures during 2022-2024 at $13.20 million. This reflects a small decrease in average annual spending on this program from $4.48 million per year to $4.40 million per year. The decrease is due to changes in EWSI's construction strategy, reflecting a decreased requirement for heavy duty vehicles and mobile equipment which would have otherwise supported the tunnel construction program.

2.0 BACKGROUND/JUSTIFICATION

3. EWSI operates a wide variety of vehicles and mobile equipment to facilitate staff in the processes of building, servicing, repairing and decommissioning of drainage services in the greater Edmonton area. The Fleet and Vehicles Program is an annual capital program to upgrade, replace and purchase new vehicles and equipment. This program consists of the purchase of life cycle replacement for existing essential vehicles, as well as additional new vehicle types to support the sanitary and stormwater system as Edmonton continues to grow. This program's primary purpose is to equip EWSI staff with the appropriate and properly functioning vehicles and mobile equipment for their ongoing work in operational and construction activities. The availability and dependability of EWSI vehicles is essential to ensuring that EWSI's sanitary and stormwater systems are maintained in a reliable manner and that its operations are carried out safely and effectively. Failure to maintain an appropriate and functioning fleet would result in EWSI staff spending longer periods of time to complete work throughout Edmonton. Additionally, EWSI staff would have to use existing assets for extended use, further diminishing the assets' reliability and potentially leading to critical failure. Critical failure of a fleet asset leads to additional impact to service reliability at best, safety of staff or public at worst.

4. The scope and scale of planned and unplanned vehicle purchases are dependent on construction and operational requirements. EWSI requires reliable fleet assets to ensure the

ability to operate, maintain, repair, or replace aging Drainage systems and respond to emergency situations. The purpose of this program is to ensure that the vehicle & equipment inventory is adequately stocked and in good working condition to meet the dynamic needs of Drainage Services.

5. The scope of this program for the 2022-2024 PBR term includes:

- end of life cycle replacement of existing fleet vehicles to reduce vehicle maintenance costs and increased reliability and vehicle availability; and
- net growth or change of existing fleet vehicles to ensure safe and effective execution of field work.

6. The size and business need of the existing fleet will be continuously assessed as operational reviews are completed and potential synergies and efficiencies are identified. The outcome of this process will accommodate any requirement for growth or changes in the type of fleet vehicles required. Therefore, no growth or change of existing fleet has been specifically identified in the program term. As indicated in Table 2.0-1, the total projected number vehicle replacements over the 2022-2024 PBR term is 64 units. Of the 64 units, 54 units are specialized and must be custom built.

Table 2.0-1
Fleet and Vehicles Program
Vehicle Replacements by Type
2022-2024

	Vehicle Type	A Number of Vehicle Replacements
1	Light Duty Vehicle	13
2	Medium Duty Vehicle	15
3	Sewer Flusher	6
4	Boom Truck	2
5	Crane	3
6	Backhoe/Excavator	4
7	Welding Truck	2
8	Construction Trailer	8
9	Skid Steer	1
10	Tandem Dump Trunk	2
11	Font Wheel Loader	1
12	Fork Lift	2
13	Boat	3
14	ATV/mower	2
15	**Total**	**64**

7. EWSI fleet assets approaching end of life cycle require additional repair and maintenance work, leading to higher operational costs and extended periods of downtime. This downtime further impacts operational efficiency of work crews and requires increased use of alternatives such as rental units. Rental vehicles can only be obtained for the 10 units which are not specialized, customer built units. Further, EWSI has experienced an increased level of safety concern with vehicles approaching end of life as they are pushed to the limits of design tolerance levels. As such, failure to replace vehicles which have reached the end of their service lives will result in increased vehicle operating costs and reductions in worker safety and productivity.

3.0 PROGRAM DESCRIPTION

8. There are 64 units designated to be replaced from 2022 to 2024. These units in question have been selected for replacement based on their service lives ending between 2022 and 2025. Project scope will be executed for each Fleet Unit in accordance with a 5-Gate Fleet Capital Project Delivery System (CPDS), which includes the following gates. Only vehicles with high utilization proceed through the CPDS process. Low utilization units will be excluded and disposed without replacement, or replaced with short term alternative rentals when deemed as most feasible alternative.

1.) Gate 1 – Business Assessment
2.) Gate 2 – Design Specifications
3.) Gate 3 – Procurement & Building
4.) Gate 4 – Prep for Delivery
5.) Gate 5 – Turnover Care Custody and Control of Fleet to operation

9. EWSI assesses each Vehicle/Unit in Gate 1 to verify cost effectiveness of purchasing a replacement vehicle compared to rental or contractor alternatives on a net present value basis (NPV). The NPV of net new units will include operator costs and fleet hourly rates.

10. The Fleet manager will ensure fleet vehicles align to crew size and capacity thus maintaining high utilization. Impact on Safety and other operational strategies will be assessed in Gate 1 also. Highly specialized units will be evaluated on an individual bases when exploring replacement. Specialized units with low utilization may be retained due to the cost of replacement and an overall evaluation of the monthly/yearly operating costs.

11. EWSI's goal will be to maintain high utilization of fleet and leveraging capital expenditure to lower utility rates. Gate 1 business assessment will ensure capital is spent in the required areas.

Each fleet sub-project lead-times vary between 5 to 16 months total. Approximate timelines to obtain new vehicles are set out in Table 3.0-1.

Table 3.0-1
Fleet and Vehicles Program Timelines

	Fleet Vehicle Type		A Gate 1 Assessment	B Gate 2 Design	C Gate 3 Procurement	D Gate 3 Build	E Gate 5/4 Deliver	F Total Lead Time
1	LD & MD Truck	Chassis	1 week	1 week	2 weeks	10 weeks	2 weeks	5-6
2	(<$100k)	Body	1 week	1 week	2 weeks	6 weeks	2 weeks	months
3	MD & HD Truck	Chassis	2 weeks	4 weeks	4 weeks	8 weeks	4 weeks	10-11
4	($200-$400k)	Body	2 weeks	6 weeks	6 weeks	8 weeks	4 weeks	months
5	Specialty HD & MD Truck	Chassis	3 weeks	8 weeks	8 weeks	8 weeks	4 weeks	13-16
6	(>$500k)	Body	3 weeks	8 weeks	8 weeks	8 weeks	4 weeks	months

*LD – Light Duty, MD- Medium Duty, HD-Heavy Duty.

12. Projects are typically expedited by reviewing combining chassis and body for major complex fleet units, reviewing existing design specification, accelerating internal customer engagement, and leveraging existing master service agreements.

13. While procurement of vehicle/units may be executed by leveraging existing master service agreements, large value/complex purchases will be procured through public tender in order to ensure competitive pricing.

14. This Program includes the costs of replacing 64 units belonging to Drainage Operations and Construction Services. This includes the procurement of the chassis, building the vehicle body, installing safety features, decals, and telematics devices. Operational costs, fuel, and regular maintenance of these units are not included in the scope of this program.

4.0 ALTERNATIVES ANALYSIS

15. EWSI assessed this program against the alternative of not replacing the current fleet and continuing to use these assets beyond their recommended life-cycle. Risks associated with this option were found to be too high. As such, EWSI is recommending to proceed with the Fleet and Vehicles Program as described above. Risks of extending use of the current fleet beyond useful life include:

- higher fleet maintenance and repair costs resulting in increase in Drainage Operating expense;
- reduced availability due to more frequent running repairs and longer scheduled preventative maintenance and inspections;

- reduced reliability which will result in more unpredictable downtime, especially when the vehicle is needed the most to respond to operational needs, therefore impacting external customers;
- reduced fuel economy therefore further increasing operating costs; and
- reduced equipment reliability impacting ability to complete and delivery capital by Drainage construction group.

5.0 COST FORECAST

16. The projected number replacements over the 2022-2024 period is 64 units, of which 54 units are specialized and must be custom built. Pricing for the new units being purchased from 2022 to 2024 reflect 2020 unit replacement pricing. These unit prices are updated to reflect historical costs for the units that will be replaced, in order to account for factors such as safety feature improvements, vendor increases, and other expected fee increases.

17. Capital Costs for each Fleet Vehicle includes:

- Engineering Design – define specification of unit and draft drawings where applicable.
- Chassis – Procure vehicle chassis from chassis manufacturer.
- Upfitting – Fabricate upfitting on chassis.
- Prep-For Service – EPCOR brand decaling, GPS, training materials, pre-delivery inspections etc.

18. EWSI's capital expenditure forecast for this program for the 2022-2024 PBR term is provided in Table 5.0-1.

Table 5.0-1
Fleet and Vehicles Program
Capital Expenditure Forecast (2022-2024)
($ millions)

		A **2022**	B **2023**	C **2024**	D **Total**
	Direct Costs				
1	Contractors	3.62	4.46	5.02	13.10
2	Internal Labour	0.03	0.03	0.03	0.09
3	**Sub-total Direct Costs**	3.66	4.49	5.05	**13.19**
4	Indirect Costs	0.01	0.01	0.01	0.02
5	**Total Capital Expenditures**	3.66	4.49	5.05	**13.20**

19. EWSI takes a number of steps to minimize the level of these capital expenditures. These include:

- EWSI has taken advantage of longer-term contracts with vendors to effectively manage the supply, upfitting of required units, and ensure quality vehicle builds. As such, EWSI has minimized the need to stock much of the required equipment reducing the overall costs of all installations and upgrades.
- External vendors will be engaged to supply chassis and outfit the units with all required equipment as specified in their management service agreements.
- Contracted services are performed by pre-qualified external vendors and done on a competitive unit price basis.
- The upfitting will be consistent with EWSI's fleet and industry standards and unit specifications.
- Every vehicle replacement is evaluated to improve economy of scale where possible.
- Where possible, work will be coordinated with other projects or maintenance activities to minimize costs.
- Every project scope is evaluated to improve economy of scale.

6.0 RISKS AND MITIGATION PLANS

20. The key risks and mitigations associated with executing this program are provided in Table 6.0-1.

Table 6.0-1
Key Risks and Risk Mitigations

	Risk	A Mitigation Plan
1	Financial: Risk associated with committing costs for chassis by ordering units prior to the year they are to be replaced.	This risk is offset by the earlier delivery of the chassis ordered allowing for upfitting to be completed prior to the specified deadline.
2	Health & Safety: Risk associated with worker injury while upfitting units.	Third party vendors are used to upfit the units at their facilities.

Appendix H8

EPCOR WATER SERVICES INC.

Drainage Services
High Priority Replacement Program
Business Case

February 16, 2021

Table of Contents

1.0 OVERVIEW

1. EWSI owns and operates over 6,500 km of sanitary, stormwater and combined sewers and over 350,000 service connections. Due to aging and deterioration of drainage infrastructure, unexpected failures may disrupt sewer service to homeowners and businesses causing a safety issue or environmental concerns. These failures lead to high priority and costly emergency replacements that require attention, and in the case of emergencies, immediate attention. These failures can range from sewer collapse, service connection collapse, outfall safety issues, force main break, etc. The average age of the assets being replaced ranges from 48 – 69 years, depending on the type of asset. These need to be dealt with on a timely basis in order to restore service to customers, or to rectify urgent safety or environmental concerns.

2. The forecast scope of work for this program for the 2022-2024 PBR term includes 600 high priority replacements per year including replacement of various asset types (services, catch basins, mainlines, manholes). Actual work completed under this program will depend on the number and type of high priority or emergency replacement required to restore or maintain service to customers.

3. This program is categorized as reliability / life cycle replacement and is one of the Drainage System Rehabilitation programs. EWSI has forecast total program capital expenditures during 2022-2024 at $52.14 million.

2.0 BACKGROUND AND JUSTIFICATION

4. EWSI owns and operates over 6,500 km of sanitary, storm and combined sewers and over 350,000 service connections. The average age of the sewer pipes is 38 years old, with 30% of them over 50 years old. Due to aging and deterioration of drainage infrastructure, unexpected failures may disrupt sewer service to homeowners and businesses causing a safety issue or environmental concerns. These failures lead to high priority and emergency replacements that require attention, and in the case of emergencies, immediate attention. These failures can range from sewer collapse, service connection collapse, outfall safety issues, force main break, etc. The average age of the assets being replaced ranges from 48 – 69 years, depending on the type of asset. These need to be dealt with on a timely basis in order to restore service to customers, or to rectify urgent safety or environmental concerns.

5. High priorities and emergencies are identified either through regular inspections or when a customer calls to EWSI's Control Center. In a significant impact event, EWSI's construction

crews may replace a pipe section or full length of mainline or service to rectify the situation or there may be a requirement for further assessment before proceeding with design and replacement. Table 2.0-1 explains the difference between emergency and high priority replacement criteria.

Table 2.0-1
Emergency and High Priority Replacement Criteria

Priority	A Definitions/Check List	B Timeline for Replacement
1 Emergency	• Sanitary service is collapsed/broken on EPCOR side of the property line. • Service Maintenance (SM)/Operational crews were unable to release the service. • A Service Maintenance foreman has confirmed that the collapsed/broken pipe is on EPCOR side if it was not clear as per the initial crew visit.	24 Hours / Within a day
2 High Priority	• Sanitary service is in poor condition on EPCOR side of the property line. • There can be one factor or multiple factors contributing to the poor condition. • Service Maintenance (SM)/Operational crews were able to release the service. • A Service Maintenance foreman has confirmed the poor condition on EPCOR side if it was not clear as per the initial crew visit. • Service cannot be relined based on the defects.	1 day to 365 days / Within a year

6. Figures 2.0-1 and 2.0-2 provide some images of high priority replacements that have occurred in the sanitary system.

Figure 2.0-1
Sanitary Sewer Service Infiltrated with Roots

Figure 2.0-2
Broken Sanitary Service Line at Entry to Mainline

7. Figures 2.0-3 and 2.0-4 provide some images of high priority replacements work completed for service replacements and deeper mainline replacements.

Figure 2.0-3
Typical Trench for a High Priority Service Replacement

Figure 2.0-3
Typical Job Site for Deeper Mainline Replacement

3.0 PROGRAM DESCRIPTION

8. Locations in the High Priority Replacement program are initially investigated by EWSI Drainage Operations. Technologists review the condition of the asset and prioritize the work based on estimated remaining life expectancy of the asset. For example, an asset that is completely blocked or collapsed is considered an emergency replacement. Crews will respond immediately to mitigate damages to the customer. In 2020, a significant amount of work was done to develop a process in which jobs are prioritized using the EPCOR risk-based approach. Each location is assessed and a risk score given utilizing a standardized assessment tool. This ensures an objective process is followed and the locations presenting higher risk are prioritized. This risk-based approach is expected to be in place in Q1 of 2021.

9. The estimated scope of work for this program for the 2022-2024 PBR term is presented in Table 3.0-1 below. Actual work completed under this program will depend on the number and type of high priority or emergency replacements required to restore or maintain service to customers. Based on high priority replacement requests that have been received from 2017-2019,it was found that of all work completed in the High Priority Replacement program, 69% were Services, 22% were Catch Basins and Leads, 8% were Mainlines and Manholes, with a small percentage of other replacements (i.e., outfalls or force mains, etc.). Based on this history,

EWSI is forecasting the following number of locations for replacements for the 2022-2024 PBR term as shown in Table 3.0-1.

Table 3.0-1
High Priority Replacements Planned for 2022-2024 PBR Term

	Types of Replacement	A %	B # of Locations (2022)	C # of Locations (2023)	D # of Locations (2024)
1	Services	69%	414	414	414
2	Catch Basins & Leads	22%	132	132	132
3	Mainlines & Manholes	8%	48	48	48
4	Other	1%	6	6	6
5	**TOTAL**	**100%**	**600**	**600**	**600**

10. Large scale extraordinary rehabilitations or replacements (generally $250,000 or greater) are treated as separate standalone projects outside of the scope of this program.

4.0 ALTERNATIVES ANALYSIS

11. EWSI evaluated the following alternatives to this program.

12. **Do Nothing** –This is not a viable option as EPCOR has an obligation to maintain service for its customers. However, EWSI could choose not to replace assets deemed high priority and instead wait for the asset to completely fail. This would mean that EPCOR would have to respond to the same assets and fix them on an emergency basis which is far more costly than when completing planned work.

13. **Contract out all High Priority Replacements and Emergencies** – Due to the reactive nature of the work, these jobs cannot be planned as is typical with work that is completed by external contractors. An ability for immediate response, especially in emergency situations, is critical to mitigate potential safety, environmental reputation and property damage risks that could result. Contractors can be utilized for some high priority work with longer time horizons, however it is difficult to schedule due to this program being highly reactive and work needing to be continually prioritized to ensure the right asset is being worked on at the right time.

14. **Complete all High Priority Replacements and Emergencies In House** - Due to the high public exposure of the work, EWSI crews are held accountable for ensuring effective, timely completion of replacements and communication with customers. They are highly trained and able to respond quickly to emergency situations thus minimizing environmental damage and maintaining employee and public safety. EWSI's in-house crews have the ability to prioritize their

work efficiently and effectively as required. Based on the advantages and disadvantages of each of the options above, EWSI proposes to complete all priority replacements and emergencies in house as the planned approach for this program.

5.0 COST FORECAST

15. Cost estimates for this program are based on historic costs. Operational efficiencies are continuously being explored and implemented, and these efficiencies have brought the costs for each rehabilitation down each year since 2018 as shown in Table 5.0-1 below. Some of these efficiencies include:

- Reduced crew sizes for all types of work;
- Tandem dispatch model resulting in contractor tandem savings;
- Use of Master Service Agreement contractors for restoration services; and
- Improved processes for allocating and planning on site work.

16. As efficiencies continue to be realized, it is assumed that the average cost per location will be less than $29,000 during the 2022-2024 PBR term.

Table 5.0-1
High Priority Replacements
Historical Costs Per Location
2018-2020
($)

	A	B	C
	2018	**2019**	**2020**
1 Cost per Location	32,165	31,635	30,000

17. Based on these assumptions, the capital expenditure forecast for the High Priority Replacement Program in 2022-2024 is shown in Table 5.0-2.

Table 5.0-2
High Priority Replacement Program
Capital Expenditure Forecast (2022-2024)
($ millions)

		A **2022**	B **2023**	C **2024**	D **Total**
	Direct Costs				
1	Contractors	3.77	3.88	4.00	11.65
2	Internal Labour	9.27	9.41	9.56	28.23
3	Vehicles and Equipment	2.76	2.82	2.87	8.45
4	**Sub-total Direct Costs**	15.80	16.11	16.43	48.34
5	Capital Overhead	1.24	1.27	1.29	3.80
6	**Total Capital Expenditures**	**17.04**	**17.38**	**17.73**	**52.14**

18. EWSI takes a number of steps to minimize the level of these capital expenditures. These include:

- EWSI has taken advantage of longer-term contracts with vendors to effectively manage the supply, quality and construction of required equipment. As such, EWSI has minimized the need to stock much of the required equipment reducing the overall costs of all installations and upgrades. Also the longer term construction contractor relationship allows us to mobilize the support contractors such as paving and barricading efficiently and effectively as they are familiar with our and City's standards and master contractor agreements are in place.
- All activities related to project management, design, drafting, construction coordination and inspection, and as-built recording will be undertaken internally by EWSI, eliminating the need for external consultants. Most of the construction will be performed internally as well, while only surface restoration will be completed by one of EWSI's long term construction contractors.
- Contracted services are performed by pre-qualified external contractors and done on a competitive unit priced basis, using comprehensive engineering packages to ensure cost and scope control.
- The installations will be consistent with EWSI's construction standards which will minimize stock requirements and speed up design and construction.
- Where possible, work will be coordinated with other locations or maintenance activities to minimize costs.
- Every location is evaluated individually to determine the appropriate construction method to meet requirements at the lowest cost.

- Every project scope is evaluated to improve economy of scale and to eliminate future throw-away of infrastructure.

6.0 RISKS AND MITIGATION PLANS

19. EWSI has identified the key risks and mitigations associated with executing this program in Table 6.0-1.

Table 6.0-1
Key Risks and Risk Mitigations

	Risk	A Mitigation Plan
1	Environmental Risks – Release of untreated sewage	EWSI will train employees to contain potential releases and will hydrovac and dispose of contaminated soil in an approved landfill
2	Customer Service Disruptions	EWSI will inform customers of the issue and upcoming work. Emergency utility locates are acquired and service is restored within 48 hours
3	Customer Property Damage	EWSI would utilize the score based on EPCOR risk approach to ensure that jobs are prioritized appropriately. Allowing construction crews to complete repair prior to failure.
4	Health and Safety Risks – Sink Holes Disrupting Traffic	EWSI will ensure the area is secured immediately and made safe for the public and traffic is diverted. Repairs are prioritized as emergency based on their impact to public safety and disruption to traffic.
5	Financial Risks – Damage to Public Property	EWSI crews ensure utility locates are in place prior to excavation. EWSI will ensure the job is planned to minimize damage to public property.

Appendix H9

EPCOR WATER SERVICES INC.

Drainage Services
LRT Relocates Program
Business Case

February 16, 2021

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1.0 OVERVIEW

1. The Light Rail Transit (LRT) Relocates Program moves drainage infrastructure that falls within the LRT conflict zone. The LRT conflict zone is an approximate 12 meters right-of-way in which all parallel utilities shallower than seven meters must be relocated and all perpendicular utilities must be lowered and cased.

2. EWSI has received formal notification from the City of Edmonton to continue to advance utility relocates for the West Valley Line LRT beginning in 2018. To meet the timeline for this section of the LRT, a portion of utility relocates for the West Valley Line LRT are required to be completed prior to August 2022, and the remainder is to be undertaken by the City's LRT contractor but still funded under this program. These modifications must be completed at the sole cost of EWSI in accordance with Section 9.1 of the Drainage Services Franchise Agreement with the City of Edmonton, which states:

> *Upon receipt of thirty (30) days written notice from the City, EPCOR shall, at its sole cost and expense, arrange to relocate or cause to be relocated any Equipment operated on the City Lands, or perform any other work in connection with any Equipment and Attachments as may be required by the City to comply with safety standards or accommodate any relocate, installation, modification, repair, construction, upgrading or removal of City facilities.*

3. This project is categorized in the growth/customer requirements PBR category. EWSI has forecast total project capital expenditures during 2022-2024 at $48.53 million to complete the remainder of the West Valley Line LRT. Construction is underway and, while assets will be placed into service as the work progresses, the final project will be closed out by 2027. The utility-funded work over 2022 to 2027 undertaken by the City's LRT contractor is what prevents the project to be closed out in 2022.

2.0 BACKGROUND AND JUSTIFICATION

2.1 Program Background

4. As part of the Franchise Agreement, referenced above, EWSI must relocate any drainage infrastructure in conflict with the proposed LRT with no cost recovery from the City of Edmonton. The relocate clause in EWSI's Franchise Agreement applies to all EWSI facilities located within City road right-of-ways, on City bridges, or within City owned land such as parks and school sites.

It also applies to any City-driven facility installation or modification including road and sidewalk realignments, bridge construction/rehabilitation, LRT track extensions, building modifications or new sewer and drainage main installations or modifications.

5. The West Valley and Metro Line LRT Relocation Projects were not part of the capital program or capital commitments at the time of transfer of the drainage utility to EPCOR. Prior to the transfer, all drainage relocations were funded and completed under the City LRT projects. On July 30, 2019 EWSI filed an application with the City Manager seeking a Non-Routine Adjustment (NRA) to sanitary and stormwater rates beginning January 1, 2020 to recover the capital expenditures associated with these the West Valley and Metro Line LRT Relocation Projects incurred during the 2018-2021 term. The approved NRA was based on the City's original schedule, which has been delayed as the City's original Request for Quotes (RFQ) had to be cancelled due to contractors' withdrawal. There has since been an increase in scope, including the cost to add 80 steel casings for pipes crossing the LRT tracks, as well as a revised cost of construction due to changes in the market conditions. [1]

6. EWSI has completed 100% of relocates for Phase One of the Metro Line and 10% of relocates for the West Valley Line. This program will see through the completion of 60% of additional of relocates for the West Valley Line, with the remaining 30% extending beyond 2024.

2.2 Program Justification

7. This program is a requirement under the Franchise Agreement with the City of Edmonton. Relocating drainage infrastructure that is in conflict with the proposed LRT tracks also protects the existing infrastructure from potential damage during the LRT construction, ensures EWSI's ability to operate and maintain the drainage network in the future, and protects the LRT from potential damage of future sewer breaks underneath the tracks.

3.0 PROGRAM DESCRIPTION

8. The purpose of this program is to enable EWSI meet its commitments under the Franchise Agreement within the 2022-2024 PBR period by relocating existing drainage infrastructure as required for LRT construction. Drainage relocates are completed based on EWSI's commitments under the Franchise Agreement and the City of Edmonton LRT Design Guidelines. Sewer mains crossing the LRT tracks must be installed inside a casing, a minimum 2.0 meters from top of rail to top of casing (except small diameter services, which do not have to be constructed in a casing).

[1] A full reconciliation of 2017-2021 NRA variances will be provided in the 2021 Progress Report.

Sewer mains, and other drainage infrastructure, parallel to the LRT tracks must be more than 4 meters from the outside of the track, with an extra meter separation required at a station.

9. Each drainage infrastructure conflict is evaluated to determine if it should be abandoned or relocated. The LRT conflict zone includes a right of way 4 meters from the center of each track in addition to 1 meter around each proposed station. In most cases, this results in an approximate 12 meters right-of-way in which all parallel utility infrastructure must be relocated and all perpendicular sewer main crossings must be lowered and installed inside a casing. Manholes, catch basins and other facilities may have to be relocated due to road widening or other changes in the road profile related to the LRT construction. In addition, existing deep trunk sewers will be inspected for their structural conditions as it is impractical to relocate due to their depth, typically 10m to 30m deep.

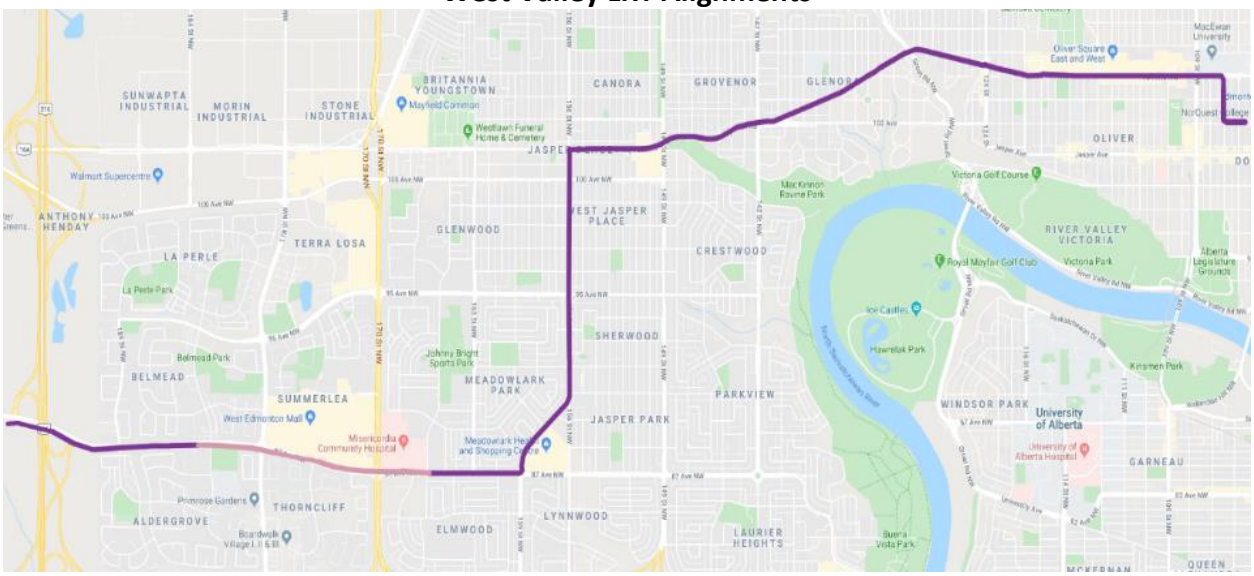
10. Any damage or deterioration to these trunks will need to be repaired prior to the construction of the LRT tracks. Since it is not known at this time whether major repairs will be required, and since the scope of repairs vary significantly, the projected capital expenditures for this program do not include repair costs. In the event that large repairs are required, EWSI will evaluate its options for the recovery of those costs, however small repairs can be accommodated through the contingency for this Program.

11. As shown in Figure 3.0-1, the current focus of this program is completing the sewer relocates for the West extension of the Valley Line LRT (Downtown to Lewis Farms), with the first phase of the construction having begun in 2020. The scope of the work was broken into three priority areas:

- Priority 1 area extends from west of 170 Street to 165 Street on 87 Avenue and is scheduled to be substantially completed in 2020. This includes external open cut relocations and sewer relining in advance of construction. In addition, EPCOR constructed two access manholes on the 87 Ave trunk by in-house crews in order to allow access for future maintenance and inspection.
- Priority 2 areas, planned for construction in 2020-2022 involves contracting our trenchless and open cut restoration work.
- A portion of the priority 3 area, shown in Figure 3.0-2, includes sewer relocations designed by EPCOR and built by the City's LRT contractor. The sewer relocation for these areas is expected to be constructed from 2021 to 2025 by the City's LRT contractor.

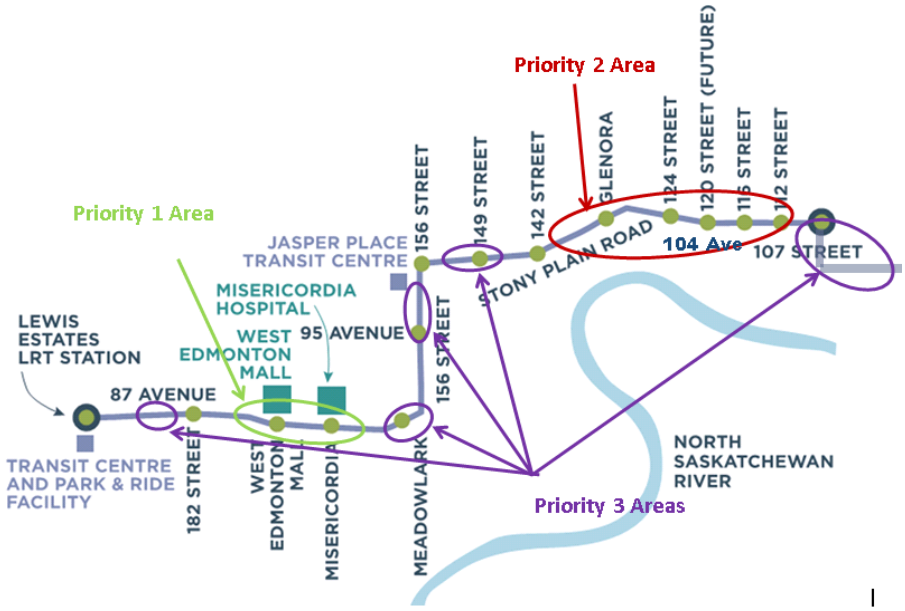
12. The remaining sewer relocations, also part of the priority 3 area, will be designed and constructed by the City's LRT contractor. It is estimated that the detailed design and construction of sewer relocation for these areas are to be conducted from 2021 to 2025.

Figure 3.0-1
West Valley LRT Alignments



*Pink indicates above-ground section.

Figure 3.0-2
West Valley LRT Drainage Priority Areas



13. It is estimated that the West Valley LRT sewer relocations will include:

- Constructing approximately 7.2 km and abandoning approximately 9.8 km of sewer lines with the sizes from 200 mm to 1350 mm in diameter which will include sanitary sewers, storm sewers and combined sewers;
- Installing approximately 120 new manholes; and
- Reconnecting approximately 140 sanitary services.

14. The other future LRT projects, e.g. Metro Line NW Phase 2 (Blatchford to Campbell Road) and Capital Line South LRT, have not been prioritized by City Council for implementation, and as such there are no timelines in place for delivery. Therefore, the sewer relocations associated with Metro Line NW Phase 2 and Capital Line South LRT projects are excluded from this business case. If the City requires EWSI to accelerate these project timelines into the 2022-2024 PBR term, EWSI may seek funding for these additional costs through a non-routine adjustment application.

15. All activities related to project selection, design, drafting, construction coordination and inspection, and as-built recording will be undertaken by internal staff, or by the City's LRT contractor as noted above. The construction and restoration activities will be completed, primarily, by EPCOR's long-term contractors and their sub-contractors. EPCOR has undertaken the construction of two access manholes as part of the Priority Area 1 work. Utility relocate alignments and construction schedules are subject to approval of the ConnectEd Transit Partnership, and also through the Utility Line Assignment (ULA) process.

16. Permits required on every project include approval from the ConnectEd Transit Partnership, a ULA permit, and an OSCAM (required for on-street construction and applied for by the contractor). Certain projects may require Historical Resource Act (e.g., construction near a historical site), contaminated soil awareness (e.g., construction near an abandoned gas station), or land administration items (e.g., utility right of way, crossing agreements, etc.). These items are checked for as part of the project review process and applied for as needed.

4.0 ALTERNATIVES ANALYSIS

17. Each LRT conflict or crossing is evaluated to determine the impacts to the drainage network if it is abandoned, and if it needs to be relocated. The proposed changes to the drainage network are evaluated for hydraulic requirements, customer servicing and future operability and maintenance. If a sewer main needs to be removed/relocated, hydraulic analysis is conducted to determine the necessary upgrades required to maintain the required system capacities including

wet weather storage requirements, and to maintain service to customers. Each design considers the requirements to meet the interim system capacities as well as the future system requirements. The construction methodologies, including relining existing pipes, installing steel casings around the pipes under the tracks and open cut and trenchless methods, were selected in order to meet the requirements of the LRT project, the system requirements as well as minimize project costs. All attempts will be made to minimize construction costs by coordinating project schedules and working with other utilities.

18. If EWSI does not complete the required LRT relocates, the existing sewer mains would likely be damaged during the LRT construction. The sewer mains would also not be accessible once the tracks were built and could cause significant damage to the tracks if a failure was to occur. The relationship between EWSI and the City would be also be negatively impacted, as EWSI would not be adhering to the requirements of the Franchise Agreement.

5.0 COST FORECAST

19. The volume and type of work is entirely driven by the number and type of requests for relocate made by the City. Because the scope of this program is driven by requests from the City of Edmonton Transportation and Drainage departments, it is not within the control of EWSI.

20. The cost estimate for this scope of work was based on the scope identified in the design process which is required to meet the requirements of the City. The capital expenditure forecast for this program is provided in Table 5.0-1.

Table 5.0-1
LRT Relocates Program
2022-2024 Program Capital Expenditure Forecast
($ millions)

		A **Prior 2022**	B **2022**	C **2023**	D **2024**	E **2022-2024 Total**
	Direct Costs					
1	Contractors	38.11	18.55	11.05	12.03	41.63
2	Internal Labour	3.30	0.36	0.30	0.22	0.88
3	Abandonments	0.00	0.40	0.67	0.67	1.74
4	Contingency	0.64	0.33	0.22	0.23	0.78
5	Risk Allowance	1.18	0.73	0.26	0.10	1.09
6	**Sub-total Direct Costs**	**43.65**	**20.37**	**12.49**	**13.25**	**46.11**
7	Indirect Costs	1.75	1.43	0.44	0.55	2.42
8	**Total Project Costs**	**45.41**	**21.80**	**12.93**	**13.80**	**48.53**

21. The contractor costs are based on a combination of actual bid prices (Priority Area 1 and 2) and preliminary design cost estimates for Priority Area 3A and 3B. An agreement is being developed between the City and EPCOR with regards to the construction costs associated with Priority Area 3A and 3B. As the work is being constructed by the City's LRT contractor, and is tightly integrated into the scope that they must complete, it was agreed that EPCOR will pay a set cost for these drainage assets. The initial estimate has been accepted, though updates are in progress to reflect additional costs, such as the inclusion of steel casings where pipes cross under the tracks. In-house construction costs are based on previous actual costs of constructing access manholes.

22. The following assumptions have been made when estimating costs for this program:

- The proposed drainage infrastructure relocates will be approved by the City, including LRT Integrated Infrastructure Services (IIS), and other utilities within a reasonable timeframe.
- There are no significant changes to the LRT design including track alignments, proposed property lines, curbs, sidewalks, elevations, drainage, and streetlights.
- The ConnectEd Transit Partnership will provide the necessary information about the final LRT designs to allow adequate time for approvals & construction of EWSI's relocate projects.
- EPCOR's contractor will have unencumbered access to the project sites, and will have enough resources to complete all the projects within specified timeframes, despite restrictions with regard to road closures, transmission main shutdowns and coordination with other utilities' construction.
- There will be no major changes in the City's pavement restoration specifications, traffic accommodation requirements or costs for services (ex. materials testing).
- Additional sewers, services, and catch basins required for new LRT stations or facilities will be constructed at the cost of the City / ConnectEd Transit Partnership as they do not fall under the Franchise Agreement.
- The inspection program will not identify any significant structural deficiencies which will require major rehabilitation.

23. EWSI will ensure the minimization of capital expenditures through the following:

- All activities related to project management, design, drafting, construction coordination and inspection, and as-built recording will be undertaken internally by

EWSI, eliminating the need for external consultants. A portion of the actual construction, including surface restoration, will be completed by EWSI's internal staff.

- Contracted services are performed by pre-qualified external contractors and done on a competitive unit priced basis.
- The installations will be consistent with EWSI's construction standards, which will speed up design and construction.
- Where possible, work will be coordinated with other projects or maintenance activities to minimize costs.
- The design and construction of the scope at each location is evaluated to improve economy of scale, to eliminate future throw-away of infrastructure and to facilitate future maintenance.

6.0 RISKS AND MITIGATION PLANS

24. Key risks and planned mitigations associated with execution of this project are described in Table 6.0-1 below.

Table 6.0-1
Key Risks and Risk Mitigations

	Risk	A Mitigation Plan
1	Financial - Due to limited space and other utility conflicts, it can be difficult to secure the optimum sewer main alignments.	Work with City designers and other utilities and construction coordinators to ensure all sewer main alignments are identified and secured as early as possible. Obtain information on other utility relocate project status' and as-built locations.
2	Financial - Unforeseen construction costs and force accounts due to hidden ground conditions or location and condition of existing utility assets differing from record information that will impact the overall costs of projects.	Work with designers, coordinators, and contractors to identify potential problems, provide accurate design and quantity estimates to minimize the need for extra work. Conduct hydrovac to determine if there are known and unknown utilities at shaft and manhole sites.
3	Customer Service – Drainage relocation work can involve presence and significant disruptions at a single site for long durations and may have negative impacts on the perception of EPCOR, the City and the LRT project.	Proactive communication to customers, such as delivering notices and engaging with key external stakeholders as required by the communications plan.

Appendix H10

EPCOR WATER SERVICES INC.

Drainage Services
Neighbourhood Renewal Program
Business Case

February 16, 2021

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1.0 OVERVIEW

1. The Drainage Neighbourhood Renewal Program is an annual program that focuses on the renewal and replacement of aging local sanitary, storm and combined sewers in mature neighbourhoods around the city of Edmonton. Local sewers account for 63% of underground pipe in the entire sewer system at approximately 4,700 km of pipe. As of 2019, local sanitary and storm infrastructure within the poor and very poor categories have an estimated replacement cost of $554 million. Risks associated with deterioration or failure of local sewer infrastructure includes roadway subsidence which poses a safety risk to the public and disruption to traffic; sewage spills to the local environment or to the river; potential service disruption to a large number of customers; potential for sewer backups into customer's basements and financial claims against EPCOR for these backups; and costly emergency repairs which are also disruptive to traffic. As an example, in Rhatigan Ridge, a local sanitary sewer collapsed and several homes had sewage backed up in their basements. There were over 100 residential properties that drain to this local sanitary pipe that could have been impacted in the Riverbend neighbourhood.

2. During the 2022-2024 PBR term, this program will include inspections of 129 km of sanitary, storm and combined pipes with a diameter of 750 mm or less as well as manholes (MHs), catch basins (CBs), and CB leads within 18 neighbourhoods. This workload is comparable to previous years. Historically, EWSI has completed 5 to 6 neighbourhoods per year under this program. Criteria for renewal under this program includes asset condition graded poor or very poor, assets graded moderate where renewal would address operational needs, or where type and severity of defects are sufficient for renewal.

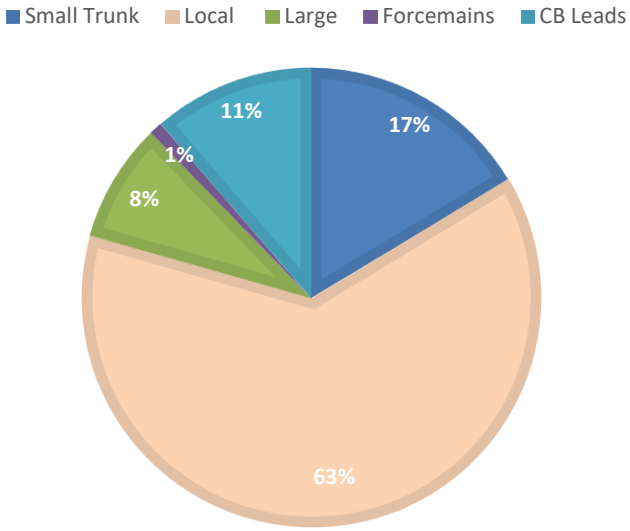
3. This program is categorized as growth / customer requirements. EWSI has forecast total program capital expenditures during 2022-2024 at $76.48 million. From 2006-2011, the average annual budget for neighbourhood renewal was about $26 million per year. From 2012-2018, the budget was about $30 million per year. The forecast of $76.48 million for this program over the three-year PBR term 2022-2024 is slightly lower on an annual average basis, but remains within the range of the annual capital expenditures over the last 14 years.

2.0 BACKGROUND AND JUSTIFICATION

4. The Drainage Neighbourhood Renewal Program focuses on the renewal and replacement of aging local sanitary, storm and combined sewers in mature neighbourhoods around the city. Local sewers account for the largest portion of underground pipe in the entire sewer system at

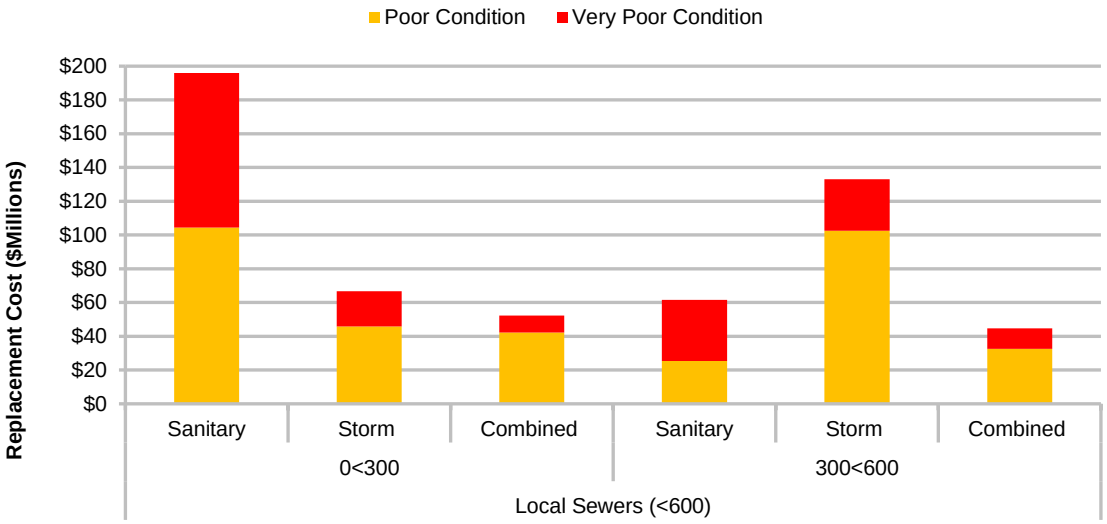
approximately 4,700 km of pipe. The graph in Figure 2.0-1 shows the proportions of sewer infrastructure with local sewers accounting for 63% of the total sewer length.

Figure 2.0-1
Proportion of Sewer Infrastructure



5. As the system ages, it is important to assess its condition to avoid emergencies and to prioritize renewal to deal with structural issues. The chart shown in Figure 2.0-2 indicates how much local infrastructure is in poor and very poor physical condition. As of 2019, assets within the poor and very poor categories have an estimated replacement cost of $554 million. Rehabilitation and replacements that are completed through renewal will have a positive effect on the condition ratings and therefore would reduce those figures.

Figure 2.0-2
Local Sewers Physical Condition Rating
Poor and Very Poor Replacement Cost
($ millions)



6. There are several risks associated with the deterioration and failure of local sewer infrastructure in neighbourhoods:

- Health and Safety – Failure of local sewer infrastructure could cause a roadway subsidence which poses a safety risk to the public.
- Environmental – Failure of a sanitary or combined local sewer could cause a sewage spill to the local environment or to the river.
- Customer Disruptions – Failure of local sewers can cause disruption to large service areas which would impact many customers, and can also cause sewer backups into customer's basements. Failed sewers also lead to more emergency repairs which are more disruptive to the roadway and therefore to the public.
- Financial – Emergency repairs of failed local sewers can be more costly than proactive renewal. Claims against EPCOR for sewer backups can also lead to a financial impact.

7. One example is the Rhatigan Ridge neighbourhood where a local sanitary sewer collapsed in March 2020. Several homes had sewage backed up in their basements. There are over 100 homes that drain to this sanitary sewer pipe that potentially could have been impacted. During the emergency construction, there were significant operations and construction activity along Rhatigan Road and Riverbend Road for 10 to 12 weeks. Figure 2.0-3 shows the extent of the

emergency construction work. Several homes were asked to restricted water use during construction and potential claims were filed.

Figure 2.0-3
Location of the Emergency Replacement Activity

8. The Drainage Neighbourhood Renewal Program provides EWSI the opportunity to proactively rehabilitate the aging local sewer infrastructure in the selected neighbourhoods through relining and open cut renewal to mitigate the risks listed above. Coordinating the proactive renewal with the reconstruction of roadways also mitigates the risk of having to cut into newly reconstructed pavement. The Drainage Neighbourhood Renewal Program runs in coordination with the City of Edmonton's (City) Building Great Neighbourhoods and Open Spaces Neighbourhood Renewal Program. Each year, the EWSI selects 4-6 neighbourhoods based on current asset condition and coordination with the Neighbourhood Renewal reconstruction schedule.

9. By conducting closed circuit television (CCTV) inspections of all the local sewers in the locations of the City's Neighbourhood Renewal Program, EWSI has the opportunity to rehabilitate or replace sections of pipe, prolonging the useful life of the pipes and improving the overall physical condition of the sewer system. Coordinating the work with the City also provides efficiencies such as reducing the likelihood of having to cut into newly reconstructed pavement,

allowing some CB, CB lead and MH rehabilitation work to be completed by the City under their reconstruction contract, and reducing disruption to the public.

10. Every individual neighbourhood project will take 2-3 years. CCTV and design will be completed in the first year, open cut will be completed in the second year and relining will begin in the second year and be completed in the third year. About 80% of the work will be done through relining which requires little disruption to the pavement. CCTV and smoke testing for the neighbourhood will be completed by EWSI Drainage Operations staff.

11. The scope for the Drainage Neighbourhood Renewal Program includes inspection and renewal of local sewers, MHs, CBs and CB leads within the neighbourhoods selected for renewal. Renewal will also include some previously identified services in need of replacement that fall within these planned neighbourhoods. Pipes that are prioritized for rehabilitation under this program are then renewed through either open cut repair or relining. The Drainage Neighbourhood Renewal Program coordinates with the Arterial Roadway Coordination Program and High Priority Repair to ensure alignment. Concept development will determine the exact scope of work to be completed.

12. The selection criteria for inspection and renewal of infrastructure in this program is shown in Table 2.0-1.

Table 2.0-1
Selection Criteria for Drainage Neighbourhood Renewal Program

	Selection Criteria for Renewal	A Definition
1	Pipe Sizes	750 mm and smaller
2	Non-linear Assets	Manholes, Catch Basins and Catch Basin leads
3	Drainage Asset Condition	Grade of 4 or 5 (poor and very poor)
4	Drainage Asset Condition	Grade of 3 and addresses operational needs, or type and severity of defects sufficient for renewal

13. The infrastructure requires CCTV inspection to determine asset conditions. Based on those inspections, the drainage infrastructure will be given a grade according to the Pipe Assessment Certification Program (PACP) and Manhole Assessment Certification Program (MACP) Ranking System shown in Table 2.0-2. PACP is the North American standard for pipe defect identification and assessment, providing standardization and consistency to the methods in which pipe conditions are identified, evaluated, and managed. Once the infrastructure has been reviewed and graded, a risk assessment and evaluation will be undertaken for each segment to determine which pipes require open cut replacement or relining. Pipes with a Likelihood of

Failure (LOF) of 3, 4 or 5 on the EPCOR Risk Matrix will move forward for open cut replacement or relining. There may also be an operational and maintenance reason for renewal or replacement of a lower LOF pipe such as roots or infiltration.

Table 2.0-2
PACP/MACP Condition Grading

Grade		A Definition
1	5	Most significant defects
2	4	Significant defects
3	3	Moderate defects
4	2	Minor to moderate defects
5	1	Minor defects

14. The following items are excluded from the scope of work:

- Any pipe greater than 750 mm, except in some exceptional cases where up to 900 mm can be included;
- Neighbourhood wide service renewal except those that are flagged by Drainage Operations and have a history of issues within the neighbourhood;
- Coordination with neighbourhood renewal projects that are mill and overlay only or drainage infrastructure asset condition is good to very good.

3.0 PROGRAM DESCRIPTION

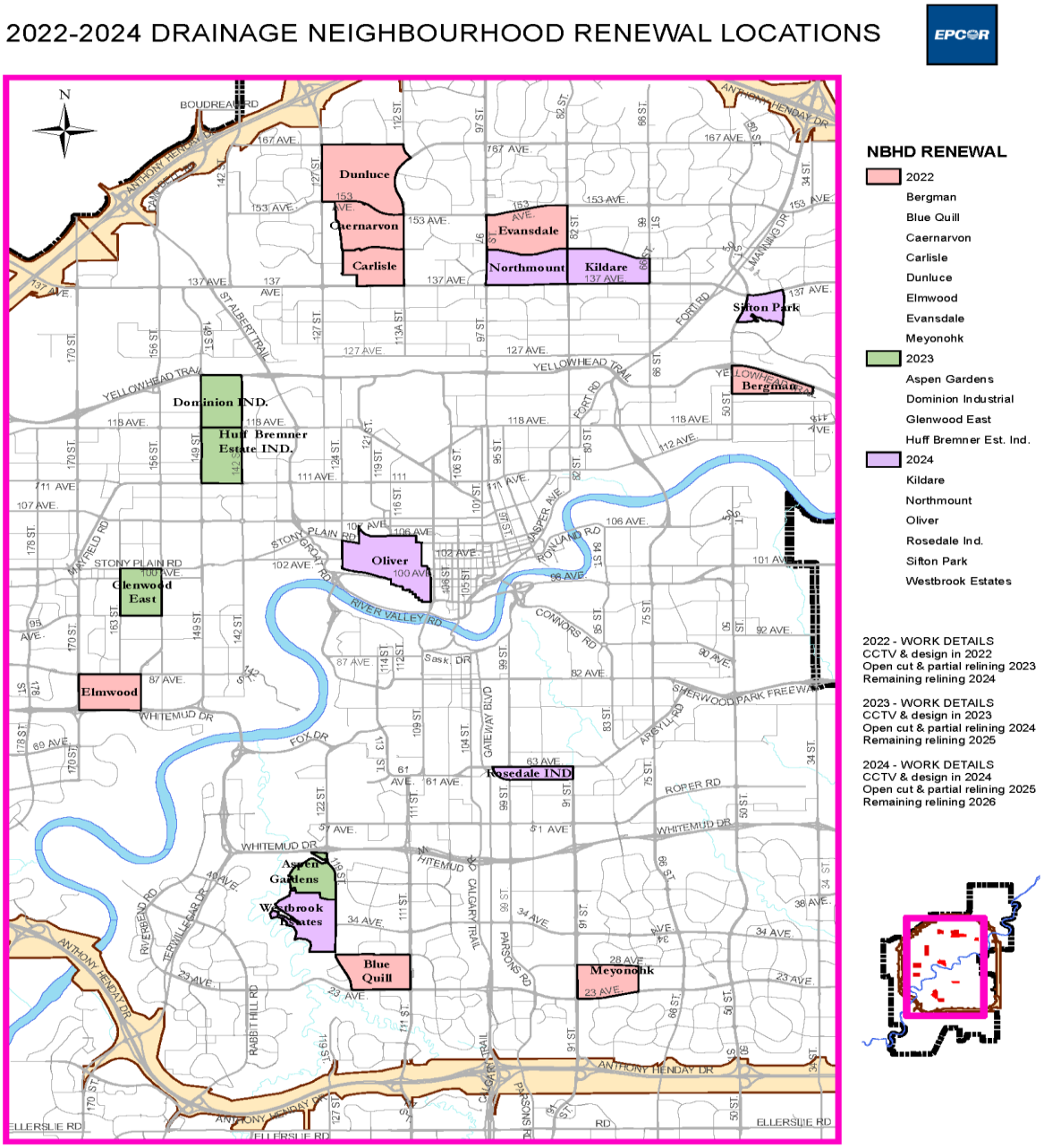
15. EWSI plans to initiate 18 neighbourhood projects during the 2022-2024 PBR term as shown in Table 3.0-1 below. These neighbourhoods are geographically located in different parts of the City. There are about 129 km of sanitary, storm and combined pipes with a diameter of 750 mm or less, as well as CB leads, MHs and CBs that will be inspected over the 2022-2024 PBR term.

Table 3.0-1
Drainage Neighbourhood Renewal Program
2022-2024 Project List

	Neighbourhood Name	A CCTV & Design	B Open Cut	C Relining
1	Bergman	2022	2023	2024
2	Carlisle	2022	2023	2024
3	Dunluce	2022	2023	2024
4	Meyonohk	2022	2023	2024
5	Blue Quill	2022	2023	2024
6	Caernarvon	2022	2023	2024
7	Elmwood	2022	2023	2024
8	Evansdale	2022	2023	2024
9	Aspen Garden	2023	2024	2025
10	Huff Breamner Industrial	2023	2024	2025
11	Dominion Industrial	2023	2024	2025
12	Glenwood East of 163 St	2023	2024	2025
13	Rossdale Industrial	2024	2025	2026
14	Kildare	2024	2025	2026
15	Northmount	2024	2025	2026
16	Westbrook Estates	2024	2025	2026
17	Sifton Park	2024	2025	2026
18	Oliver	2024	2025	2026

16. A detailed neighbourhood location map is provided in Figure 3.0-1.

Figure 3.0-1
2022-2024 Drainage Neighbourhood Renewal Location Map



17. As EWSI plans for infrastructure renewal in a neighbourhood, it will consider additional improvements that have been identified through other initiatives that could be completed and/or coordinated at the same time. These types of improvements include Low Impact Development (LID) features, flood proofing, service renewal, inflow and infiltration reduction, capacity upgrades and/or odour reduction. These improvements will be funded through separate program budgets.

18. The Drainage Neighbourhood Renewal Program will begin with CCTV inspections and concept design development in the first year which will include planning work to identify, prioritize and coordinate neighbourhoods to be initiated for renewal. Once the concept design work is completed, detailed design will begin followed by construction. Open cut and partial relining work will be completed in the second year. The remaining relining will be completed by the end of year three.

19. Table 3.0-2 provides a schedule for this program over the 2022-2024 PBR term.

Table 3.0-2
Drainage Neighbourhood Renewal Program Schedule
(2022-2024)

	Project Phases	A **2021 Q4**	B **2022 Q1**	C **2022 Q2**	D **2022 Q3**	E **2022 Q4**	F **2023 Q1**	G **2023 Q2**	H **2023 Q3**	I **2023 Q4**	J **2024 Q1**	K **2024 Q2**	L **2024 Q3**	M **2024 Q4**
1	Initiation and Approvals	α				β				μ				
2	CCTV & Design	α	α	α	α		β	β	β		μ	μ	μ	
3	Procurement					α				β				μ
4	Construction						α	α	α	α	α β	α β	α β	β
5	Commissioning												α	α
6	Close-out													α

α: Neighbourhoods initiated in 2022.
β: Neighbourhoods initiated in 2023.
μ: Neighbourhoods initiated in 2024.

4.0 ALTERNATIVES ANALYSIS

20. An alternative to the Drainage Neighbourhood Renewal Program is to not rehabilitate local sewers when they are identified and prioritized to be in poor or very poor condition. If nothing is done, the risk is that the local infrastructure under these roadways may be close to failure and if left to deteriorate, will likely cause emergency situations that would result in cutting into newly reconstructed roadways. Emergency repairs are more costly and are more disruptive to the public. As such, this alternative is rejected in favour of continuing the Drainage Neighbourhood Renewal Program.

5.0 COST FORECAST

21. The Drainage Neighbourhood Renewal Program capital cost estimate is based on historical information such as average annual lengths of CCTV required, average annual reline and open cut lengths, and unit costs from design and construction of past neighbourhood projects.

22. Assumptions and approach are as follows based on EWSI's experience and learnings from past years of the program:

- All CCTV inspections are either completed internally when resources are available or by external contractors;
- Any high priority open cut work will be handled by High Priority Repair Program;
- Pipes that have had open cut spot repair work will also have a full reline completed to eliminate joints in the pipe that can lead to more structural issues or root intrusions; and
- Both open cut and relining will be completed by external resources.

23. Table 5.0-1 provides the forecast capital expenditures for this program for the 2022-2024 PBR term.

Table 5.0-1
Drainage Neighbourhood Renewal Program
2022-2024 Program Capital Expenditure Forecast
($ millions)

		A **2022**	B **2023**	C **2024**	D **Total**
	Direct Costs				
1	Contractors	20.90	6.20	13.41	40.51
2	Internal Labour	3.63	8.52	5.93	18.09
3	Vehicles and Equipment	1.27	2.93	1.96	6.15
4	Contingency	0.80	0.99	2.75	4.54
5	**Sub-total Direct Costs**	26.60	18.64	24.05	**69.29**
6	Capital Overhead and AFUDC	1.36	2.63	3.21	7.19
7	**Total Capital Expenditures**	27.96	21.26	27.26	**76.48**

24. EWSI takes a number of steps to minimize the level of these capital expenditures. These include:

- EWSI has taken advantage of longer-term contracts with vendors to effectively manage the construction services using the contractor's equipment. As such, EWSI

has minimized the need to stock much of the required equipment reducing the overall costs of all installations and upgrades. Also the longer term construction contractor relationship allows us to mobilize the contractor efficiently and effectively as they are familiar with our and City's standards and master contractor agreements are in place.

- All activities related to project management, design, drafting, construction coordination and inspection, and as-built recording will be undertaken internally by EWSI, eliminating the need for external consultants.
- CCTV inspections will be completed by internal resources as available, and will be contracted out to external resources if required. Open Cut construction will be completed by internal resources, whereas relining will be completed by one of EWSI's long term construction contractors.
- Contracted services are performed by pre-qualified external contractors and done on a competitive unit priced basis, using comprehensive engineering packages to ensure cost and scope control.
- The installations will be consistent with EWSI's construction standards which will minimize stock requirements and speed up design and construction.
- Where possible, work will be coordinated with other projects or maintenance activities to minimize costs.
- Every project is evaluated individually to determine the appropriate construction method to meet requirements at the lowest cost.
- Every project scope is evaluated to improve economy of scale.
- All force accounts are documented and reviewed by several EWSI representatives to ensure the additional cost is justified under the terms of the contract.

6.0 RISKS AND MITIGATION PLANS

25. Table 6.0-1 provides the key risks and mitigations associated with executing this program.

Table 6.0-1
Key Risks and Risk Mitigations

	Risk	A Mitigation Plan
1	Execution Risks - The Program is subject to such execution risks including utility conflicts, unexpected scope increases, poor soil conditions, new road restoration requirements, increase in overall construction prices, and csection onflicts with other construction projects in the area.	EWSI will circulate all projects through the Utility Line Assignment (ULA) system, deal with force accounts on an individual basis. To manage program schedules, EWSI will ensure inspectors are recording all delays and force accounts. EWSI will work with the City to identify and clarify new requirements and or changes to the project and will coordinate construction with other utilities and City. EWSI's internal Drainage Services resources will undertake all project related activities including any required inspection, project management, design, construction coordination and survey as well as-built recording. EWSI will employ pre-qualified external contractors for additional CCTV inspection required due to lack of internal resources availability, open cut and relining works to complete construction.
2	Traffic Disruption Risks - The City's commitment to prevent significant traffic impacts from construction, especially downtown, may impact EWSI's ability to get OSCAM permits or restrict our work to off-peak hours.	EWSI will advise the City's Traffic Operations Group of all projects where roads are affected well in advance of construction.
3	Health and Safety - There is a risk of local drainage asset failure such as main lines and services that could result in sewer backup which is a potential health risk to the public.	Replacing or rehabilitating pipe, manhole and service would extend the life of the assets and lower the risks of asset failure.
4	Customer Impacts - There is a risk of sewer failure that could result in service interruption affecting the residents in the neighbourhoods for a few weeks.	The proposed rehabilitation project would lower the risks of sewer failure and service interruption in the neighbourhoods.
5	Financial - The potential sewer main failure could result in more costly emergency replacement.	The proposed neighbourhood renewal program would lower the risks of sewer failure in the neighbourhoods and, therefore, reduce the emergency replacement costs

Appendix H11

EPCOR WATER SERVICES INC.

Drainage Services
Private Development
Construction Coordination Program
Business Case

February 16, 2021

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1.0 OVERVIEW

1. The Private Development Construction Coordination Program is an annual program that includes costs to support the planning and development processes and facilitating the construction of new drainage infrastructure by private developers. The costs in this program covers EWSI's and the City of Edmonton's cost for staff to review land development applications, technical reports, and design drawings, and EWSI's cost to complete inspections during and after construction, recording as-built drawings which are required to ensure that new developments are designed in accordance with the City's Design and Construction Standards. This program also covers the City of Edmonton's costs to administer the Permanent Area Contribution (PAC) system and other development levies for the cost sharing of larger "bulk" infrastructure. The City's personnel costs are paid for by EWSI under the terms of the Urban Form and Corporate Strategic Development Services Agreement, and a portion of those costs are subsequently capitalized by EWSI. This program ultimately facilitates the growth of the drainage network and EWSI's customer base, and ensures that the infrastructure that EWSI inherits is suitable to operate and maintain for its intended life span.

2. This program is essential to the orderly development of the drainage system, ensuring not only that the City of Edmonton Design and Construction Standards are met, but also that sanitary and stormwater mains will be constructed with consideration for future development requirements. As EWSI will assume ownership of these assets upon completion, it is essential that EWSI be involved throughout the planning, design, and construction process to ensure proper asset information is available for future operation and maintenance activities.

3. Costs and recoveries associated with this program are dependent on activity levels in Edmonton's housing market and therefore fluctuate from year to year and can be difficult to forecast. This program is estimated to cost $12.24 million (gross) and covers the internal labour costs associated with construction coordination activities undertaken by EWSI and the City of Edmonton Drainage staff from the planning phase to the point at which EWSI takes ownership of the new drainage infrastructure. These costs are also partially offset by contributions (estimated at $0.92 million over the 2022-2024 PBR term) from the City of Edmonton in the form of inspection fees collected from developers. These fees are intended to cover a portion of the costs associated with the program, specifically engineering drawing review, inspection, and crew time. Net of these contributions, the cost forecast for this program for 2022-2024 is $11.32 million.

4. This program is categorized as growth / customer requirements and is one of the Drainage System Rehabilitation programs. This program was initiated in 2018 following the transfer of Drainage Services to EPCOR in September 2017. Prior to the transfer, Drainage Services under the City of Edmonton operated a similar capital program to fund these activities. Following the transfer, some of the functions under this program stayed with the City of Edmonton (including drawing review, reports and applications review). The Private Development Construction Coordination Program does not include the cost of constructing the drainage infrastructure. Drainage infrastructure construction is funded by private developers as part of the costs of their development, and cost-shared amongst benefiting landowners through the City's PAC system.

2.0 BACKGROUND/JUSTIFICATION

5. This is an annual program that supports planning and development processes, ultimately facilitating the construction of new drainage infrastructure by private developers. Land development in Edmonton is driven by developers who hire planning and engineering consultants to plan and design new neighbourhoods, then hire contractors to construct the infrastructure necessary to serve the development, which infrastructure gets turned over to EWSI as contributed assets.

6. Throughout the stages of planning, rezoning, subdivision, and engineering design, developers are required to submit various applications, technical reports, design drawings, and other documents for review and approval from a drainage utility perspective. EWSI and City of Edmonton collaborate on these processes, as outlined in the Urban Form and Corporate Strategic Development Services Agreement. EWSI performs inspections during and after construction, and also records as-built information. In addition, the City administers development levies for the cost sharing of larger "bulk" infrastructure which ensures that costs are shared appropriately between benefiting landowners, and that funds are collected from developers to support the Sanitary Servicing Strategy Fund (SSSF).

7. These activities, all which are funded by this program, are required to ensure that new developments are designed and built in accordance with the Design and Construction Standards, and that infrastructure is recorded accurately in EWSI's Geographic Information System (GIS). This program ultimately facilitates the growth of the drainage network and EWSI's customer base, and ensures that the infrastructure that EWSI inherits is suitable to operate and maintain for its intended life span.

3.0 PROGRAM DESCRIPTION

8. The cost associated with the following activities are covered under this program:

Activities completed by EWSI Water Services:

- Construction Completion/Final Acceptance inspections (approximately 475 per year);
- Inspector review of developer applications;
- Infill Water and Sewer Servicing staff time for development inquiries and customer account setup; and
- Land administration services.

Activities completed by EWSI Drainage Services:

- Infrastructure as-built recording for contributed assets (approximately 200 subdivisions per year);
- Review of development applications and inspection of specialized infrastructure (approximately 50 per year); and
- Reviews of development applications and program coordination.

Activities completed by City of Edmonton:

- Engineering drawings reviews (approximately 780 per year);
- Land Development Applications reviews; and
- Administration of the PAC system and other drainage development levies.

9. This is an annual program beginning on January 1st and ending on December 31st each year.

4.0 ALTERNATIVES ANALYSIS

10. The alternatives to maintaining the status quo are limited. Some smaller municipalities hire external consultants to review developer design submissions and perform inspections on their behalf where they do not have the internal staff or expertise within the organization. This option is not considered viable in Edmonton due to the volume of submissions and the potential for issues with consistency if the hired consulting firm were to change from year to year. EWSI could risk losing control over the quality of submissions and the infrastructure as it would be entirely dependent on the consulting firm to maintain the quality.

11. Not participating in these processes all together, and thus relying entirely on the engineer who designs and certifies on behalf of the developer that the infrastructure is constructed in accordance with the standards, is also not considered to be a realistic option.

12. Without EPCOR's participation in the City's planning and development processes, the quality, integrity, and reliability of privately constructed drainage infrastructure (around $135 million per year in new assets over the past 5 years) would be jeopardized, as well as compliance with regulations, standards, and environmental requirements. Operational and maintenance costs would increase due to improper planning, design, and installation of drainage infrastructure. In addition, the orderly sequential development of the drainage system could break down, making it difficult or inefficient to service future subdivisions. This would ultimately lead to negative impacts on EPCOR's finances, operation, and reputation.

5.0 COST FORECAST

13. This program has only been in operation for two full calendar years, starting after Drainage was transferred from the City to EPCOR in September 2017. The actual costs and revenues for 2018 and 2019 are broken down as shown in Table 5.0-1.

Table 5.0-1
2018-2019 Private Development Construction Coordination Program Costs
($ millions)

	Year	A City of Edmonton Activity Costs	B EWSI Costs (salaries, mileage, overhead, etc.)	C Recoveries (Inspection Fees)	D Total
1	2018	$ 1.81 (excl. PAC)	$ 1.79	($0.56)	$ 3.03
2	2019	$ 2.38 (incl. PAC)	$ 1.54	($0.18)	$ 3.74

14. The costs and revenues for this program can be somewhat dependent on the economy and housing market, and therefore can fluctuate from year to year. However, it is possible to estimate based on the level of development activity seen over the past two years and the corresponding demand seen on the program, along with the level of development activity anticipated during the PBR period. This is considered the most reasonable approach to estimating future costs and revenue because it is based on actual data.

15. Recent discussions with the City and the development industry suggest that lower activity levels in 2019 represent a new normal. The COVID-19 pandemic may result in a decrease in both costs and revenues, however, no significant changes have been seen as of yet. On the other hand, when the land development industry has went through slower periods in the past,

developers have often shifted their focus to smaller-sized subdivisions that have still had significant demands on this program. To balance these two effects, EWSI has assumed that the costs and revenues seen in 2019 provide a reasonable basis to estimate the annual costs and revenues over the 2022-24 PBR term.

16. For program costs, City of Edmonton costs are estimated at $2.35 million per year (in 2020 dollars), which is similar to 2019. Internal EPCOR staff costs/hours were estimated using a combination of 2019 actual values and input from the applicable business units that charge to the program. Program hours by job type were analyzed for 2019, then similar values were applied to the PBR period, with the majority of hours attributed to recording of as-builts (3,740 hours) and inspections by Drainage Operations labour staff (2,012 hours). Using 2019 as a baseline is expected to provide a reasonable indication of these costs for the PBR term.

17. Program recoveries come solely from Inspection Fees paid by developers when they enter into servicing agreements with the City, just prior to construction. The amount of revenue is dependent on development activity levels, which again, are difficult to predict and fluctuate each year. Revenue was considered to be abnormally low in 2019 ($184,348) when compared to the 10 year average of approximately $625,000 per year, however, revenues are not expected to rebound to historical average levels in the near future due to economic conditions. Therefore, an estimate of $300,000 was used.

18. Forecast capital expenditures for the 2022-2025 PBR term are shown in Table 5.0-2.

Table 5.0-2
2022-2026 Capital Expenditure Forecast
($ millions)

		A **2022**	B **2023**	C **2024**	D **Total**
1	City of Edmonton Costs	2.5	2.5	2.6	7.6
2	Water Services Costs	0.7	0.8	0.8	2.3
	Drainage Costs:				
	Direct Costs				
3	Contractors	0.00	0.00	0.00	0.00
4	Internal Labour	0.65	0.66	0.68	1.99
5	Vehicles and Equipment	0.03	0.03	0.03	0.10
6	Abandonments	0.00	0.00	0.00	0.00
7	Contingency	0.00	0.00	0.00	0.00
8	Risk Allowance	0.00	0.00	0.00	0.00
9	**Sub-total Direct Costs**	3.89	3.97	4.04	**11.90**
10	Capital Overhead and AFUDC	0.11	0.11	0.12	0.34
11	**Total Capital Expenditures**	4.00	4.08	4.16	**12.24**
12	Less: Inspection Fees (Recoveries)	(0.30)	(0.31)	(0.32)	(0.92)
13	**Net Program Capital Expenditures**	3.70	3.77	3.85	**11.32**

19. EWSI takes steps to minimize the level of these capital expenditures. These include:

- All activities related to project review, coordination, inspection, and as-built recording are undertaken by either EWSI or the City, eliminating the need for external consultants.
- Opportunities for process improvements and Water-Drainage synergies to better manage program costs.

6.0 RISKS AND MITIGATION PLANS

20. Key risks and mitigation plans associated with execution of this program are described in Table 6.0-1.

Table 6.0-1
Key Risks and Risk Mitigations

	Risk	A Mitigation Plan
1	**Financial Risks** - The number of submissions and construction projects is under the control of developers and consultants, who are under the influence of market conditions. Costs and revenues can fluctuate if market conditions vary.	EWSI will monitor costs and revenues each month as part of its regular capital management and governance processes with an effort to manage any anticipated cost increases.
2	**Execution Risks -** A key execution risk is the possible lack of adequate staffing to handle workloads, particularly when complex situations or issues arise.	On a regular basis, EWSI will carefully monitor resource and work levels and adjust as necessary.

Appendix H12

EPCOR WATER SERVICES INC.

Drainage Services
Proactive Service Renewal Program
Business Case

February 16, 2021

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1.0 OVERVIEW

1. The Proactive Service Renewal Program is an annual program to inspect and reline services that have structural and/or maintenance issues, but are in adequate condition for relining. Within the City of Edmonton, over 48,000 services are rated as poor and very poor and consist mainly of sanitary clay tile pipe aged 65 years and older. This large cohort of assets are nearing the end of their expected life of 75 years.

2. Failure of services requires more expensive open cut emergency repairs or replacements under EWSI's High Priority Repair Program. The average cost of open cut emergency repairs is approximately $29,000, depending on the length of service. The number of emergency service repairs and replacements have been on an increasing trend. Service failures also impact EWSI's customers through sewer blockages and back up.

3. By proactive relining of services through this program, identified asset risks are mitigated and managed appropriately to reduce risk exposure which aligns with the asset management objectives set out by EPCOR. Proactive relining typically costs between $8,000 and $13,000 depending on service length, which is a significant cost savings over reactive open cut costs (approximately $29,000). Fewer customer impacts will increase EPCOR's reputation and will reduce the number of service complaint calls.

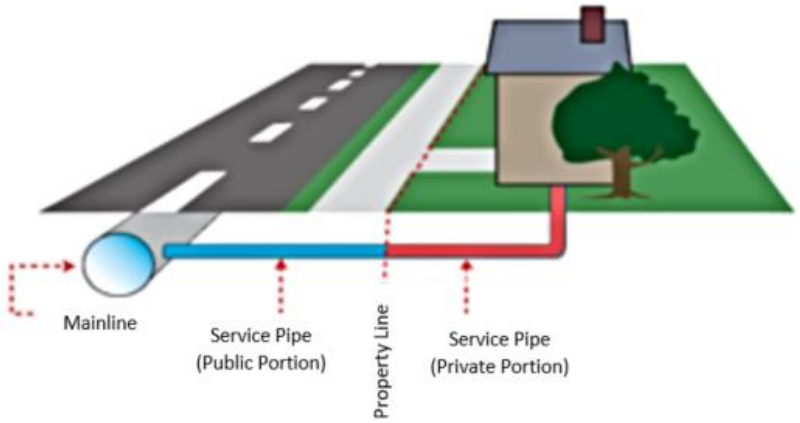
4. The Proactive Service Renewal Program is a new program which will begin in 2023, allowing time to plan for this program and gain experience from the renewal work on services from other programs. For the 2022-2024 PBR period, the scope is estimated to include 350 service renewals per year for 2023 and 2024. The scope of work will include investigation and relining of services and will be limited to the public portion of the service.

5. This program is categorized as reliability / life cycle replacement and is one of the Drainage System Rehabilitation programs. EWSI has forecast total program capital expenditures during 2022-2024 at $10.28 million. This new program will start in 2023 and there is no previous similar program to compare to.

2.0 BACKGROUND/JUSTIFICATION

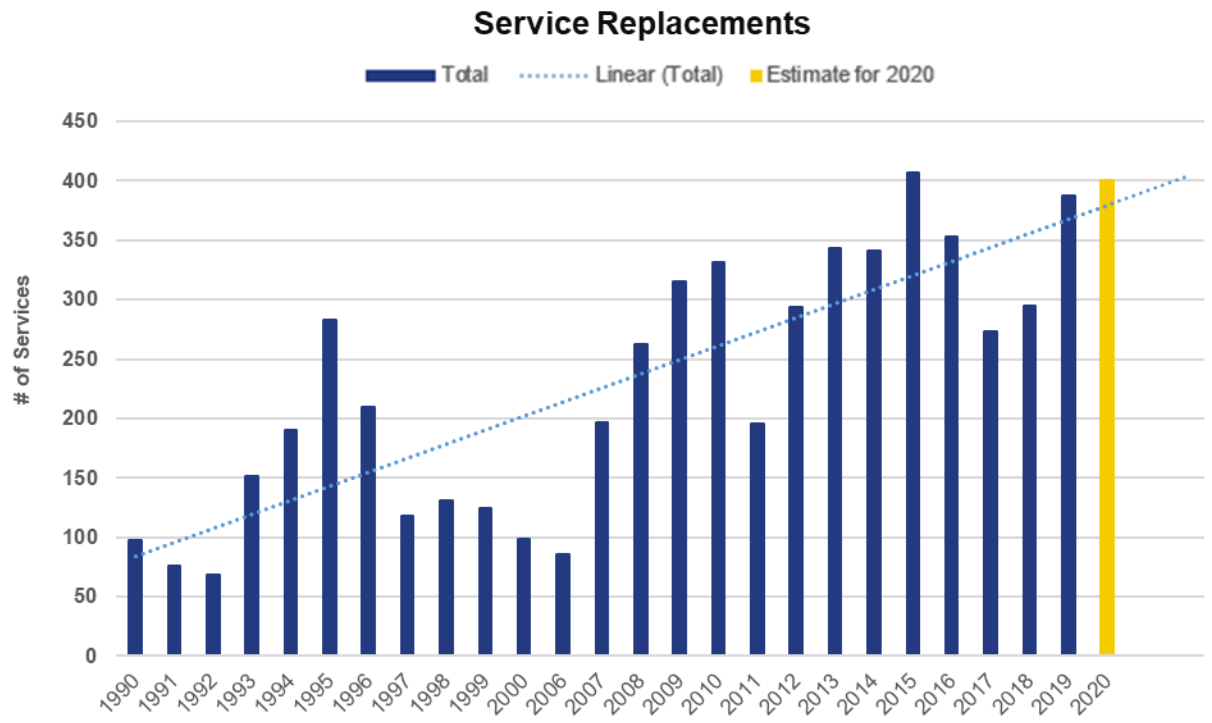
6. Service connections (services) owned by EWSI are defined as the service pipes (see Figure 2.0-1) from the lateral mainline to the property line. Figure 2.0-1 indicates the private and public portions of the service pipe. Services within private property from the property line to the home are owned and maintained by the owner. EWSI maintains over 420,000 sanitary and storm services, and the overall average age of services is 38 years for sanitary services and 30 years for storm services. EWSI receives on average 3,100 annual service calls related to issues with this aging infrastructure. These calls result in a high frequency of reactive maintenance. In 2019, 388 high priority service replacements were required.

Figure 2.0-1
Typical Service Pipe



7. Figure 2.0-2 shows the total number of services replaced annually from 1990 to 2020 (forecast). The chart shows a general increasing trend over this timeframe. EWSI anticipates that as the City of Edmonton grows and the system ages, the number of service replacements required each year will continue to increase. To deal with this ever growing problem, a dedicated Proactive Service Renewal Program has been developed. This program will focus on the renewal of aging services in mature neighbourhoods of the city. The program is currently being developed and will be implemented over the 2022-2024 PBR term.

Figure 2.0-2
Total Number of Services Replaced Per Year



**2020 is projected #, based on 203 completed to June 2020.*

8. The current process for addressing failing services is to replace them at or near failure using open cut technologies. These services are replaced either through EWSI's High Priority Repair Program, Medium Priority Renewal Program, or the Drainage Neighbourhood Renewal Program. The High Priority Repair Program addresses emergency situations where the service needs to be replaced within one year. The Medium Priority Renewal Program addresses services that require replacement but can be completed within 1 to 3 years. The Drainage Neighbourhood Renewal Program addresses services that have been identified as needing replacement and also coordinate within the neighbourhood scheduled for renewal. Services that have not failed, but have operational concerns (blockages, root intrusions, sags, etc.), are maintained using flushing, auguring, flailing and root cutting technologies. Once services become unmaintainable, they are prioritized for replacement through the programs listed above. A typical cost for complete replacement of the public portion of a service using open cut technologies averages approximately $29,000.

9. A proactive service relining project was initiated in 2019 in the Ritchie neighbourhood to address a number of services that were on the root maintenance program or experienced repeat sewer obstructions. The root maintenance program is offered to customers who have

experienced repeated sewer back-up as a result of tree roots in the EPCOR portion of their sanitary service. The roots are augured on a regular schedule. The Ritchie neighbourhood had a high concentration of customers on the root maintenance program, so it was a good candidate for the proactive renewal approach. Approximately 550 services require relining in the Ritchie neighbourhood, and about 250 have been completed. The costs have been close to $13,000 per service. EWSI expects that costs will decrease from this level as more experience is gained and efficiencies are achieved over time. EWSI's experience with the Ritchie neighbourhood will provide information for planning future projects within this program.

10. The Proactive Service Renewal Program will inspect and reline services that have structural and/or maintenance issues but are in adequate condition for relining. Locations will be targeted and prioritized based on a number of factors such as condition assessments, high concentrations of operational and maintenance issues and high concentrations of past service replacements. Locations will be chosen on a neighbourhood basis and then narrowed down to streets or areas based on the above factors. Typically if a street or area has had a significant number of issues with services in the past, it is likely that other services in the same area will also be in a similar condition with similar issues. It is also beneficial to take advantage of efficiencies of renewing a large number of services in close proximity. Mobilization and demobilization costs can be reduced significantly by undertaking renewal of services that are in the same general area. Another factor in choosing locations is to target neighbourhoods that have been through Drainage Neighbourhood Renewal Program since the mainline pipes will have already been relined or replaced.

11. Within the City of Edmonton, over 48,000 services are rated as poor and very poor and consist mainly of sanitary clay tile pipe constructed prior to 1955 (65 years and older). This large cohort of assets are nearing the end of their expected life of 75 years.

12. Risks associated with the growing number of services in poor and very poor condition include:

- Financial Risk – open cut emergency repairs are costly and the number of high priority service replacements are increasing each year.
- Customer Service Disruptions – customer frustration and potential damage to customer properties will increase as more customers deal with service issues such as blockages and sewer back up, and the reputation of EPCOR will be impacted.

13. By proactively relining services through this program, identified asset risks are mitigated and managed appropriately to reduce risk exposure which aligns with the asset management objectives set out by EWSI. Proactive relining typically costs between $8,000 and $13,000 depending on service length, which is a significant cost savings compared to the reactive approach involving open cut and complete replacement of the public portion of a service which averages approximately $29,000. This program will also reduce the number of disruptions and customer complaints associated with services back up and blockages. Work completed in the PBR 2022-2024 term will inform the level of expenditures for future PBR periods.

3.0 PROGRAM DESCRIPTION

14. The Proactive Service Renewal Program will begin in 2023 and continue on an annual basis. For the 2022-2024 PBR period, the scope is estimated to include between 200 and 350 service renewals per year for 2023 and 2024. The number that are completed will depend on the cost per service in order to remain within the targeted budget. While EWSI has been relining services for at least 15 years, this is the first formalized program focusing specifically on this type of work. This program will start in 2023 to coordinate with work completed through other service renewal work and the High Priority Repair Programs. The Medium Priority Renewal Program will continue until the end of 2021 and if any additional medium priority services are required after 2021, they will be prioritized and addressed through the High Priority Repair Program. This Proactive Service Renewal Program will begin in 2023 which allows time to prepare through planning and learning from the Medium Priority Service Renewal Program which ends in 2021. The scope of work for this Program will include investigation and relining of services and will be limited to the public portion of the service line. The scope may also include some relining of the mainline pipes in locations where it has not already been completed through the Drainage Neighbourhood Renewal Program or other local sewer renewal programs.

15. Existing inspection records will help in the selection of areas to target for the 350 service renewals. Additional inspections will also be required on other services in the target area. In order to determine which locations will require rehabilitation, inspections will be reviewed and assessed for condition and operational issues. Condition ratings will be based on the Lateral Assessment Certification Program (LACP) Ranking System index score for pipe condition assessment as shown in Table 3.0-1 below. LACP is the North American standard for lateral defect identification and assessment, providing standardization and consistency to the methods in which lateral conditions are identified, evaluated and managed.

Table 3.0-1
Lateral Assessment Certification Program

	Rating	A Criteria
1	5	Immediate attention needed; most significant defects
2	4	Poor; significant defects
3	3	Fair; moderate defects
4	2	Good; minor to moderate defects
5	1	Excellent; minor to no defects

16. The benefit of relining services that have structural issues and ongoing maintenance needs, identified through LACP, is that it eliminates ongoing, repetitive operational maintenance costs, claims and dissatisfied customers. This program will allow EWSI to continue to provide a high level of service to customers by reducing the risk of service failures and by minimizing disruptions. It is also a less costly alternative than open cut replacements if the services can be addressed before they fail.

17. Table 3.0-2 provides a schedule of the phases of work occurring within this program.

Table 3.0-2
Proactive Service Renewal Program Schedule
(2022-2024)

	Program Phases	A 2022 Q4	B 2023 Q1	C 2023 Q2	D 2023 Q3	E 2023 Q4	F 2024 Q1	G 2024 Q2	H 2024 Q3	I 2024 Q4
1	Initiation/Approvals	x				x				x
2	Preliminary Design	x	x			x	x			x
3	Detail Design		x				x			
4	Procurement			x				x		
5	Construction			x	x	x		x	x	x
6	Commissioning					x				x
7	Close-out					x				x

4.0 ALTERNATIVES ANALYSIS

18. An alternative to this Proactive Service Renewal Program is to maintain the status quo and continue dealing with services either by the open cut repair/replacement method under the existing programs and/or ongoing maintenance programs. Open cut requires excavation to repair or replace a service at an average cost of approximately $29,000 per service. This method commonly requires portions of the public street/sidewalk, private landscaping, and private driveways to be excavated and then restored. Some clay tile services can contain significant deficiencies in the form of breaks, collapsed sections, misalignments, and offset joints which

make relining not possible. In these situations, open-cut excavations are a viable method to renew the pipe and they will be completed through either EWSI's High Priority Repair Program, Medium Priority Renewal Program or the Drainage Neighbourhood Renewal Program. With the implementation of this Proactive Service Renewal Program, EWSI expects that over time the number of severely deteriorated services that require open cut replacement will be reduced.

19. The open cut alternative would also continue to place services on a root maintenance plan. Currently, services that are deemed to be candidates for maintenance are placed on a 1, 2 or 3 year cycle. Service crews auger roots by means of the private cleanout. Maintaining the public portion in this manner does pose a liability risk, but it also benefits the customers as their pipe also receives root removal at the same time. The maintenance cycle does not actually fix the underlying issue which is the poor condition of the service line. This alternative also runs the risk of causing sewer back up in the home.

20. Continuing with the open cut approach will increase the existing backlog of poor condition services requiring repairs/replacements due to lack of capacity and emergency locations. This backlog will continue to increase as the system ages. As the trend in Figure 2.0-2 shows, costs will continue to rise for emergency repairs and operational and maintenance costs will also continue to increase as more homes become dependent on the root maintenance program.

21. The Proactive Service Renewal Program will extends the life of the pipe up to 50 years through relining. Compared to the open cut approach, relining will cause less disruption to the customer by eliminating sewer back up and crews entering the home to perform regular maintenance, and will cause fewer traffic disruptions. Relining eliminates the need to restore the landscaping and work is completed within hours as opposed to days. Relining can now be performed from the mainline access point which provides minimal disturbance to the customer.

5.0 COST FORECAST

22. Provided that the existing service is in adequate condition, relining is a much more cost-effective method of service renewal. EWSI has estimated that the average cost of relining is $8,000 to $13,000 per service based on current contractor rates, far lower than the open-cut alternative. The proactive relining approach will provide benefit beyond the current PBR period by increasing the life of the assets and potentially reducing the number of services requiring future open cut replacement

23. In instances where a service has a long history of root intrusions, the current practice is to send the service for an open-cut replacement. Statistical data shows that 65% of residential/commercial sewer troubles are due to root intrusions. Many services that are prone to root intrusions are also prone to cracks. Relining technology is extremely effective at preventing root intrusions and crack formation/propagation in services, and is therefore a solution that provides a significant reduction in expenses.

24. Drainage Operations maintains root compromised services on average for 10 years until the service eventually fails. There are approximately 2,000 services on the Root Maintenance Program currently. The average cost to maintain these services is $700,000 annually. Since this program is being implemented in 2023, EWSI is not forecasting a reduction in operating expenses during the 2022-2024 PBR term. However, forecast operational savings from the Proactive Service Renewal Program will be included in the future operating cost forecast in the next PBR term.

25. Costs for the 2022-2024 PBR period are shown below in Table 5.0-1. The number of services to be completed within the budget is between 200 and 350 services depending on service length and based on the estimated costs of between $8,000 and $13,000 per service. The work will be contracted out to an external contractor to complete the relines. Internal costs are for design resources, project management, providing direction and review when required, as well as to provide post rehabilitation inspections.

Table 5.0-1
Proactive Service Renewal Program
Capital Expenditure Forecast (2022-2024)
($ millions)

		A **Pre-2022**	B **2022**	C **2023**	D **Total**
	Direct Costs				
1	Contractors	0.00	4.68	4.98	9.66
2	Internal Labour	0.00	0.11	0.11	0.22
3	Contingency	0.00	0.17	0.19	0.36
4	**Sub-total Direct Costs**	0.00	4.97	5.28	**10.25**
5	Indirect Costs	0.00	0.02	0.02	0.04
6	**Total Capital Expenditures**	0.00	4.99	5.30	**10.28**

26. EWSI takes a number of steps to minimize the level of these capital expenditures. These include:

- EWSI has taken advantage of longer-term contracts with vendors to effectively manage the supply, quality and construction of required equipment. This is important

for the successful execution of this Program due to the limited available contractors. As such, EWSI has minimized risk of unavailable contractors and reduces the overall costs of all installations and upgrades. Also the longer term construction contractor relationship allows us to mobilize the contractor efficiently and effectively as they are familiar with our and City's standards and master contractor agreements are in place.

- EWSI has started assessing the potential to complete some of this type of work using internal resources.
- All activities related to project management, design, drafting, construction coordination and inspection, and as-built recording will be undertaken internally by EWSI, eliminating the need for external consultants. The actual construction, including surface restoration, will be completed by one of EWSI's long term construction contractors.
- Contracted services are performed by pre-qualified external contractors and done on a competitive unit priced basis, using comprehensive engineering packages to ensure cost and scope control.
- The installations will be consistent with EWSI's construction standards which will minimize stock requirements and speed up design and construction.
- Where possible, work will be coordinated with other projects or maintenance activities to minimize costs.
- Every project is evaluated individually to determine the appropriate construction method to meet requirements at the lowest cost.
- Every project scope is evaluated to improve economy of scale and to eliminate future throw-away of infrastructure.
- All force accounts are documented and reviewed by several EWSI representatives to ensure the additional cost is justified under the terms of the contract.

6.0 RISKS AND MITIGATION PLANS

27. EWSI has identified the key risks and mitigations associated with executing this program in Table 6.0-1.

Table 6.0-1
Key Risks and Risk Mitigations

	Risk	A Mitigation Plan
1	Health & Safety - Reline material not properly cut-out at connections can cause sewer back up which poses as a health risk to customers.	Ensure EPCOR hires reline contractors that are competent and have a track record of producing quality work.
2	Operational Impact - Damage to reline by service crews when performing sewer auguring.	Deliver proper training to crews as to how to avoid damage to relined pipes. Use smaller cutter heads.
3	Customer Impacts - There is a risk of service failure that could result in service interruption affecting the residents in the neighbourhoods.	The proposed program would lower the risks of service failure and interruption.
4	Financial • Service failure will result in more costly emergency replacement. • Maintain services through Root Maintenance Program is costly and not effective long term.	• The proposed program would lower the risks of service failure and reduce the overall costs. • The proposed program will reduce the dependence on the Root Maintenance Program.
5	Execution Risk - On going root intrusion issue if application of relining material does not cure properly.	Ensure that pipes being relined are in good condition for the reline application.

Appendix H13

EPCOR WATER SERVICES INC.

Drainage Services
Pump Station Rehabilitation Program
Business Case

February 16, 2021

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1.0 OVERVIEW

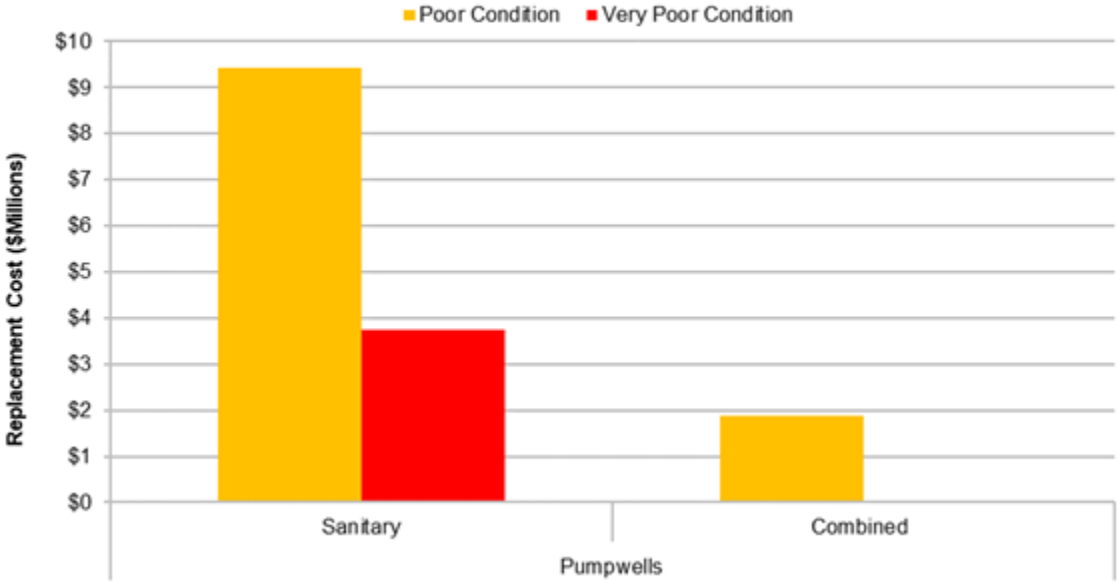
1. The Pump Station Rehabilitation Program is an annual program that focuses on the renewal of aging pump stations within the City of Edmonton. This annual rehabilitation program allows EWSI to rehabilitate or replace deteriorated pump stations to mitigate the risks of pump station deterioration and failure. Maintaining an acceptable level of environmental protection and service requires rehabilitation of the pump stations on an on-going basis. There are several risks associated with the deterioration and failure of pump stations including health and safety risks to EWSI staff and the public associated with spilled sewage and basement backups, environmental risks associated with floods and spills into the local water bodies, financial risks associated with costly emergency repairs and disruptions to customer service.

2. EWSI owns and maintains 91 pump stations across the City of Edmonton, with 46 of these having medium-high or high risk of failure. Failure risk is determined based on likelihood of failure (based on asset condition) and consequence of failure. During the 2022-2024 PBR term, this program will include rehabilitation of 8 pump stations. The amount of rehabilitation work is forecast based on an average value obtained from historical information. Criteria for renewal under this program includes asset condition graded as poor or very poor condition, risk assessment and prioritization. This program is categorized as reliability / life-cycle replacement and is one of the Drainage System Rehabilitation programs. EWSI has forecast total program capital expenditures during 2022-2024 at $15.5 million. This reflects an increase in annual spending on this program from an average of $1.9 million per year over 2020 and 2021 to $5.2 million per year. The increase is required to address the high number of pump stations in poor condition and reduce the risk of failure for this drainage asset.

2.0 BACKGROUND/JUSTIFICATION

3. EWSI owns and maintains 91 pump stations across the city and the average age of pump stations is 27 years. The total expected life for the building superstructure (of a pump station is 50 years, while all other subsystems (such as pumps, valves, etc.) have a life expectancy of 20 years. The total replacement cost for all pump stations in poor and very poor condition is estimated to be $15 million. As the system ages, it is important to assess their condition to avoid emergencies and to prioritize renewal to deal with deterioration, leaking and odour issues. Figure 2.0-1 indicates the replacement cost associated with pump station infrastructure which is in poor and very poor physical condition for sanitary and combined systems.

Figure 2.0-1
Pump Station Physical Condition Rating
Poor and Very Poor, Replacement Cost



4. There are several risks associated with the deterioration and failure of pump stations:

- Health and Safety Risk – deteriorated or failed pump stations could pose a safety risk to the EWSI staff who operate and maintain the pump stations. There is also a safety risk to the public if a pump station fails and causes spilled sewage and basement backups.
- Environmental Risks – deteriorated or failed pump stations could lead to floods and sewage spills to the local environment or water bodies which could lead to violations of EWSI's approval to operate and potential fines. This program will reduce the risk of station failures and the subsequent release of untreated sewage.
- Financial Risks – Emergency repairs to failed pump stations are more costly than proactive rehabilitation or replacement. Failed pump stations can also lead to flooding which are costly to manage and clean up, and can lead to claims from customers with flooded basements.
- Service Disruption Risk – A failed pump station could lead to sewage backup or neighbourhood flooding, which could result in service issues and damage to customer properties. This Pump Station Rehabilitation Program will reduce the risk of station failures and the subsequent impacts to customers.

5. There are several examples of pump stations that demonstrate the consequences of failure and associated risks:

- Walterdale Pump Station: An incident occurred at this station when the level of the North Saskatchewan River started to rise rapidly. The gate closed in response but was unable to close properly due to ice buildup at the bottom of the gate. Failure of the gate to operate properly caused an opportunity for untreated wastewater to be mixed with water from the river resulting in the potential discharge of untreated wastewater to the river. EWSI also identified that working in the confined space of this station is a health and safety risk due to inability to properly isolate the pump system when employees are performing intrusive work.
- Beverly Raylo Pump Station: This station overflowed multiple times due to high discharge volumes as well as a consequence of its internal processes. The overflows spilled untreated wastewater flows to the surrounding environment and river. The events were reported to Alberta Environment and Parks and remediation work is planned to address the situation.
- Elsinore Pump Station: A problem with the forcemain caused leaking in the surrounding area and caused street flooding which posed a safety risk to the public and a potential environmental issue.

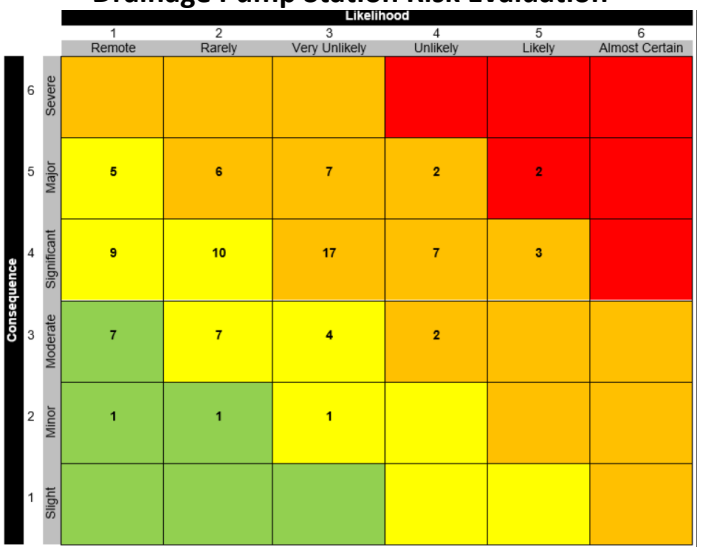
6. This annual rehabilitation program allows EWSI to rehabilitate or replace deteriorated pump stations to mitigate the risks listed above. Maintaining an acceptable level of environmental protection and service requires rehabilitation of the pump stations on an on-going basis. This program aligns with EPCOR's asset management objectives by identifying emerging risks and managing them appropriately, reducing risk exposure and reducing negative impacts on the environment.

7. All pump stations are inspected regularly for a physical condition and performance assessment by Drainage Operations. These inspections include the following:

- site and building;
- substructure;
- pipes and valves;
- motors and pumps; and
- may include forcemains.

8. Deficiencies are cataloged and then assessed to help determine the needs for pump station rehabilitation. The overall risk evaluation of pump stations is shown in Figure 2.0-2. Pump stations in the orange and red areas of the matrix are classified as high and medium high risk. The factors that were included in this risk ranking health and safety, environmental, regulatory, reputation, service interruption and financial consequences.

Figure 2.0-2
Drainage Pump Station Risk Evaluation



9. The highest likelihood pump stations have issues based on Operations inspections such as badly deteriorating site and building, concrete structure cracks, pumps and motors that are beyond their useful life, small wet well that can't handle severe storm events, dry well leaks, etc.

10. Figure 2.0-3 below provides the pumpstations falling into the red and orange categories indicating those EWSI plans to complete in prior to the 2022-2024 PBR term and for future. EWSI continues to update risk ranking of pumpstations as more information becomes available.

Figure 2.0-3
Drainage Pump Station Risk Evaluation

ID	PW Name	Waste Type	Consequence of Failure Max	Likelihood of Failure	Max Risk Score	Max Risk Level	Sum of Risk	Risk Ranking (Max)
105	Duggan	San	5	5	10000	IV	24579	High
111	Laurier Heights	San	5	5	10000	IV	21487	High
174	Nest	San	4	5	3162	III	11587	Medium-High
102	Westbrook	San	4	5	3162	III	9641	Medium-High
113	Groat Rd. Clifton Place	San	4	5	3162	III	6111	Medium-High
163	Twin Brooks	San	5	4	3162	III	6111	Medium-High
121	Cloverdale	Cmb	5	4	3162	III	5462	Medium-High
200	South Terwillegar	San	4	4	1000	III	3265	Medium-High
104	Kaskitayo Carma-2C	San	4	4	1000	III	3049	Medium-High
203	Windermere Interim Ambleside	San	5	3	1000	III	2832	Medium-High
112	St. Georges Crescent	San	4	4	1000	III	2548	Medium-High
171	Walterdale	Cmb	5	3	1000	III	2479	Medium-High
156	Whitemud Dr & 111 St	Stm	5	3	1000	III	2242	Medium-High
141	Eastgate Industrial	San	4	4	1000	III	2149	Medium-High
116	Rundle Heights	San	4	4	1000	III	2149	Medium-High
182	Beverly (Raylo)	San	4	4	1000	III	1864	Medium-High
115	Riverdale	Cmb	4	4	1000	III	1716	Medium-High
212	Rtq Ravine Stn212	San	5	3	1000	III	1626	Medium-High
173	Yellowhead Trail At 50 Street	Stm	5	3	1000	III	1536	Medium-High
188	North Edmonton San Trunk NC1	San	5	3	1000	III	1511	Medium-High
168	Ellerslie	San	5	3	1000	III	1363	Medium-High
120	Buena Vista	San	3	4	316	III	1897	Medium-High
159	Dunluce Pond	San	4	3	316	III	896	Medium-High
184	The Grange (San)	San	4	3	316	III	874	Medium-High
119	Castle Downs	San	4	3	316	III	874	Medium-High
110	South Westridge	San	4	3	316	III	827	Medium-High
162	Elsinore	San	4	3	316	III	816	Medium-High
130	Dunluce	San	4	3	316	III	748	Medium-High
128	Gold Bar Park	San	3	4	316	III	748	Medium-High
169	Blackburn	San	4	3	316	III	748	Medium-High
157	Whitemud Drive & 106 Street	Stm	5	2	316	III	730	Medium-High
199	Magrath Heights	San	4	3	316	III	726	Medium-High
187	Haddow Neighbourhood	Stm	4	3	316	III	716	Medium-High
158	82 Street & Yellowhead Trail	Stm	5	2	316	III	680	Medium-High
195	The Hamptons (San)	San	4	3	316	III	679	Medium-High
108	William Hawrelak Park	San	4	3	316	III	679	Medium-High
155	Wedgewood Heights	San	4	3	316	III	679	Medium-High
109	Saskatchewan Drive	San	4	3	316	III	589	Medium-High
185	South Edmonton San Trunk	San	5	2	316	III	583	Medium-High
122	Rundle Park	San	4	3	316	III	543	Medium-High
184	The Grange (Stm)	Stm	4	3	316	III	499	Medium-High
195	The Hamptons (Stm)	Stm	4	3	316	III	499	Medium-High
133	Mitchell Ind. (Stm)	Stm	5	2	316	III	443	Medium-High
135	Fort Road	San	4	3	316	III	431	Medium-High
193	South Edmonton Common San	San	5	2	316	III	381	Medium-High
194	South Edmonton Common Stm	Stm	5	2	316	III	353	Medium-High

Ongoing/Completed Projects
2021 Planned Projects
To Be Abandoned

11. Based on the risk evaluation, the poorest condition pump stations will be reviewed to determine the mitigation requirements to reduce the risk. A high level evaluation of the locations will be completed to look for alternative solutions to rehabilitation such as abandonment. This review will also identify any unique characteristics about the pump stations that need to be

accommodated. For example, a pump station that only services one public washroom could potentially be abandoned and replaced with an alternative solution such as a storage tank. These types of conditions will be evaluated at a high level prior to the start of any concept development. Once the high level review has taken place and a refined list of priorities has been developed, further study will continue through concept development. Concept development will include additional inspections if required, development of rehabilitation options, a constructability assessment and will propose recommendations for the pump stations that will reduce the identified risks.

3.0 PROGRAM DESCRIPTION

12. The scope of this program is to evaluate pump stations, determine what is required to reduce the risk and implement the rehabilitation, replacement or alternative solution. As noted above, the highest risk pump stations will be evaluated at a high level for alternatives and quick wins. Once the evaluation is complete, concept development will begin on the refined priority list. The outcome of the concept development will be recommendations for rehabilitation, replacement or alternative solutions, and these recommendations will be reviewed to determine a program plan and schedule.

13. Based on historical experience of pump station rehabilitation, the following are the major categories and areas of rehabilitation upgrades:

- Site and Building:
  - Structural deterioration and cracks
  - Narrow building access
  - Insufficient/no safety fences
  - Poor roof condition
  - Metal surface corrosion
- Substructure:
  - Wet well/ladder corrosion
  - Insufficient wet well storage
  - Difficult access to remove grit from wet well
  - Leakage in dry well
  - Cracking in concrete base
  - No guard rails or gate to isolate wet well

- Pipes and Valves:
  - Corroded pipe and valves
  - Flow metre missing or needing replacement
- Motors and Pumps:
  - Pumps at the end of service life
  - Undersized pumps that require capacity upgrades
  - Height restriction for pulling out pumps

14. The program will aim to complete about eight pump station rehabilitations over the 2022-2024 PBR term. The number of rehabilitations will be dependent on the size of each project, bid prices and scope of work. As we plan for specific pump station rehabilitation, consideration will be given to additional improvements that have been identified through other initiatives that could be completed and/or coordinated. These types of improvements include capacity upgrades, safety improvements and/or odour reduction modifications. If these improvements are identified, they will be funded through separate capital programs.

15. Preliminary and detailed design will be initiated and completed in 2022. The pump station rehabilitation, replacement or upgrades will be completed in 2023. Another new set of projects will be initiated in late 2023 for construction in 2024. Table 3.0-1 provides the quarterly schedule for this program for the 2022-2024 PBR term.

Table 3.0-1
Pump Station Rehabilitation Program Schedule
(2022-2024)

	Program Phases	A **2022 Q3**	B **2022 Q4**	C **2023 Q1**	D **2023 Q2**	E **2023 Q3**	F **2023 Q4**	G **2024 Q1**	H **2024 Q2**	I **2024 Q3**	J **2024 Q4**
1	Initiation/Approvals	x				x				x	
2	Preliminary/Detailed Design	x	x			x	x			x	x
3	Procurement		x	x			x	x			x
4	Construction	x	x	x	x	x	x	x	x	x	x
5	Commissioning	x	x			x	x			x	x
6	Close-out		x				x				x

4.0 ALTERNATIVES ANALYSIS

16. One alternative to the Pump Station Rehabilitation Program is to do nothing. If nothing is done, the pump stations will be at risk of eventual failure and the likelihood of failure will continue to increase as the assets age. This will continue to increase the risk of flooding to the

surrounding environment, and will increase the safety risk posed to the public and EWSI staff. Although the do nothing alternative can provide cost savings in the short term, delaying rehabilitation or other solutions will not resolve the problem and will ultimately move required work and higher expenditures to future years.

17. There are alternatives to full rehabilitation or replacement that will be considered as part of the evaluation stage of this program to reduce the identified risks. Each pump station is unique and will require a different approach based on the deterioration, risk ranking, age, and location. Alternatives to full rehabilitation that can be evaluated include abandonment or redirection of flows. Hydraulic assessments will be required to support the validity of these alternatives.

5.0 COST FORECAST

18. This program is forecast to cost $15.52 million for the 2022-2024 PBR term to complete 8 pump station rehabilitation projects. The program cost forecast is based on historical costs of inspection, planning, design and construction of past pump station rehabilitation projects. As pump stations are all unique with distinct characteristics, it can be difficult to provide accurate cost estimates for rehabilitation, upgrades or replacement prior to concept development and design. The cost estimates will be tracked and refined as the program progresses.

19. Table 5.0-1 provides the capital expenditure forecast for this program for the 2022-2024 PBR term.

Table 5.0-1
Pump Station Rehabilitation Program
Capital Expenditure Forecast
2022-2024
($ millions)

		A **2022**	B **2023**	C **2024**	D **Total**
	Direct Costs				
1	Contractors	3.88	3.53	5.71	13.11
2	Internal Labour	0.20	0.12	0.19	0.51
3	Vehicles and Equipment	0.03	0.02	0.03	0.07
4	Abandonments	0.00	0.00	0.00	0.00
5	Contingency	0.87	0.00	0.51	1.38
6	Risk Allowance	0.00	0.00	0.00	0.00
7	**Sub-total Direct Costs**	4.98	3.67	6.43	**15.08**
8	Indirect Costs	0.07	0.18	0.20	0.45
9	**Total Capital Expenditures**	5.05	3.85	6.63	**15.52**

20. Forecast costs for each project can vary widely depending on the particular pump station. On average, based on about 15 historical projects, EWSI has estimated that approximately 15% of the capital expenditures will be for superstructure (site and building), 20% for substructure and 65% for equipment, process, pumps, etc. For forcemains, EWSI assumed that each pump station would require some work on the forcemain.

21. Key assumptions in developing the cost forecast are as follows:

- All inspections will be completed internally by Drainage Operations;
- Internal resource estimates are provided by the project management team;
- External cost estimates are taken from historical contractor bid prices;
- Construction and design costs for each pump station are assumed to be $625,000 based on historical projects which breaks down as about $94,000 for site and building, $125,000 for the substructure, and $406,000 for equipment, pumps, process, etc.
- Construction and design costs for each forcemain are assumed to be $675,000 based on historical projects;
- All other costs are based on historical experience with similar projects.

22. EWSI takes a number of steps to minimize the level of these capital expenditures. These include:

- EWSI has taken advantage of contracts with vendors to effectively manage the supply, quality and construction of required equipment. As such, EWSI has minimized the need to stock much of the required equipment reducing the overall costs of all installations and upgrades.
- All activities related to project management, drafting, construction coordination and inspection, and as-built recording will be undertaken internally by EWSI. External consultants will be utilized for concept development and design. The actual construction, including surface restoration if required, will be completed by one of EWSI's construction contractors.
- Contracted services are performed by pre-qualified external contractors and done on a competitive unit priced basis, using comprehensive engineering packages to ensure cost and scope control.
- The installations will be consistent with EWSI's construction standards which will minimize stock requirements and speed up design and construction.

- Where possible, work will be coordinated with other projects or maintenance activities to minimize costs.
- Every project is evaluated individually to determine the appropriate construction method to meet requirements at the lowest cost.
- All force accounts are documented and reviewed by EWSI representatives to ensure the additional cost is justified under the terms of the contract.

6.0 RISKS AND MITIGATION PLANS

23. EWSI has identified the key risks and mitigations associated with executing this program in Table 6.0-1.

Table 6.0-1
Key Risks and Risk Mitigations

	Risk	A Mitigation Plan
1	Execution Risks - As most of the pump stations are located near residential areas, there are potential construction impacts to neighbourhood traffic and noise levels.	EWSI will develop a construction plan to minimize disruption to traffic and use of heavy equipment during morning and evening rush hours.
2	Health & Safety - Risk of sanitary flooding in the neighborhood during construction, particularly during the summer.	EWSI will develop a bypass plan as needed and contingency plan that will ensure minimal adverse impacts especially during rainy season.
3	Financial Risks – Actual contactor bids may vary from the estimates.	EWSI will conduct pre-bid meeting with potential contractors to gauge current market condition.

Appendix H14

EPCOR WATER SERVICES INC.

Drainage Services
SIRP Dry Pond Program
Business Case

February 16, 2021

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1.0 OVERVIEW

1. EWSI's Stormwater Integrated Resource Plan (SIRP), presented to the City of Edmonton Utility Committee and Council in 2019, is a system wide integrated approach to mitigate flood risk by reducing the health, and safety and social risk of flooding with lower overall capital investment than compared to traditional engineering approaches. SIRP recommended a five theme strategy for flood mitigation (SLOW, MOVE, SECURE, PREDICT and RESPOND) that included a mix of grey (trunks and tunnels) and green infrastructure (dry ponds and low impact development (LID)) components. One of the larger investment categories of the SIRP strategy is the "SLOW" theme – slow the entry of stormwater into the drainage network by absorbing it in green infrastructure and by holding it in ponds, creating space in the collection system during storm events. Green infrastructure includes dry ponds which capture large volumes of stormwater within a neighbourhood during the storm event and then release the stormwater slowly back into the existing piped storm trunk network after the storm event reducing the requirement for large trunk lines to the river. The SIRP Capital and Operational plan estimated $470 million in dry ponds would be implemented over the next 20 to 30 years.

2. Dry ponds are a critical element of EWSI's Stormwater Integrated Resource Plan (SIRP) to mitigate flood risks across the city of Edmonton. Using dry ponds, EWSI is able to achieve flood mitigation objectives at a lower overall capital investment than seen with traditional engineering approaches. The City of Edmonton had been installing dry ponds throughout the City as part of the City Wide Flood Mitigation capital programs in place prior to the Drainage Utility transferring to EPCOR. The SIRP analysis, completed by EWSI in 2018-2019, reaffirmed that dry ponds are a recommended solution for the flooding risks in Edmonton and prioritized the ponds for future investment over the next 20 to 30 years.

3. The SIRP Dry Pond Program mitigates a number of risks associated with flooding events including: (i) health and safety risks associated with basement flooding puts residents, contractors and EWSI employees at risk of illness through contact with sewage during clean-up and repairs: (ii) environmental risks associated with sewage spills to the local environment or water bodies; (iii) financial risks associated with costly clean up of flooding and basement backups and potential damage claims; and (iv) service disruption risks associated with neighbourhood flooding on roads and private properties.

4. EWSI together with the City submitted an application for federal grant funding for dry ponds projects under the Disaster Mitigation and Adaption Fund (DMAF) and received a total of

$43.6 million dollars to complete fourteen dry pond by 2028. The schedule proposed for the dry ponds in this business case is aligned with the schedule provided to the Federal government as part of the grant application.

5. The SIRP Dry Pond Program is a new program initiated for the 2022-2024 PBR term. While EWSI will manage each individual dry pond as a separate capital project, the individual projects are consolidated within this program in order to manage the overall program investment levels within the PBR term, manage project scheduling and to optimize the grant funding. Each dry pond project due to the size of the project typically requires three to four years to complete the conceptual design, detailed design, construction and commissioning. For the 2022-2024 PBR term, the SIRP Dry Pond Program includes eleven active dry pond projects at various stages of development at a forecast cost of $128.76 million of which $35.63 million is estimated to be covered by grant funding resulting in the net capital expenditures of $93.13 million.

2.0 BACKGROUND AND JUSTIFICATION

6. The dry ponds proposed within EWSI's SIRP strategy are intended to mitigate and reduce flood risk in targeted high risk communities. Two aspects in particular drove the SIRP choice to include dry ponds as a major infrastructure upgrade. These aspects are: (i) the lower risk of sewer backups and basement flooding; and (ii) the reduction of ponding on the road after storm event. Dry ponds, and additional storm pipe infrastructure, reduce the peak stormwater flows and reduce the volume of surface runoff entering the combined sewer system thereby lowering the risk of sewer backups and basement flooding. Dry ponds can remove large volumes of stormwater from the drainage system and reduce flooding risk within clusters of communities, in addition to providing benefits in other adjacent neighbourhoods.

7. Figures 2.0-1 provides examples of two completed dry ponds to provide context on the type of structures that are constructed as part of this capital program.

Figure 2.0-1
Dry Pond Examples

Ellingson Dry Pond

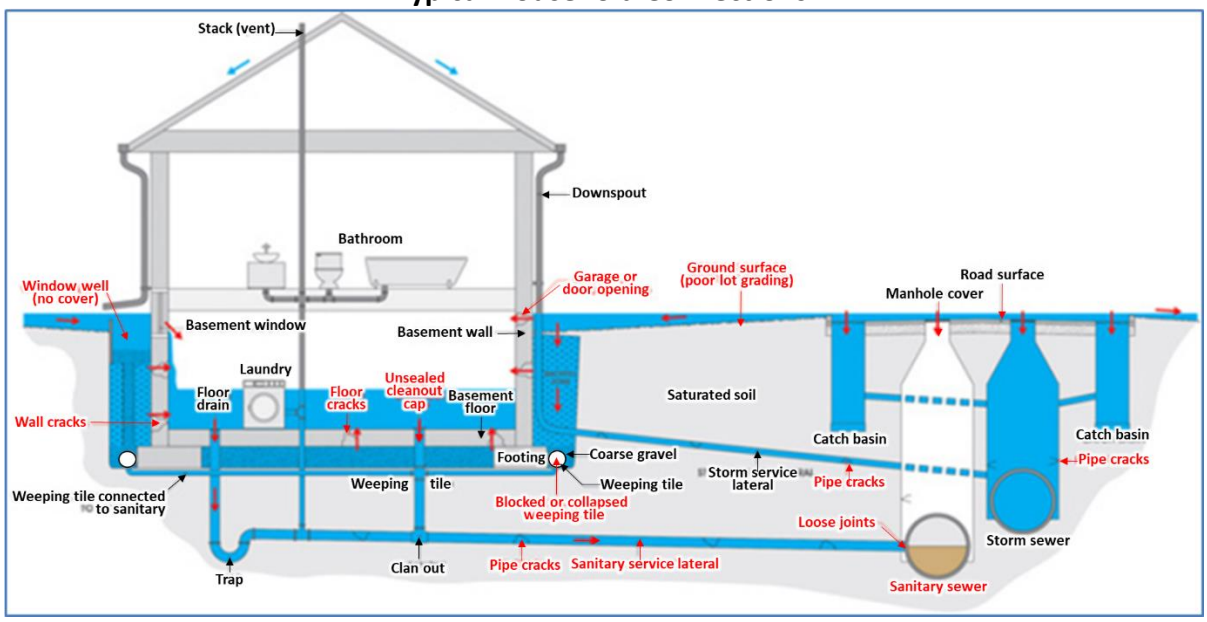
Duggan Dry Pond

8. Dry ponds mitigate a variety of risk categories:

- Health and Safety Risk – Basement flooding, from surface or sewer backup, puts residents, contractors and EPCOR employees at risk of illness through contact with sewage and mold during clean-up and repairs. Surface flooding and prolonged street ponding increases risk of traffic accidents and injuries. Excessive combined sewer flows could pose a safety risk to the EWSI employees who operate and maintain the drainage infrastructure. Frequently flooded basements can also affect the physical and mental health of the occupants.
- Environmental Risks – Excessive combined flows could lead to floods and sewage spills to the local environment or water bodies and may cause damage or contamination to the natural environment and wildlife. This will affect the usage of these facilities by the public and require substantial investment to restore the affected areas. The release of untreated sewage into the environment also violates Drainage's Approval-to-Operate issued by Alberta Environment and Parks.
- Financial Risks – Unmanaged large storm events can lead to surface flooding and basement backups which are costly to manage and clean up and can lead to claims from customers with flooded homes and basements and other property damage (vehicles) worth thousands of dollars to be replaced or fixed.
- Service Disruption Risk – Unmanaged large storm events could lead to neighbourhood flooding especially for houses in a localized sag area. Figure 2.0-2 below from the CSA Standard Z800-18 – Guideline on Basement Flood Protection and Risk Reduction

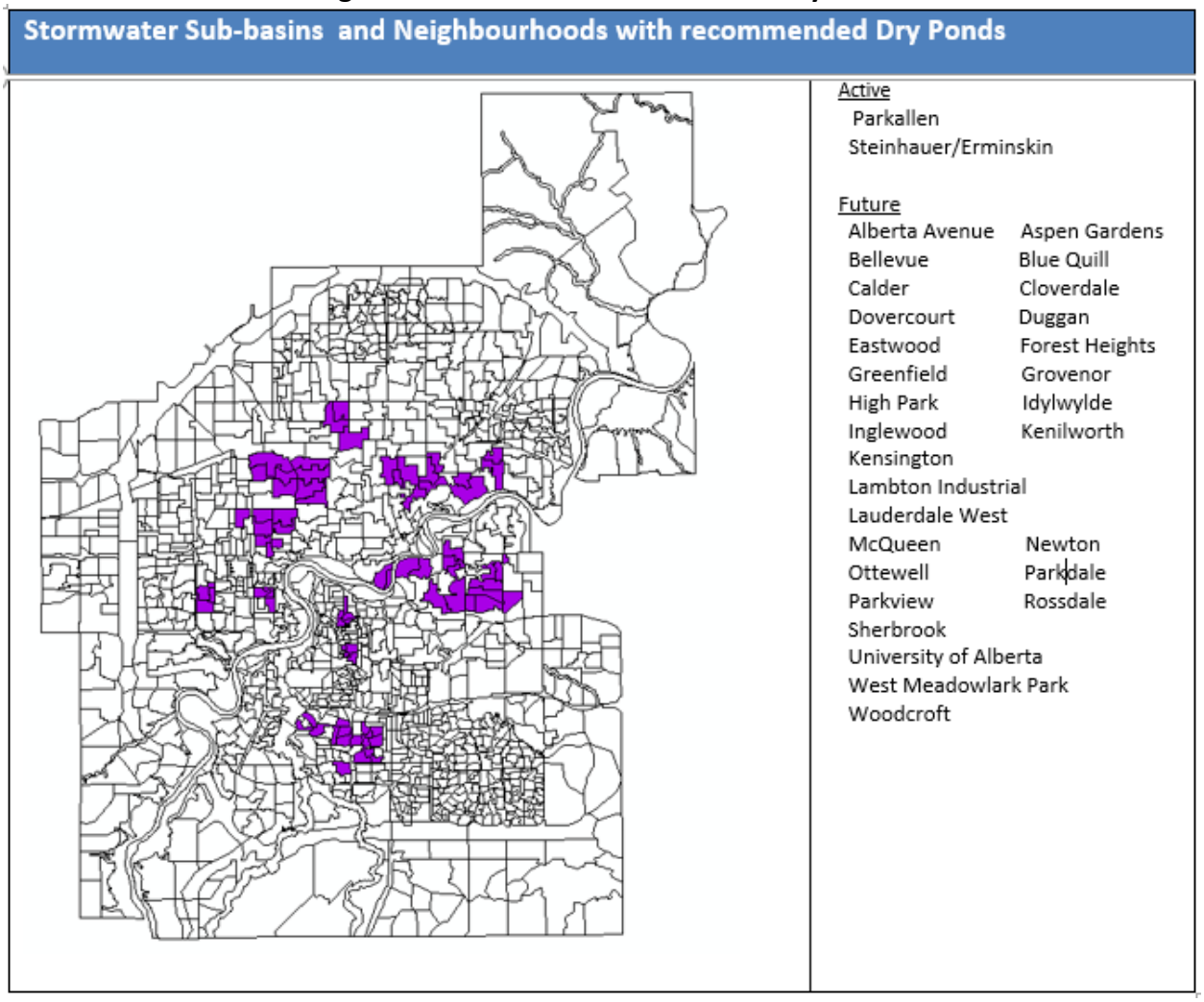
illustrates (in red font) the different paths where stormwater can potentially enter a property that is in a localized sag area. Following a storm event, the longer the duration that the water pools on the road surface the higher the risk that the water will access the sanitary pipes and/or foundation drains of properties without adequate flood proofing and enter the building. By directing storm flows to dry ponds EWSI aims to reduce the risk of water ponding in localized sag areas during large storm events.

Figure 2.0-2
Typical Household Connections



9. Under SIRP, EWSI plans to proceed with the 31 dry pond locations throughout the City as shown in Figure 2.0-3 below. In addition to these projects identified through SIRP, the Malcolm Tweddle dry pond, which was underway prior to SIRP, will also be completed as part of the SIRP Dry Pond Program.

Figure 2.0-3
Stormwater Sub-Basins and
Neighbourhoods with Recommended Dry Ponds



10. EWSI has been working with the City of Edmonton Open Spaces team to review each of the proposed dry pond locations as required under the City's Open Space Policy and in accordance with the Open Spaces Needs Justification and Assessment Reporting Procedure. The procedure includes a two phase review process with the City and entities such as the school boards that utilize or own the open spaces. Phase one of the Open Spaces review process identifies any major constraints for the proposed development. Phase two of the Open Spaces review process identifies more specific recreational and joint use requirements to inform the detailed design of the dry pond.

11. In 2020, the phase one of the Open Spaces review process was completed for all 31 proposed new dry ponds and the majority of locations were confirmed to not have any major

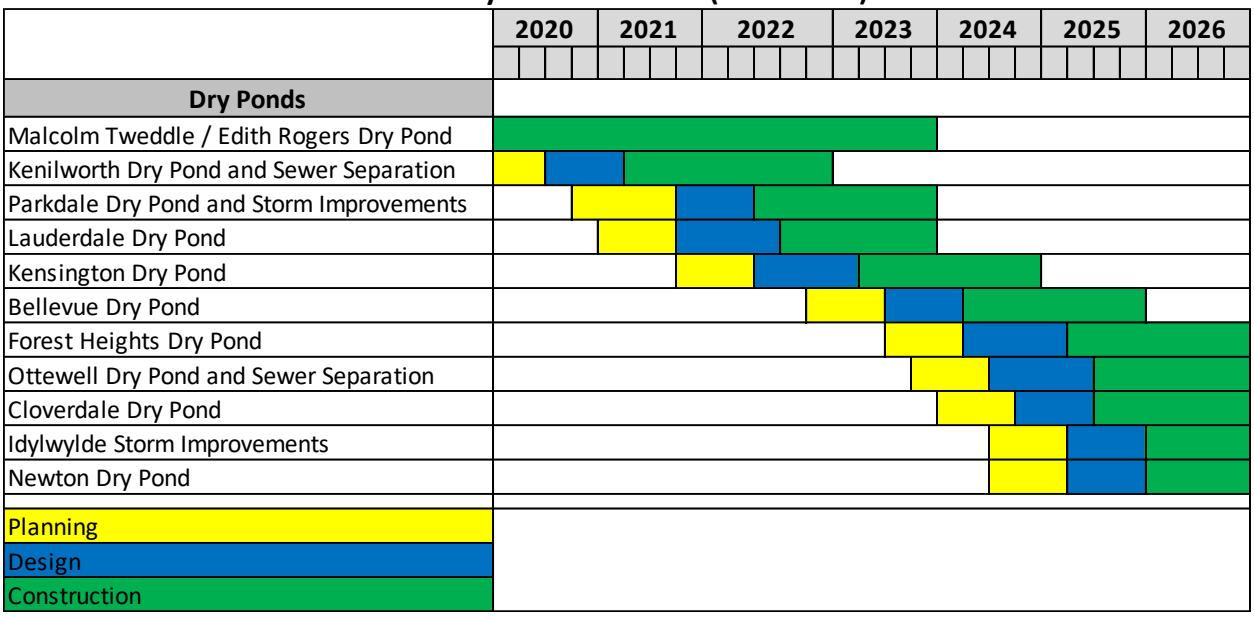
constraints. The City required a delay in the timing for completing the Idylwylde pond to better coordinate with the City's overall plans for that location. To ensure the adjusted timing of this pond will not impact the approved DMAF grant funding, EWSI plans to accelerate the timing of the Ottewell pond location. EWSI anticipates that the phase two review process will occur for each dry pond once the conceptual design is completed in conjunction with the local community consultation activities that occur during this phase of the project.

3.0 PROGRAM DESCRIPTION

12. As part of developing the SIRP Strategy, EWSI identified 31 locations for dry ponds. These 31 locations have been prioritized and scheduled based on SIRP risk ranking and based on the ability to coordinate with other projects. Dry ponds located within higher flood risk areas are proposed to initiate earlier as they will have the greatest impact to reducing the flood risk throughout the city. If EWSI is able to work in concert with a neighbourhood renewal project for example, project costs will be lower and the impact to the residents of the area will be dramatically reduced. This scheduling coordination plays an important role in delivery cost efficiency for the dry pond program. Typically the infrastructure included within a dry pond project includes the dry pond, inlet and outlet structures, and neighbourhood storm piping to move the water to and from the pond. If EWSI is able to coordinate this work with a Drainage or City neighbourhood renewal project, the cost of road resurfacing is reduced.

13. Another important consideration for the scheduling of the program is managing the projects to meet the overall annual program spending budget. Dry pond and storm separation projects have large capital expenditures, which can lead to years with significantly more capital spend than others. In order to mitigate these variances, dry pond project timelines are occasionally adjusted. For the 2022-2024 PBR term, EWSI is planning to have a mix of dry pond projects at different stages of development in any one year to better manage projects resources: two in construction, two in design, and two in conceptual design planning. Figure 3.0-1 shows the ponds scheduled in the SIRP Dry Pond Program for the 2022 to 2024 PBR term.

Figure 3.0-1
SIRP Dry Pond Schedule (2020-2026)



14. Another factor determining the dry pond schedule is the Disaster Mitigation and Adaption Fund (DMAF) grant which EPCOR and the City received from the federal government. This grant funding totals $43.6 million for fourteen approved pond projects to be completed by 2028. This funding applies to 40% of approved external costs, which will significantly reduce the cost to ratepayers for this program for the next decade.

15. The SIRP Dry Pond Program can be categorized as having levels of projects defined within the 2022-2024 PBR term: active pond projects and planned pond projects. Active pond projects include projects that are in construction or design phase and have received approval or a Letter of Support from the City as part of the Open Spaces phase two review process. Planned Pond Projects are those that will initiate their phase two Open Spaces Review and conceptual design within the 2022-2024 PBR term.

Active Projects

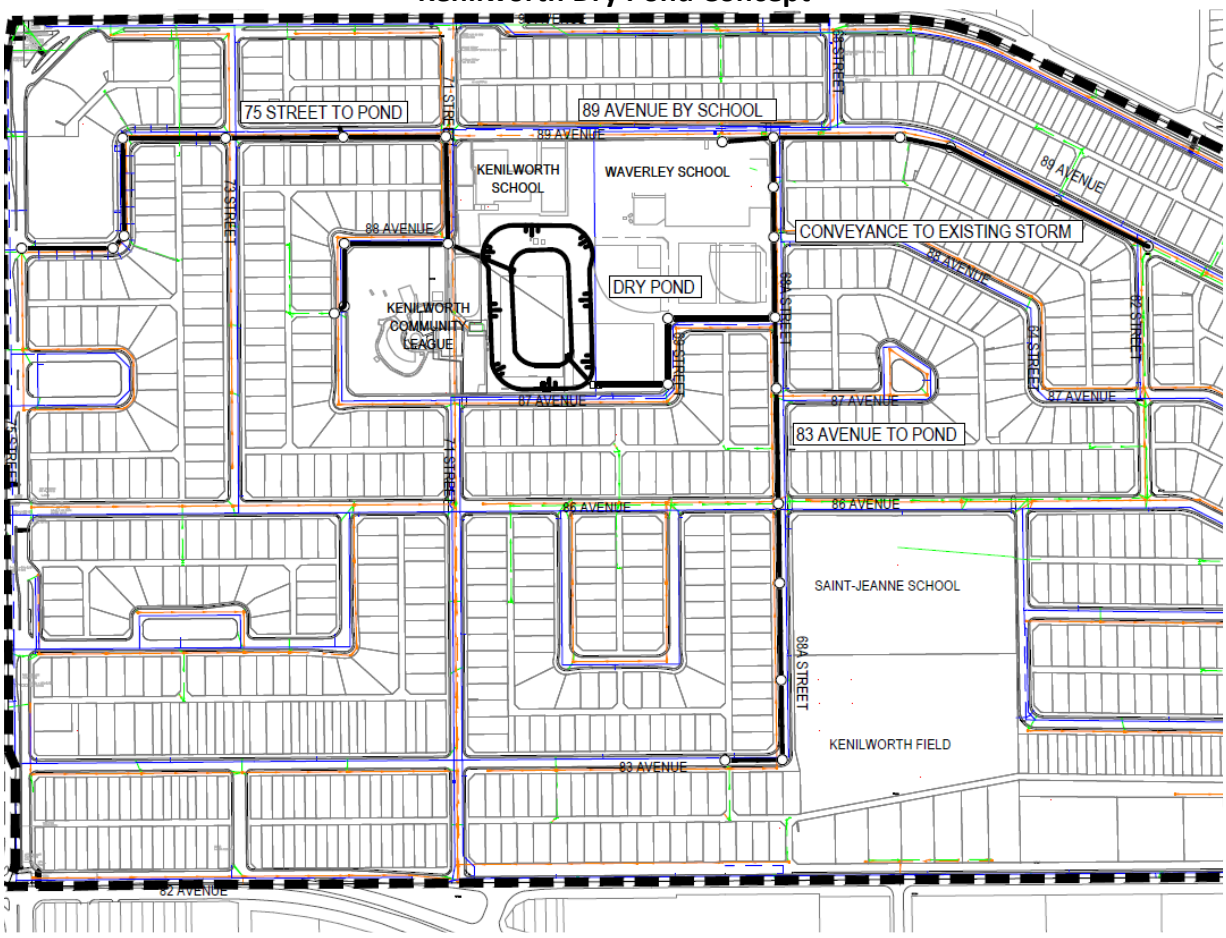
16. Active Pond Projects include projects that are in construction, design, have received internal EWSI approvals or a Letter of Support from the City. The active dry pond projects that fall within this program are:

1. Malcolm Tweddle / Edith Rogers Dry Pond
2. Kenilworth Dry Pond and Sewer Separation
3. Parkdale Dry Pond and Storm Improvements
4. Lauderdale Dry Pond

17. Malcom Tweddle / Edith Rogers Dry Pond project has completed major construction milestones. The north and south ponds are complete and have received their Construction Completion Certificate. The separated storm system portion of the project connecting the local sewers to the new pond is currently in the procurement phase.

18. Kenilworth Dry Pond and Sewer Separation is well into preliminary design, with construction scheduled for 2021. Prior to preliminary design, the concept validation workshop estimated that the SIRP risk ranking for the basins within Kenilworth would improve by 5 ranks, from risk rank "B" to risk rank "G". Figure 3.0-2 below shows the concept of the Kenilworth Dry Pond which is moving forward with design.

Figure 3.0-2
Kenilworth Dry Pond Concept



19. Parkdale Dry Pond is currently being reviewed by the City. These discussions have yielded a potential alternative site which would allow for more storage and potentially increase the

neighbourhood green space. The prospective site will not be fully encompassed by dry ponds, so maximizing storage through the neighbourhood will be critical for a successful project.

20. Lauderdale Dry Pond, has received a Letter of Support from the City following review and discussion of the justification report. The discussion included concerns such as: LRT right of way, slopes and accessibility, lighting, safety and hygiene. The City and EWSI will work to manage space considerations for competing land needs and on-going use during construction.

Planned Projects

21. The planned dry pond projects that fall within the SIRP Dry Pond Program for the 2022-2024 PBR term include:

1. Kensington Dry Pond
2. Bellevue Dry Pond
3. Forest Heights Dry Pond
4. Ottewell Dry Pond and Sewer Separation
5. Cloverdale Dry Pond
6. Idylwylde Storm Improvements
7. Newton Dry Pond

22. The Kensington Dry Pond will work to mitigate a high risk basin within the neighbourhood boundary, as well as high risk areas in the surrounding communities. This project could potentially reduce flooding on Yellowhead Trail by alleviating some of the capacity issues downstream within 107th Street Trunk. This dry pond would work to meet EPCORs commitment to the City to reduce flood risk of nearby and downstream basins to an acceptable level of risk.

23. EWSI found that the Bellevue area is a high risk location. Based on the SIRP assessments, EWSI is proposing that new infrastructure for the Bellevue and the surrounding neighbourhoods includes dry ponds, large scale sewer separation, and one of the few tunnels included in the SIRP capital plan. Though this project will focus on delivery the dry pond in Bellevue, the entire community will need to be examined to ensure that the flood risk reduction solutions are comprehensive and collaborative. EWSI has started discussions with the City to utilize some of the Exhibition Lands redevelopment in order to provide storage for the area and hopefully reduce the requirements for neighbourhood ponds and tunnels.

24. Forest Heights Dry Pond will work to mitigate the high flood risk due to sewer surcharging in the neighbourhood. The identified project site is already in the City land inventory and was ranked as “High Feasibility” during the City Open Space review.

25. EWSI’s SIRP assessment ranked the Ottewell neighbourhood to be at high risk. Risk of flooding in Ottewell comes from two sources: sewer backup due to combined sewer surcharging and surface flooding. The size of the Ottewell neighbourhood makes wide scale sewer separation quite expensive, so EWSI is planning a targeted concept for dry pond and sewer separation.

26. The Cloverdale neighbourhood is high risk due to combined sewer surcharging and also surface flooding. Installing a dry pond and additional storm pipe infrastructure would offset the peak flow and reduce the volume of surface runoff entering the combined sewer system, lowering the risk of sewer backups and basement flooding.

27. The Idylwylde Storm Improvement concept includes pocket ponds along with potential coordination with the Bonnie Doon mall redevelopment. This will mitigate the high risk in the neighbourhood which is present due to combined sewer surcharging and surface flooding.

28. The Newton Dry Pond is planned to mitigate combined sewer surcharging and surface flooding in Newton and surrounding neighbourhoods. Newton is very high risk and this project will reduce flooding risk in Newton and surrounding neighbourhoods by alleviating some of the capacity issues downstream.

4.0 ALTERNATIVES ANALYSIS

29. Alternatives considered include: (i) Do Nothing; (ii) Delay timing, and (iii) A grey infrastructure approach through additional neighbourhood sewer pipes, storm tunnels, and outfalls.

Do Nothing Alternative

30. Not implementing dry pond projects and the related sewer separation would provide little to no flood mitigation for Edmonton. EWSI would not be able to achieve the commitments set out in the SIRP Strategy that was presented to City Council in 2019. Residents would see continued flooding during minor and major events. Additionally, there are financial risks associated with potentially losing the DMAF grant funding if EWSI is not able to complete the agreed scope of work prior to the 2028 timelines committed with the Federal Government.

31. EWSI is regulated by Alberta Environment and Parks (AEP) and under approval to operate the collection system there is a commitment and requirement to reduce contaminant loading from collection system entering the river. Dry ponds and separated storm sewers reduce the volume of water going to combined sewer system, which will reduce the frequency of combined sewer overflow events as well as volume of combined sewer discharges resulting in overall contaminant loading reduction. Not proceeding with the ponds would require an assessment of additional measures at the outfall locations to meet the AEP requirements. EWSI chose to not proceed with this alternative given the above risks and its commitments to the City, AEP and its customers.

Delay Timing for Pond Investments Alternative

32. The overall capital investment during the 2022-2024 PBR term could be reduced by extending the timeframe to complete the initial high priority dry ponds. Under this alternative, EWSI would still complete all of the proposed ponds within the 20-30 year period, however, some of the initial ponds would be shifted beyond the 2022-2024 PBR term. Under this alternative, dry ponds in the planning stage would not be initiated within the 2022-2024 PBR period and would be shifted to initiate in the 2025 to 2029 PBR at a higher level of investment that planned originally as part of the SIRP strategy. The risks with this approach is ongoing flooding risks within high risk stormwater subbasins would continue, resulting in higher risk of property damage to residents. Additionally, there are financial risks associated with potentially losing the DMAF grant funding if EWSI is not able to complete the agreed scope of work prior to the 2028 timelines committed with the Federal Government. This alternative was rejected on the basis of this additional risk.

Grey Infrastructure Alternative

33. Without the ability to construction dry ponds throughout the existing urban area, the increased volumes of stormwater would require the construction of a significant network of stormwater trunks and new outfalls throughout the City. This alternative would require building wide-spread neighbourhood sewer separation, storm tunnels and outfalls. In some neighbourhoods additional local pipe sewers would be installed to capture the peak storm volumes while limiting surface ponding of water. In the combined sewer areas, sewer separation would be completed. Additional outfalls would also be required. The City had completed some preliminary estimates of implementing a grey infrastructure approach to manage storm volumes with cost estimates of up to $4.6 billion with an 80 year time frame to construct due to the

complexities of adding a new storm trunk tunnel network through the existing urban area. This alternative was not considered based on the much higher cost impact to ratepayers.

5.0 COST FORECAST

34. Cost estimates for the pond projects that are currently active are based on detailed design construction estimates and/or tender prices for the ponds currently under construction. Cost estimates for each pond project where detailed design is not complete were developed based on historical costs from previously completed pond projects. Cost estimates are based on EWSI's estimate of the area of each pond and generally assumes a depth of two meters or less. EWSI has also assumed no significant utility conflicts and that standard construction methods and timelines will be applied. Some of the ponds also require sewer separation to fully integrate into the neighbourhood. For sewer separation costs, EWSI used standard unit rates for the various lengths of sewers required for each project. Consultant fees were estimated based on previous projects, project complexity and construction costs. Contingencies were estimated based on project phase and complexity and range from 30% to 50%.

35. Land costs can also vary considerably between dry pond locations and depend on the ownership of the parcel selected for the pond construction. For those dry pond projects where the land is already owned by the City, there are minimal land costs. For other dry pond projects where land is owned by the Edmonton Public School Board, EWSI has estimated the cost of acquiring the land based on costs of previous pond acquisitions from these entities. Any land purchased for a dry pond will be owned by the City of Edmonton with access rights provided to EPCOR for the dry pond operation and maintenance.

36. Table 5.0-1 provides the capital expenditure forecast for the SIRP Dry Pond Program by cost category for the 2022-2024 PBR term.

Table 5.0-1
Dry Pond Program
Capital Expenditure Forecast
2022-2024
($ millions)

		A 2022	B 2023	C 2024	D Total
	Direct Costs				
1	Contractors	31.20	34.83	26.31	92.34
2	Internal Labour	0.61	0.63	0.74	1.97
3	Vehicles and Equipment	0.04	0.03	0.03	0.11
4	Land	3.60	0.00	4.00	7.60
5	Contingency	1.72	6.99	9.08	17.79
6	Risk Allowance	0.00	2.74	0.00	2.74
7	**Sub-total Direct Costs**	**37.17**	**45.22**	**40.17**	**122.55**
8	Capital Overhead and AFUDC	1.24	1.41	2.56	5.21
9	**Total Project Costs**	**38.40**	**46.63**	**42.72**	**127.76**
10	Less: Grant Funding	(13.29)	(12.33)	(9.00)	(34.63)
11	**Net Project Costs**	**25.11**	**34.30**	**33.72**	**93.13**

37. Table 5.0-2 provides the capital expenditure forecast for the SIRP Dry Pond Program by pond project for the 2022-2024 PBR term.

Table 5.0-2
Dry Pond Program
Capital Expenditure Forecast by Project
2022-2024
($ millions)

		A 2022	B 2023	C 2024	D Total
	ACTIVE POND PROJECTS				
1	Malcolm Tweddle & Edith Rogers Dry Ponds*	13.81	22.74	9.74	46.28
2	Kenilworth Dry Pond	11.12	0.00	0.00	11.12
3	Parkdale Dry Pond	6.34	5.62	0.00	11.97
4	Lauderdale West Dry Pond	6.78	14.85	14.87	36.50
	PLANNED POND PROJECTS				
5	Kensington Dry Pond and Sewer Separation	0.35	1.79	9.14	11.28
6	Bellevue Dry Pond	0.00	0.66	4.76	5.42
7	Forest Heights Dry Pond	0.00	0.46	1.12	1.58
8	Ottewell Dry Pond and Sewer Separation	0.00	0.51	1.70	2.21
9	Idylwylde Dry Pond	0.00	0.00	0.43	0.43
10	Cloverdale Dry Pond	0.00	0.00	0.34	0.34
11	Newton Dry Pond	0.00	0.00	0.63	0.63
12	**Total Dry Pond Capital Expenditures**	**38.40**	**46.63**	**42.73**	**127.76**
13	Less: Grant Funding	(13.29)	(12.33)	(9.00)	(34.63)
14	**Total Project Net Costs**	25.11	34.30	33.72	93.13

38. EWSI takes a number of steps to minimize the level of these capital expenditures. These include:

- EWSI will utilized open competitions for consulting and contracting activities for the dry pond program. This allows EWSI to minimize contract expenditure while also qualifying for DMAF grant funding. EWSI will continue to aggressively pursue grant funding options to reduce the overall costs of this program to ratepayers.
- Dry pond projects undertake multi-stakeholder reviews at several checkpoints throughout the process to ensure individual projects meet the goals of SIRP, EWSI operability, and the needs of the community.
- Where possible, work will be coordinated with other projects or maintenance activities within EPCOR, the City and the partner organization if applicable to minimize costs.
- Every project is evaluated individually to determine the appropriate construction method to meet requirements at the lowest cost.
- Every project scope is evaluated to improve economy of scale.

6.0 RISKS AND MITIGATION PLANS

39. Table 6.0-1 provides a summary of key risks associated with executing the SIRP Dry Pond Program and EWSI's plans to mitigate these risks.

Table 6.0-1
Key Risks and Risk Mitigations

	Risk	A Mitigation Plan
1	Execution Risk - Some dry pond project sites may have competing land requirements which may limit the development of a dry pond.	EWSI has engaged with the City as part of the Open Spaces Repurposing procedure. The initial review of the dry pond sites has been complete, with the majority of the sites not showing significant constraints. During project development and initiation, EWSI drafts a land justification report which contains more detail than the initial review. Since dry ponds have the potential to change recreation amenities, neighbourhood greenspaces and have other community impacts, the justification report must be circulated across multiple departments and stakeholders for review prior to approval.
2	Execution Risk – There may be public resistance to the selected project sites.	EWSI will work engage with residents, community leagues, and users to ensure the need for the dry pond is understood. Coordination with the City on construction phasing to be considered when necessary to maintain amenity access. EWSI will identify additional or modified recreational amenities in the final design. EWSI will undertake public consultation throughout the design process to get feedback and make changes to accommodate community needs. EWSI will work with the City to make the area appealing, inviting and part of the community open space inventory and aligned with the City of Edmonton Breathe objectives for green spaces.
3	Financial Risk - Availability of DMAF funding.	EWSI has put together a Grant Funding Committee to assist with development and delivery of grant funding. If projects are undertaken within proposed program timelines then funding should be available. The committee also looks at additional grant funding opportunities from the Province as projects move into active construction phases.

Appendix H15

EPCOR WATER SERVICES INC.

Drainage Services

SIRP - LID Program

Business Case

February 16, 2021

Table of Contents

1.0 OVERVIEW

1. EWSI's Stormwater Integrated Resource Plan (SIRP), presented to the City of Edmonton Utility Committee and Council in 2019, is a system wide integrated approach to mitigate flood risk by reducing the health, and safety and social risk of flooding with lower overall capital investment than compared to traditional engineering approaches. SIRP recommended a five theme strategy for flood mitigation (SLOW, MOVE, SECURE, PREDICT and RESPOND) that included a mix of grey (trunks and tunnels) and green infrastructure (dry ponds and low impact development) components. One of the larger investment categories of the SIRP strategy is the "SLOW" theme – slow the entry of stormwater into the drainage network by absorbing it in green infrastructure and by holding it in ponds, creating space in the collection system during storm events. Green infrastructure includes Low Impact Development (LID) which involves incorporating vegetation, engineered soils and natural processes into developed areas to manage stormwater. LID installations have the ability to capture, absorb, slow and filter stormwater before it flows into the sewer system, groundwater or surface waters. The SIRP Capital and Operational plan estimated $480 million in LID would be implemented over the next 20 to 30 years.

2. LID is a critical element of EWSI's SIRP Strategy to mitigate flood risks across the city of Edmonton. LID provides another strategy to achieve climate change adaptation and to maintain and improve the health of the local creeks and the North Saskatchewan River. With LID, EWSI is able to achieve its flood mitigation targets at a lower overall capital investment than seen with traditional engineering approaches. Without LID, EWSI will not meet on site storage requirements for small storm events. By providing on site storage, LID increases the overall capacity of the stormwater system by preventing water from reaching the piping system. Installing more and larger pipes has a higher cost, and only moves the capacity issue from one location to another.

3. The LID Program is a new annual program, initiated in 2019, to construct and design LID installations throughout Edmonton on both public property and privately-owned commercial, industrial, and institutional properties in alignment with the SIRP strategy and to meet the PBR Green Hectares PBR metric. Large-scale LID is an emerging technology in Edmonton, used to improve stormwater management and implementation involves significant coordination with both the City and private owners of industrial and commercial property where LID installation is planned. EWSI's LID Program includes forecast capital expenditures of $53.07 million for the

2022-2024 PBR term. EWSI will adjust its plans for implementing this program as experience is gained with LID through the course of the 2022-2024 PBR term.

2.0 BACKGROUND AND JUSTIFICATION

4. The green infrastructure, including LID, incorporates vegetation, soils, and natural processes into the built environment to mitigate the impacts of climate change and to maintain healthy and sustainable communities. Green infrastructure was first advanced as a component of stormwater management and flood risk mitigation over 20 years ago. Today it is applied in communities across North America. Green infrastructure keeps water on site long enough to allow for volume reduction through natural processes like absorption, evapotranspiration and infiltration that results in runoff volume reduction but it is also crucial to protection of the receiving waterbodies. Green infrastructure installations have two primary functions for flood mitigation - retention and detention. Retention allows surface runoff to infiltrate into the specialized soils to be used by plants or to evaporate. Detention allows a delayed release of the remainder of stormwater runoff into the sewer system, thereby reducing peak stormwater flows and the demand on sewer infrastructure.

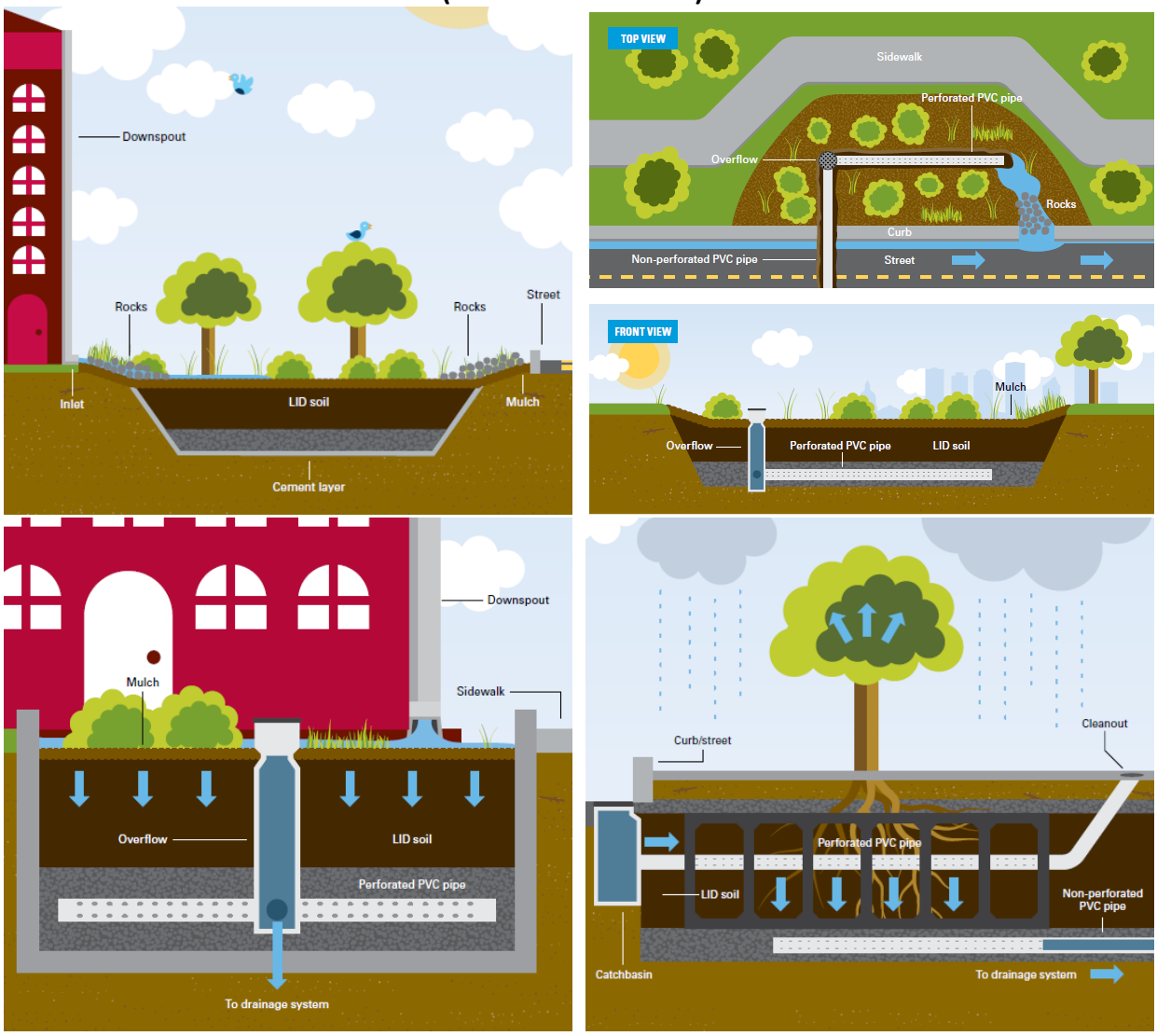
5. LID can be more cost effective over its life span compared to grey stormwater infrastructure. LID also meets multiple land development and stormwater management objectives and is becoming more common throughout North America (City of Vancouver, Philadelphia, New York, Toronto and Calgary to name a few) as measures to adapt to climate change. However, there are still barriers due to unfamiliarity with these types of infrastructure.

6. In addition to the flood mitigation benefits, LID installations provides water quality benefits. Water quality benefits come from green infrastructure's ability to manage surface runoff at the source reducing the volume of water released. The engineered soil and vegetation promote natural processes to capture, absorb and filter the water. Water that isn't captured within the LID feature is filtered, removing solids and other contaminants from the runoff before it leaves the feature.

2.1 Types of LID

7. Four types of LID have been standardized as part of this program. These include: bioretention gardens; bioretention basins; box planters; and soil cells. The four types of LID are depicted in Figure 2.1-1.

Figure 2.1-1
Bioretention Garden, Bioretention Basin, Box Planter, and Soil Cells
(Clockwise from Left)



8. Bioretention Gardens - Bioretention gardens may appear similar to flower/shrub beds however they utilize specified LID soil media and vegetation to capture and treat rainwater and are located at the low point of a landscape. Bioretention gardens are the only LID type that does not contain an underdrain or a connection to the sewer system. They consist of an inlet (with pretreatment), ponding area, LID soil, plant materials, an outlet and a structural storage layer. Structural storage layers are any man-made component that aids in the storage of water such as a concrete barrier, storage tank/pipe, storm chamber, or soil cell structure. This list is not exhaustive and other man-made components could be utilized.

9. Bioretention Basins - The bioretention basin is very similar to the bioretention garden in that it relies on vegetation, specialized soil media and a storage layer to function. However, bioretention basins have an underdrain where excess water is collected and transported to the sewer system. The vegetation, soils, and storage layer help the stormwater infiltrate into the feature, filter the water and be retained in the LID system.

10. Box Planters - Similar to bioretention basins, box planters use vegetation and specialized soil media to filter and retain stormwater. However box planters are contained within a box-like structure which may or may not have a bottom. Box planters are ideal for areas with small footprints such as downtown neighbourhoods. This is because box planters have smaller footprints (vertical sides) and can be located close to buildings. Box planters can be raised or located flush with/below ground. Box planters also contain an underdrain pipe.

11. Soil Cells - Soil cells provide structural support for sidewalks and roadways while allowing space for specialized uncompacted soil media to facilitate tree rooting and provide stormwater management by promoting absorption, evapotranspiration and interception. Stormwater can be directed into the soil cell system through a catch basin with pre-treatment, sheet flow through a curb cut or roof drain connection.

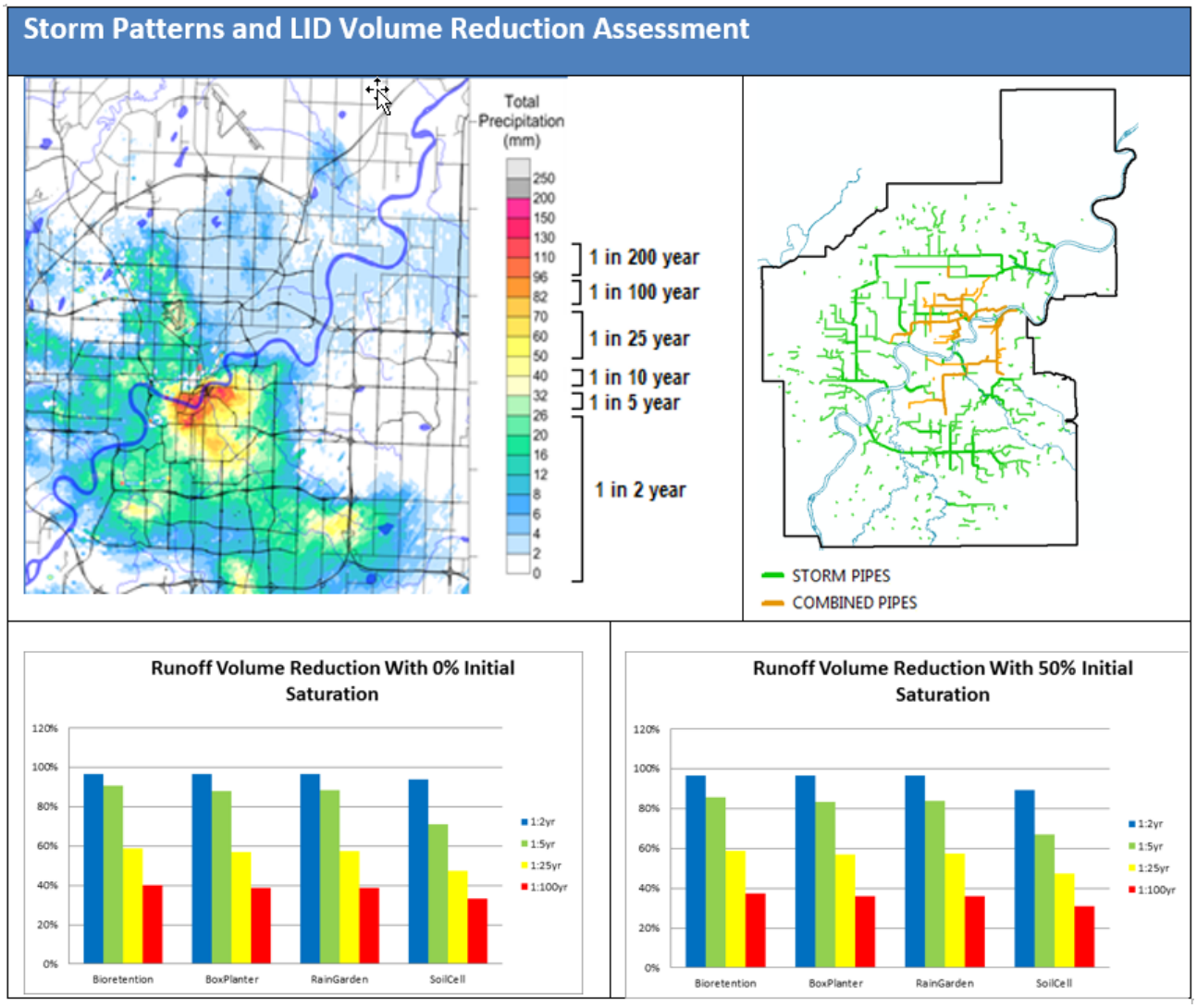
2.2 Storm Events and Flooding in the City of Edmonton

12. To develop its SIRP strategy, EWSI reviewed storm patterns in the Edmonton region. There were two aspects of flooding events in the city of Edmonton that drove EWSI's decision to include green infrastructure as part of its SIRP strategy. These include: (i) the impact of ponding on the road after a storm event; and (ii) the majority of storm events in Edmonton are small, and large intensity events tend to impact smaller localized area over a short duration. The nature of storms in Edmonton is such that unstable atmospheric conditions result in localized events, intense and short in duration surrounded with less intense rainfall around the core of the storm as shown in Figure 2.2-1. The figure shows the variation in water volumes during a 6 hour period over the City of Edmonton during a recent storm event in July 2016 and indicates that one rain event can be extreme in one area and less intense in another.

13. LID is particularly effective in capturing the lower volumes of water in the periphery of the intense storm cell and retaining the water to allow for more capacity in the pipes and ponds in the direct path of the intensive portion of the storm. The bar graphs in Figure 2.2-1 illustrate the runoff volume reduction that each of the standardized LID types can achieve in various storm events (the results for rain gardens are comparable to bioretention gardens). City-wide LID

implementation can keep runoff from the majority of the rainfall impacted areas away from the collection system (peak flow and overall runoff volume reduction). The localized impacts of ponding on the road after a storm event drove the SIRP Operational and Capital Plan to include green infrastructure (LID) in the overall SIRP Capital and Operational Plan.

Figure 2.2-1
Edmonton Storm Patterns and LID Volume Reduction Assessment



14. Water ponding on the roads and sag areas after a storm event increase the risk of flooding due to water reaching sanitary pipes or foundation drains. Green infrastructure/LID will reduce ponding in sag areas and provide additional capacity in the immediate path of the storm and reduce the impact on the entire pipe network as storms travel across the community.

2.3 Strategies for Implementing LID

15. EWSI developed the SIRP Risk Framework for a number of sub-basins (stormwater catchment areas) within the city of Edmonton. EWSI identified approximately 1,300 sub-basins and risk ranked each of them based on urban and riverine flooding hazard levels using four perspectives: (i) social; (ii) financial; (iii) health and safety; and (iv) environmental. EWSI is recommending investment in LID for each sub-basin based on previously completed engineering studies, additional data/information analysis and system wide assessment for hydraulic feasibility. EWSI has determined the number and locations of LID installations at the sub-basin level based on localized ponding conditions and where these capital cost savings can be achieved.

16. EWSI will install LID features on public lands and on privately-owned commercial and industrial sites. EWSI will fund, own and operate LID features on both public and private land. LID features on private land will be covered by a Utility-Right-of-Way Agreement or a Land Use Agreement. EWSI has developed a number of strategies to overcome various technical, physical, regulatory and legal barriers associated with LID implementation. Much of this work has already been completed. These strategies and their status is illustrated in Table 2.3-1.

Table 2.3-1
EWSI LID Strategies and Current Status

	Strategies	A Status
1	Develop of LID Design Standards.	Completed August 2020
2	Complete geotechnical assessment of local Edmonton conditions including suitability of LID related to local soils, freeze-thaw conditions, groundwater impacts and cold weather.	Completed May 2020
3	Develop a LID Native Plant Selection Guide to aid in selecting plantings that: (i) compliment local conditions; (ii) reduce maintenance requirements; (iii) are drought and salt tolerant; (iv) are adaptable; and (v) support wildlife.	Completed July 2020
4	Develop a modelling tool to support LID Design and efficiency.	Completed August 2020
5	Prepare communications and education on LID and LID implementation.	Ongoing since 2019
6	Complete outreach material to provide information on LID and LID Implementation.	In progress

17. EWSI will continue to develop these strategies to overcome barriers to implementing LID, ensure cost effectiveness of implementing this annual program and provide positive impacts to local communities. These efforts will include partnering with the City of Edmonton and private property owners.

3.0 PROGRAM DESCRIPTION

18. This LID Program has two components: LID on public lands and LID on privately owned commercial, industrial, and institutional sites. In order to more effectively and efficiently plan LID implementation moving forward, EWSI is prioritizing locations based on the ability to achieve risk reduction and cost-benefit analysis without giving consideration to the land ownership and location – whether public or private lands. This approach allows for more flexibility when making the decision to invest dollars into areas that provide more benefit to the storm/combined system.

19. As EWSI continues to evolve the LID Program over time, a greater focus will be placed on the commercial, industrial and institutional properties as well as opportunistic projects. The portion of funds from this program allocated towards road right of way (ROW) installations through the City's Building Great Neighbourhoods (BGN) program will remain relatively constant. These types of LID installations will be used to build momentum and to showcase the program to privately-owned commercial, industrial and institutional stakeholders. EWSI will also continually evaluate the effectiveness and costs of the different LID types and design standards to be able to more efficiently install LID.

20. EWSI also proposed a metric to assess the implementation and success of SIRP called the Green Hectare. A Green Hectare is the volume of managed runoff spread evenly over an area of 15 mm depth. This proposed metric has been approved by the City of Edmonton's Utility Committee and represents green infrastructure implementation progress measure by tracking/measuring a volume of runoff managed by green infrastructure. EWSI's target for the green hectare PBR metric targets for the 2022-2024 PBR term are shown in Table 3.0-1 below. Green infrastructure may include stormwater storage, LID and small dry ponds[1]. The Green Hectare is based on the approach that utilizes green infrastructure to manage 15 mm of runoff (1 in 2 year frequency event or approximately 90% of rainfalls in Edmonton is from storm events of 15 mm or less) from 1 hectare of impervious area. An equivalent methodology is used in both New York City and Philadelphia to track their flood mitigation efforts.

[1] Larger dry ponds are not included in the Green Hectare performance metric as they are only operational during large storm events.

Table 3.0-1
EWSI 2022-2024 PBR Metric Target for Green Hectares

	Year	A Annual Green Hectare Target
1	2022	45
2	2023	90
3	2024	180

21. EWSI has completed design of six neighbourhoods and construction of four neighbourhoods began in summer 2020. Thirteen LID features in the four neighbourhoods were planned for construction with costs for each LID feature ranging from $30,000 to $830,000 for construction. Prior to the 2019-2021 program there were some small one-off projects that included LID however these projects were more focused on using LID as a water quality feature instead of for flood mitigation. 2020 is the first year of implementing LID on privately-owned commercial and industrial lands. EWSI has identified sites for LID on privately-owed property and has begun its communications with customers but has not yet completed design or construction work at the date of this Application.

22. The scope of the LID Program includes design and construction of LID installations throughout Edmonton from 2022-2024 on both public and privately-owned lands. Specific projects for this annual program will be selected based on the following criteria:

- SIRP Risk Ranking of the project location or its upstream proximity to high risk areas;
- catchment size and impervious area size;
- LID Benefits – flood mitigation, total loading or other environmental benefits;
- cost/benefit analysis of the LID including $\$/m^2$ and $\$/m^3$;
- coordination with other EWSI and City of Edmonton capital programs and ease of installation; and
- service type in the area (combined or separate sewers).

23. The scope of work completed under the LID Program includes:

- liaising and coordinating with City departments and customers for LID development and inclusion within programs/properties (completed in-house);
- developing initial neighbourhood designs - including initial assessment of neighbourhood overland drainage plans; identification and delineation of potential LID locations within each confirmed location; calculation of catchment areas and imperviousness; storage provided by LID; type of LID installation; cost-benefit

analysis; and general constraints (such as utilities and existing trees). Initial neighbourhood designs may be developed in-house or externally by a consultant;

- developing preliminary designs - including preliminary layouts of each proposed LID feature; drawing packages; refinement of calculations such as storage capacity, runoff volume reduction, and peak flow attenuation and reduction; cost estimates for construction; and stakeholder engagement. Not all LID features/locations that have undergone preliminary design will move into detailed design. Preliminary designs will be developed externally by a consultant, however EWSI is planning on developing LID expertise in-house and may complete some LID designs in-house in the future;
- developing detailed designs - including detailed grading plans; planting plans; profiles/cross sections; details; specifications; and refined calculations; detailed design will be developed externally by a consultant, however EWSI is planning on developing LID expertise in-house and may complete some LID designs in-house in the future. Planting plans will likely be developed externally by a consultant;
- construction, construction management, inspection, and commissioning of LID (may be conducted in-house or may be conducted externally by a consultant); and
- operation and maintenance of the LID features until features are accepted. During the warranty phase operation and maintenance of the LID features should be conducted by the contractor who completed the construction. After the warranty period EWSI will be responsible for operations and maintenance of the LID features.

24. LID projects chosen may be constructed as part of any number of City programs including but not limited to:

- Building Great Neighbourhood's Program – This City program renews roads, sidewalks, curbs, gutters and streetlights in mature neighbourhoods or arterial roadways. This program has a number of neighbourhoods undergoing planning and design (typically a 1-3 year process depending on the neighbourhood) and construction (typically a 1-3 year process depending on the neighbourhood) every year. During this process, redevelopment of other City-owned areas such as parks and green spaces within each neighbourhood can also be explored.
- Alley Renewal Program – This City program renews back alleys in mature neighbourhoods. This program has a set number of kilometres that are renewed each year.

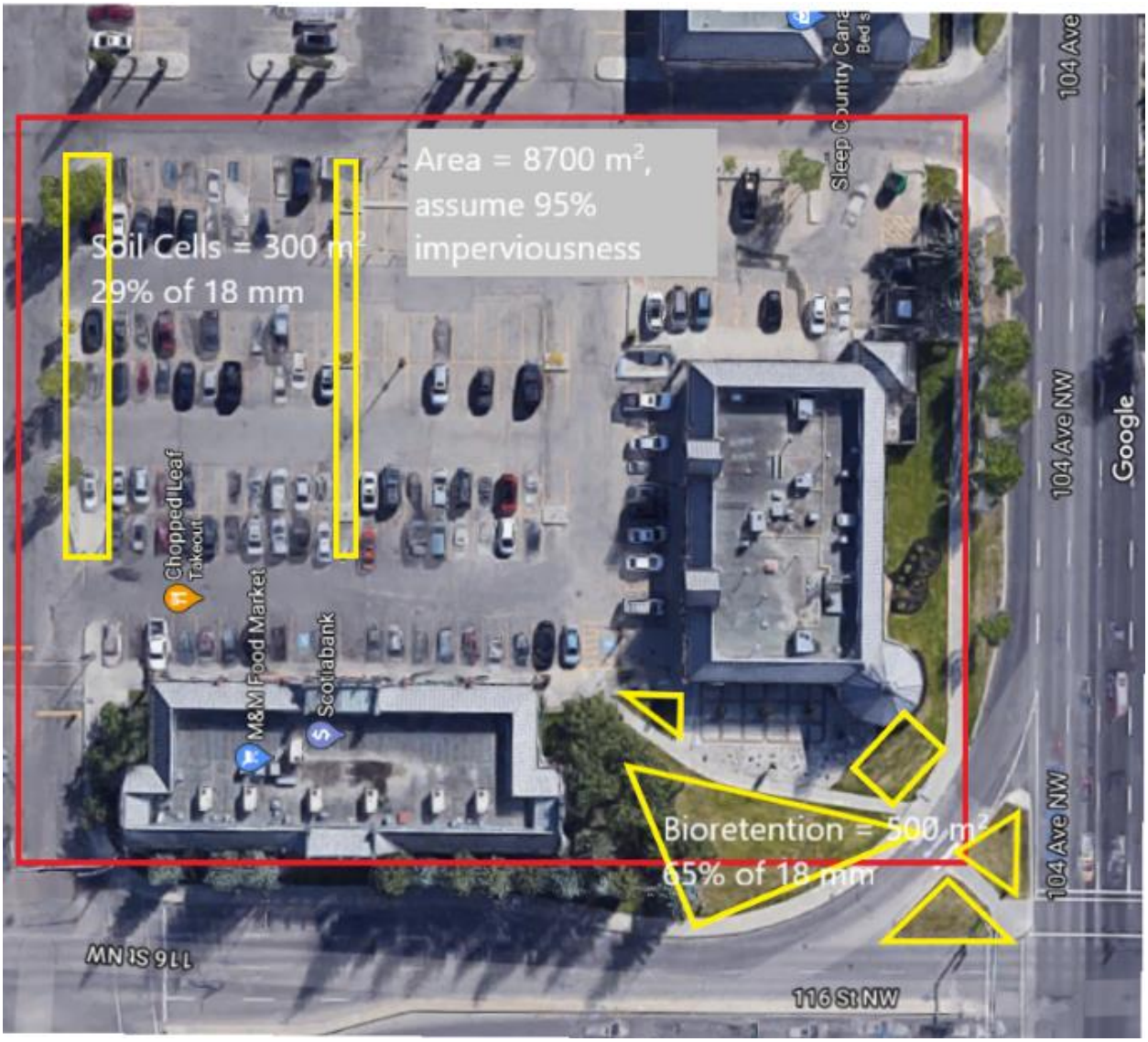
- Parks and Open Spaces' Program – This City program constructs or renews park and green spaces throughout Edmonton.
- Urban Renewal Program – This City program has two main initiatives that apply to LID; Green and Walkable Downtown and The Quarters revitalization. This program may include streetscapes, park spaces, public mixed-use spaces (such as plazas), or other projects within the revitalization areas.
- Corner Store Grant Program – This City Program is targeted to Neighbourhood Commercial properties or properties that meet the commercial needs of local residents. This program is new for 2020 and often works in conjunction with the Building Great Neighbourhoods program but which also has the potential to provide improvements to standalone commercial properties.
- City Transportation projects such as the Yellowhead Trail widening/redevelopment.
- City Facilities projects such as development/redevelopment of recreational facilities.

25. EWSI is coordinating LID with City projects when possible. EWSI has initiated training sessions with City staff and is actively involved with various City teams and programs. An LID Coordination Team has been created and EWSI is constantly engaging and educating additional groups at the City.

26. For privately-owned commercial and industrial sites, EWSI will reach out to customers to design and construct LID features on their land. LID features will be protected with a registered instrument (utility right of way, easement or similar) or land use agreement. Additional selection criteria for privately-owned commercial, industrial, and institutional sites may include the company's green initiatives and whether or not they have an existing utility right-of-way agreement with EWSI. Customers that approach EWSI to be part of this program will also be considered.

27. Figure 3.0-1 is an example of a commercial site in the Oliver neighbourhood. In this example, simply modifying the existing green spaces and adding soil cells in the parking lot can capture 95% of the required runoff from the site.

Figure 3.0-1
LID at Commercial Site – Oliver Neighbourhood Example



4.0 ALTERNATIVES ANALYSIS

28. When developing the City Wide Flood Mitigation Strategy (prior to SIRP) large scale grey infrastructure such as tunnels and an increased pipe network was considered, but was found to be very expensive. EWSI presented the SIRP Strategy to Utility Committee and City Council during 2019. Based on these discussions, EWSI plans to move forward on the SIRP Strategy and, as such, only alternatives following the basis of SIRP were considered. EWSI evaluated four alternatives including: (i) Do Nothing; (ii) Installation of LID in Public Road ROW and Public Lands Only; (iii) Installation of LID on Commercial/Industrial Properties Only; and (iv) Installation of LID on Public

and Private Lands (proposed LID Program). The risks and benefits of the first three alternatives compared to the proposed alternative are discussed below.

Do Nothing Alternative

29. Not implementing LID infrastructure would require implementing an approach similar to the City's original Flood Mitigation Strategy. Grey infrastructure would collect and divert more runoff to collection system moving problems from one area to another as the overall system capacity would not improve. Adding more pipes without retaining volume at the source would not help with system capacity and would also bring faster and cause more environmental damage to natural watercourses (creeks and North Saskatchewan River).

30. EWSI is regulated by Alberta Environment and Parks (AEP) and under approval to operate the collection system there is a commitment and requirement to reduce solids loading from the collection system entering the river. Green infrastructure implementation will mitigate and reduce loadings (volume reduction through natural processes of plant absorption and infiltration as well as retention and treatment of runoff at the source) and keep EWSI in compliance with its total loading objectives. Providing additional capacity within mature areas would specifically benefit areas with combined sewer service, would support COE infill targets and help with reduction of combined sewer overflow occurrences both frequency and volume. Reaching EWSI's SIRP target would be impossible with the do nothing alternative.

Installation of LID in Public Road Right of Way (ROW) and Public Lands Only

31. EWSI's plan is to utilize public road ROW's for green infrastructure and we are currently coordinating LID installation program with the City's Building Great Neighbourhoods (BGN) Program. A memorandum of understanding with the City has been created for current projects and EWSI is funding design and construction of LID installations with BGN. This work will continue from 2022 to 2024. However, as roadways only make up about 4% of the City's total area, it would be extremely difficult to achieve EWSI's ultimate SIRP targets focused solely on implementing LID on public road ROWs and this work is very disruptive to the public.

32. This LID Program pairs LID construction with neighbourhood and street renewals to minimize this disruption. To execute the LID Program in conjunction with neighbourhood and street renewals, EWSI must rely heavily on the City of Edmonton and work within the scope and confines of their neighbourhood and street renewal projects. Additional restrictions include installation of LID features in areas of the City of Edmonton's choosing, increased costs, project

complexity due to coordination efforts and the reduced benefit of LID as a result of small drainage areas controlled/managed by LID installation (land available within ROW is limited). With these projects there can also be other restrictions that can affect installation of LID such as future land use restrictions and utility conflicts, resident concerns, and inexperienced contractors, to mention few.

33. Because LID installation involves surface type work, implementation of LID in neighbourhoods will follow EWSI's completion of underground upgrades completed as part of EWSI's Neighbourhood Renewal Program. EWSI will coordinate with the City's Building Great Neighbourhoods which also occurs after EWSI's Neighbourhood Renewal Program and often involves adjustment of roads, curb alignment and sidewalk layouts. Coordination with the City's BGN Program is part of the Installation of LID on Public Lands.

Installation of LID on Commercial/Industrial Properties Only

34. Privately-owned commercial and industrial properties make up about 11% of the City's area, and are primarily impervious areas resulting in high volume contribution to the collection system during storm events. Installation of LID features on commercial and industrial properties can be completed with relative ease, and in some cases minimal disturbance to the public. EWSI's main concern with this option is land ownership and property or business owner support. This work will be accompanied with extensive communication and outreach and potentially incentive program for land owners in form of reduced stormwater fee (currently in development). EWSI will fund design and construction and will commit to operate and maintain these facilities. As EWSI has just started to work towards implementing LID on privately owned commercial and industrial properties in 2020, uptake from these customers is currently unknown. However, from the limited dataset, three of the four customers contacted have agreed to move forward with the process.

35. Given the disadvantages of the two more focused programs (city lands only or private lands only), EWSI is proposing a broader approach with more flexibility as set out in this LID Program which includes installation of LID features throughout Edmonton both on public lands, in conjunction with a number of City programs, and on private lands and, on an opportunistic basis, LID included as part of other EWSI capital projects. City-wide installation of LID features through a number of different locations allows EWSI to more effectively and efficiently plan LID implementation moving forward. With these increased options, EWSI has more flexibility to invest dollars into areas that provide more benefit to the storm/combined system. The increased

flexibility also provides the greatest opportunity for EWSI to meet its environmental and performance targets.

5.0 COST FORECAST

36. Table 5.0-1 provides the forecast for the LID Program for the 2022-2024 PBR term.

Table 5.0-1
LID Program
Capital Expenditure Forecast (2022-2024)
($ millions)

		A **2022**	B **2023**	C **2024**	D **Total**
	Direct Costs				
1	Contractors	6.69	13.48	25.62	45.78
2	Internal Labour	0.23	0.46	0.59	1.28
3	Contingency	0.63	1.25	2.32	4.21
4	**Sub-total Direct Costs**	7.55	15.19	28.53	**51.27**
5	Capital Overhead and AFUDC Costs	0.28	0.55	0.98	1.80
6	**Total Capital Expenditures**	7.83	15.74	29.51	**53.07**

37. In forecasting the costs for this program for the 2022-2024 PBR term, EWSI has applied the following assumptions:

- Unit rates based on 2020 LID Construction estimates were developed for four LID type and size combinations as follows:
  - 2-layer soil cell streetscape - $5285/m^3
  - 1-layer soil cell small - $9,150/m^3
  - Bioretention/box planter small - $4350/m^3
  - Bioretention large - $1900/m^3
- Unit rates are based purely on construction costs however cost savings are assumed to be recognized as the program progresses. For commercial/industrial projects, costs are expected to be lower as there are no additional overhead fees from the City.
- The breakdown of LID features based on cost is forecast as:
  - 35% streetscape installations (BGN, Urban Renewal, Transportation, Commercial/Industrial);
  - 5% small soil cell installation (BGN);
  - 20% small bioretention/box planters (BGN, Commercial/Industrial, Parks, Facilities, Urban Renewal); and

  - 40% large bioretention (Parks, Commercial/Industrial, Urban Renewal, Facilities, Transportation).

- On average, 6 neighbourhoods or collector renewals undergo construction each year as part of BGN. This includes multiple construction years for most renewals. For 2022-2024 there are a total of 23 construction years scheduled for 16 different neighbourhoods' costs for each construction year range from $0.25 million to $1.5 million.
- Based on conceptual sizing and rough cost estimates, construction costs for the privately-owned commercial and industrial LID installations range from $0.5 million to $1.5 million. EWSI estimates 18 commercial/industrial sites identified will be completed during 2022-2024.
- Eight other LID projects are forecast to be completed under the LID Program during 2022-2024 as part of either or the City's urban renewal, transportation projects, facilities projects and parks projects or as part of EWSI''s stand-alone and opportunistic projects. Preliminary costs for some of these projects indicate costs similar to the Commercial/Industrial program.

38. The actual number of sites completed will vary depending on the cost-benefit analysis of the various LID features and programs and available projects; factors that may influence this include the size of the LID feature and catchment area, the ease of installation, coordination with other programs, and LID type. As this program allows flexibility in LID installations project costs may vary as the program progresses. EWSI is in the very early stages of implementing LID and will be able to refine its costs estimates in the future as it gains more experience with implementing LID in coordination with the various programs and at various locations.

39. Table 5.0-2 summarizes the LID Program details as described above using average costs and number of sites/neighbourhoods to illustrate the feasibility of the program. As described the program can be flexible and scope can be added or removed to the individual programs and projects within the overarching LID Program.

Table 5.0-2
Forecast Costs of Proposed LID Program for 2022-2024
($ millions)

	Program	A Average Construction Cost per Site/Year	B Number of Sites/Years	C Construction Cost	D Design Cost*	E Total Forecast Costs
1	BGN	0.9	23	20.7	3.1	**23.8**
2	Commercial/ Industrial	1.0	18	18.0	2.1	**20.1**
3	Other Projects	1.0	8	8.0	1.2	**9.2**
4	**Total Costs**			**46.7**	**6.4**	**53.1**

*Design costs are estimated at 15% of Construction Costs for BGN and Other Projects which are initiated and managed by external contractors. Design costs are estimated at 12% of Construction Costs for Commercial/Industrial which are initiated and managed internally by EWSI.

40. EWSI takes a number of steps to minimize the level of these capital expenditures. These include:

- Contracted services are performed by pre-qualified external contractors and done on a competitive unit priced basis, using comprehensive engineering packages to ensure cost and scope control.
- The installations will be consistent with EWSI's construction standards which will minimize stock requirements and speed up design and construction.
- Where possible, work will be coordinated with other projects or maintenance activities to minimize costs.
- Every project is evaluated individually to determine the appropriate construction method to meet requirements at the lowest cost.
- Every project scope is evaluated to improve economy of scale and to eliminate future throw-away of infrastructure.
- All force accounts are documented and reviewed by several EWSI representatives to ensure the additional cost is justified under the terms of the contract.

6.0 RISKS AND MITIGATION PLANS

41. Key risks and mitigations associated with the execution of this program are detailed in Table 6.0-1.

Table 6.0-1
Key Risks and Risk Mitigations

	Risk	A Mitigation Plan
1	Risk of Limited uptake by commercial/industrial property owners - As this is a relatively new program, there is a risk that none of the identified properties will agree to be part of the program. Although EPCOR is funding design and construction of the LID, there will always be some impact to the property that the site owner(s) will have to agree to.	EWSI is developing an extensive list of commercial/industrial properties to help mitigate this risk. EWSI's Communication team has been involved and a number of educational materials have been developed to help engage customers to install LID features on their site. To date 3 of the 4 commercial/industrial sites that have been approached have agreed to move forward with the process. EWSI is developing educational materials and an educational program explaining LID to affected stakeholders including the public as necessary.
2	Construction Risks - Risk of utility conflicts, bad soil conditions/high groundwater table, restoration requirements, lack of space, and conflicts with other construction projects.	EWSI has developed LID Standards as part of the City of Edmonton's Volume 3 Drainage & Construction Standards, as part of the standards EWSI developed and released a number of tools and guidance documents including a report addressing geotechnical issues such as soil conditions and groundwater table, that are more specific to Edmonton. To avoid utility conflicts EWSI will circulate all projects through the Utility Line Assignment (ULA) system, or through the City's circulation process. EWSI will work with the City to identify and clarify new requirements and or changes to the project and will coordinate construction with other utilities and City.

Appendix H16

EPCOR WATER SERVICES INC.

Drainage Services
SIRP Proactive Manhole Relining Program
Business Case

February 16, 2021

Table of Contents

1.0 OVERVIEW

1. The Stormwater Integrated Resource Plan (SIRP) has identified that an increased risk of basement flooding occurs in areas where there are localized sag areas with water ponding on the road prior to draining through the piped stormwater network. The Proactive Manhole Relining Program is a new annual program initiated to reduce inflow and infiltration (I/I) into the sanitary and combined sewer system with risk of flooding due to sewer backups from these local sag areas. This program will focus on reducing I/I by relining the 1.5 m top portion of the sanitary and combined manholes. If the relining work is not done, this may lead to increased health and safety risks to EWSI's employees and to its customers due to potential for sewer backups and basement flooding; increased environmental risks associated with sewage spills to the local environment or water bodies; increased financial risks due to costly emergency repairs to failed drainage infrastructure; and increased risks of service disruptions due to neighbourhood flooding.

2. Prior to 2020, there was no previous proactive program to reline manholes and work was done on as needed basis in different programs such as neighbourhood renewal and local sewer rehabilitation. Since the initiation of this program in 2020, more than 1,000 manholes have been relined. The program is targeted to complete proactive relining of 1,000 manholes annually.

3. Sites for manhole relining will be selected according to the priority of SIRP risk ranking. EWSI has identified more than 9,000 sanitary and combined manholes that are located in ponding areas in the City. For the 2022-2024 PBR term, the scope of this program includes inspecting manholes in sag areas, repair severe structural deficits if required, install 1,800 inserts for manholes with critical ponding depth deeper than 0.3 metres and do relining for 3,000 manholes located in sag areas in selected neighbourhoods, as well as replacing the manhole frames and covers.

4. This program is categorized as reliability / life cycle replacement and is one of the SIRP-SECURE programs. EWSI has forecast total program capital expenditures during 2022-2024 at $18.71 million. The first annual Proactive Manhole Relining program was initiated in 2020.

2.0 BACKGROUND AND JUSTIFICATION

5. EWSI presented the Stormwater Integrated Resources Plan (SIRP) to the City of Edmonton Utility Committee and Council in 2019 as part of its non-routine adjustment application, following EWSI's October 2018 presentation of the SIRP Risk Framework Methodology. SIRP is a system wide integrated approach to mitigate flood risk by reducing the health, safety and social risk of flooding with lower overall capital investment than compared to traditional engineering approaches. SIRP recommended a five theme strategy for flood mitigation (SLOW, MOVE, SECURE, PREDICT and RESPOND) that included a mix of grey (trunks and tunnels) and green infrastructure (dry ponds, low impact development) components. The SIRP Proactive Manhole Relining Program is a critical component of the SIRP Strategy under the SECURE theme.

6. This new program was initiated as part of SIRP's "Secure" theme which will focus on securing individual properties in higher risk areas against flooding. SIRP has identified that there is an increased risk of basement flooding in areas where there are localized sag areas with water ponding on the road prior to draining through the piped stormwater network.

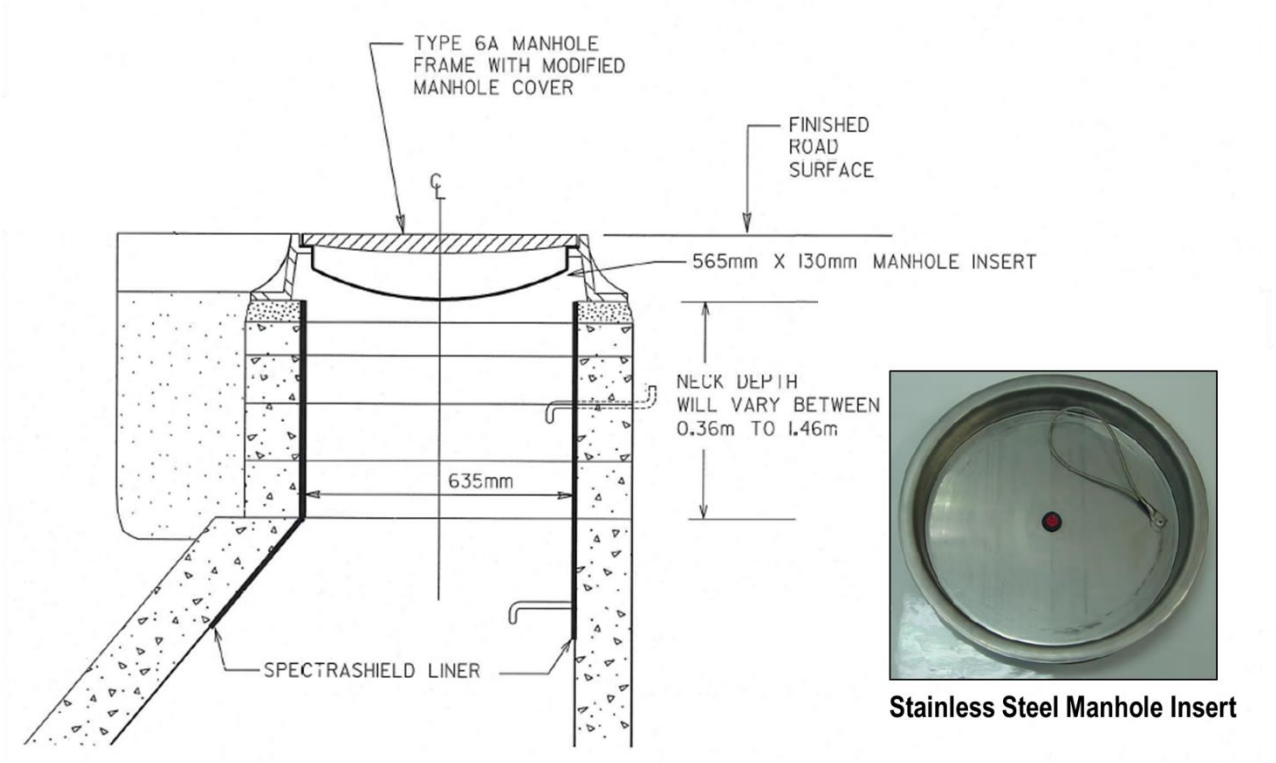
7. If the relining work is not done, excess inflow of rain water will be entering the sewer network over the surface ponding areas. This may overload the sewer capacity, cause sewer backups and increase the risk of basement flooding. Depending on the severity and duration of storm events, property damage may occur due to flooded basements in the area. In addition, there are concerns related to health and safety of customers and the frequent mobilization of operational crews due to basement flooding.

8. As one of the initiatives to reduce inflow and infiltration (I/I) into the sanitary system and the risk of flooding due to sewer backups from these local sag areas, this Proactive Manhole Relining Program will focus on reducing I/I by relining the 1.5 m top portion of the sanitary manholes (see Figures 2.0-1 and 2.0-2). The relining work designed for the top portion of a manhole is recommended by recent studies and field observations. The majority of I/I is due to surface runoff entering a manhole around the manhole neck and cone area which is about 1.2 to 1.5 m below surface. That is the area that receives the most impact from traffic. Unless there is evidence of major cracks along the manhole barrel, the most cost effective approach to minimize I/I from entering to sewer pipe through manhole is to reline the top portion of a manhole. In areas where the depth of ponding exceeds 0.30 metres, a manhole insert bowl will also be installed to seal the manhole lid to further prevent water flowing into the manhole through the pick-holes.

Figure 2.0-1
Typical Manhole Before and After Relining

Before After

Figure 2.0-2
Schematic of a Relined Manhole with Stainless Steel Insert (Bowl)



9. Sites for manhole relining will be selected according to the priority of the SIRP risk ranking. SIRP risk ranking is developed based on a combination of risk level from four different areas: Health and Safety, Environmental, Financial and Social. Each storm sub-area is assigned one of the 8 risk groups (A to H) under 4 Risk Levels (High, Medium High, Medium, Medium Low to Low). However, if these areas are listed under the City's neighbourhood renewal schedule, then the relining works for these sites are grouped and included in another EWSI capital program called

Manhole Relining and Insert Program. That program will be coordinated with the City's neighbourhood renewal schedule.

10. For this Manhole Relining Program, selected manholes will be inspected first and relining will be completed only if such works were not done previously at these locations. Approximately 60 manhole frames that have previously been identified as having maintenance issues will be replaced as part of this program. In addition, after field inspection and condition assessment, EWSI will address manholes with severe structural defects prior to relining if required. Based on site inspections, EWSI estimates that roughly 25% of manholes will require minor repair works and 5% will require major structural rehabilitation. As there are many products available in the market, the most suitable method for relining and sealing will be finalized at the procurement stage.

11. The relined top portion of the manhole will extend the life of the manhole. This program also provides a high level of service to residents by lowering the risk of sewer back-ups due to I/I and reducing service disruptions due to manhole collapses.

12. There are other EWSI programs that will also reduce I/I including:

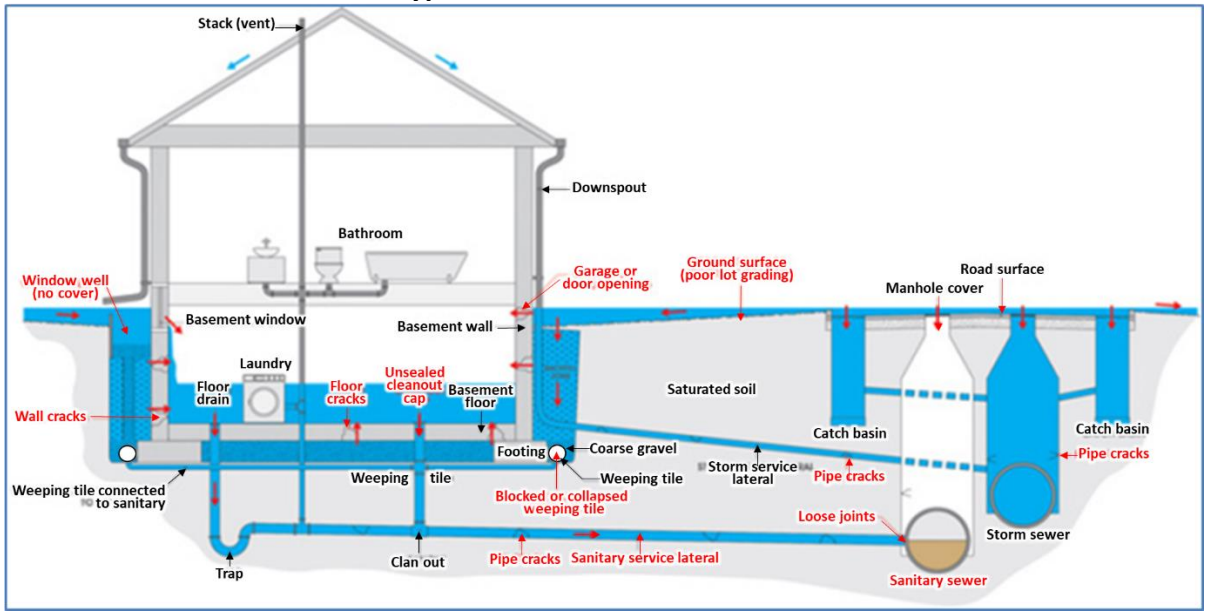
- manhole relines in Drainage Neighbourhood Renewal Program;
- opportunistic manhole and catchbasin repairs done as part of operations activities; and
- relining pipes (sanitary and combined) in ponding areas.

13. The risks associated with not completing this program include:

- Health and Safety Risk – Excessive I/I could pose a safety risk to the EWSI staff who operate and maintain the drainage infrastructure. There is also a safety risk to the public if the area is flooded due to high I/I which can cause spilled sewage and basement backups. Frequently flooded basements can also affect the physical and mental health of the occupants.
- Environmental Risks – Excessive I/I could lead to floods and sewage spills to the local environment or water bodies and may cause damage or contamination to the natural environment and wildlife. This will affect the usage of these facilities by the public and require substantial investment to restore the affected areas. The release of untreated sewage into the environment also violates Drainage's Approval-to-Operate issued by Alberta Environment and Parks.

- Financial Risks –High I/I can also lead to flooding which is costly to manage and clean up and can lead to claims from customers with flooded basements impacting the level of service and expectation of customers.
- Service Disruption Risk – High I/I could lead to neighbourhood flooding especially for houses in a localized sag area. Figure 2.0-3 below from the CSA Standard Z800-18 – Guideline on Basement Flood Protection and Risk Reduction illustrates (in red font) the different paths where stormwater can potentially enter a property that is in a localized sag area. Following a storm event, the longer the duration that the water pools on the road surface the higher the risk that the water will access the sanitary pipes and/or foundation drains of properties without adequate flood proofing and enter the building. This is why the focus for SIRP on programs is to reduce the risk of water ponding in localized sag areas during a storm event.

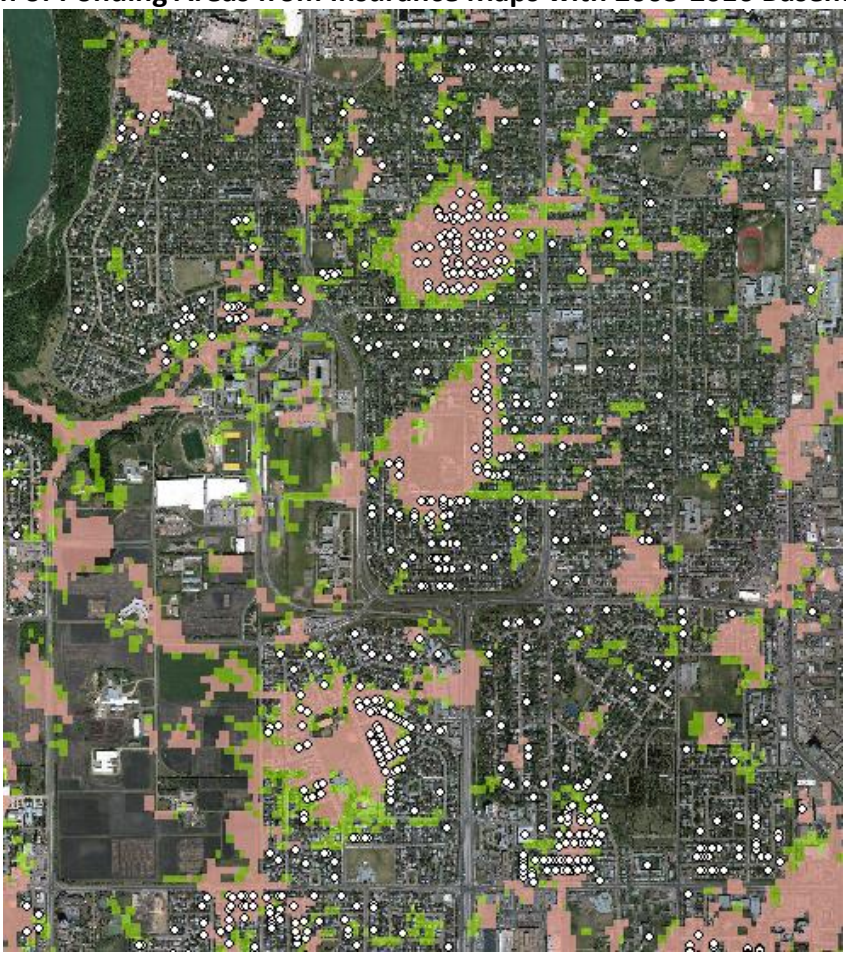
Figure 2.0-3
Typical Household Connections



14. The higher risk of ponding to properties was evident from the risk analysis of the stormwater sub basins where water was predicted to pond on the roads after a storm event. Historical basement flooding records for Edmonton confirmed this increased risk level as shown in Figure 2.0-4. Figure 2.0-4 identifies customer calls to 311 to report flooding events (during 2003-2016) in white dots compared to the pink and green areas which represents the ponding area identified by the insurance industry pluvial flood modelling using federal topographical maps under different storm intensities. There are strong correlation of locations of predicted

ponding locations with historical basement flooding records indicating I/I is a strong driver in causing basement flooding.

Figure 2.0-4
Comparison of Ponding Areas from Insurance Maps with 2003-2016 Basement Floods



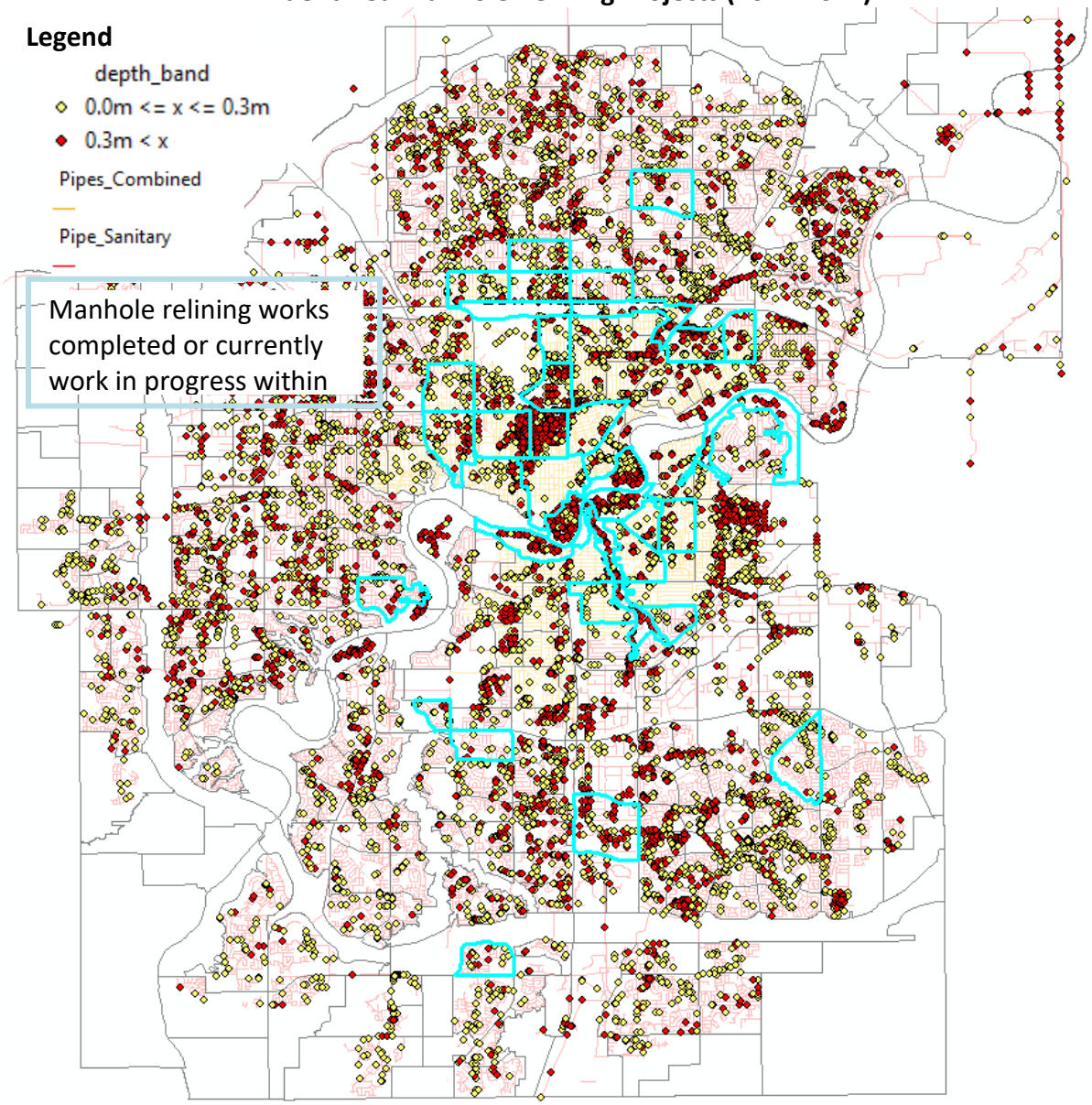
3.0 PROGRAM DESCRIPTION

15. EWSI has identified more than 9,000 sanitary manholes that are located in ponding areas in the City. Of these, EWSI is planning to seal and reline a total of 3,000 manholes during the 2022-2024 PBR term. These manholes will be selected based on ponding depth and SIRP risk ranking of the area. It is estimated from previous projects that approximately 1,800 manholes will be selected for relining and insert installation at locations with surface ponding depth of 0.30 metres or deeper and the remaining 1,200 manholes will require relining only. These manholes will be inspected first to determine if additional work to address structural defects is required. After field inspection and condition assessment, manholes with severe structural defects will be addressed prior to relining if needed. The costs to address these structural defects are included

in the scope of this program. This program is created based on EWSI's 10-year plan to complete a total of a 10,000 manholes in ponding areas by 2030. An additional 1,000 manholes are expected to be identified during the 10-year implementation period to supplement the initial 9,000 locations through site survey and field inspections.

16. Figure 3.0-1 below provides a map of the 9,000 sites identified for manhole relining including those greater than 0.3 metres in ponding depth identified in red and those less than 0.3 metres in depth identified in yellow.

Figure 3.0-1
Identified Manhole Relining Projects (2022-2024)



17. The scope of this program for the 2022-2024 PBR term includes:

- inspect manholes in sag areas;
- repair severe structural defects of manholes prior to relining if needed;
- relining of a total of 3,000 manholes located in sag areas within the selected neighbourhoods;
- installing about 1,800 inserts for manholes located in critical ponding depth deeper than 0.3 metre; and
- replace manhole frames with identified maintenance issues in areas with critical ponding depth.

18. Pipe relining is not included in this program but this program will coordinate with the Proactive Pipe Relining program in order to maximize the effort and avoid any conflicts of schedule.

19. Table 3.0-1 provides the criteria for inclusion in the Manhole Relining Program.

Table 3.0-1
Manhole Relining Program Criteria

	Criteria	A Rationale
1	Manholes in any SIRP sub basin identified as at risk of sewer backup and basement flooding	Reduce risk of sewer back up and basement flooding
2	Manholes not included in the current City's neighbourhood renewal List	Relined manholes will not be disturbed with the City's neighbourhood renewal list
3	Manholes in an identified sag location	Location of water ponding contributing to I/I in the sub basin
4	Sewer manholes	Reduce I/I in the sewer system to reduce risk of system overloading, sewer back up and basement flooding
5	Manholes in ponding areas where depth of ponding exceeds 0.30 metres	Insert will be added to seal the manhole lid. For drop manhole, insert will not be installed.

20. Minimal operational impact during program execution is expected to EWSI's Drainage Operations as there will be no interruption to the service connections and flows in the sewer pipes at the construction sites. Advanced notification will be provided to all impacted customers at the proposed construction sites. There are no abandonments or retirements for this program. There will though be a requirement to create a new procedure for on-going maintenance requirements of sealed manholes.

21. There is an opportunity to coordinate this construction with a communication with adjacent home owners to ensure they have flood proofed their properties. EWSI will leverage the opportunity when applicable to increase flood risk awareness to the adjacent properties to these sag locations.

22. This program will be delivered by a design bid build method. EWSI will complete site inspection, design, procurement and construction using existing relining master service agreements as it does not have the equipment and expertise in installing liner to the manholes.

23. This program is an annual program to relining manholes for I/I reduction. The program is targeting the relining of approximately 1,000 manholes each year. The delivery method has been divided into five stages as shown below, including tasks to be completed by internal resources and external contractors:

- Initial Review and Checking: Database review, previous rehabilitation works, types of manhole frame and covers, abandonment, etc. This will be done using internal resources.
- Condition Assessment: Inspection and confirmation of the physical condition of manholes and type of frame and covers, etc. This will be done using internal resources.
- Manhole Rehabilitation: Up to 30% of the selected manholes may require repairs which will be contracted out. The average cost per replacement without capital overhead or salary transfer is $6,500.
- Manhole Relining and Sealing: This work will be contracted out to external resources.
- Installation of Inserts and Type F39 Frames: It will be done using internal resources.

24. Table 3.0-2 provides the program schedule based on the phases of work.

Table 3.0-2
Proactive Manhole Relining Program Schedule

	Project Phases	A 2020-2021	B 2022 Q1/2	C 2022 Q3/4	D 2023 Q1/2	E 2023 Q3/4	F 2024 Q1/2	G 2024 Q3/4	H 2025 Q1/2	I 2025 Q3/4
1	Initiation/Approvals	X								
2	Preliminary Design		X		X		X			
3	Detail Design		X	X	X	X	X	X		
4	Procurement			X		X		X		
5	Construction			X	X	X	X	X	X	X
6	Commissioning					X		X		X
7	Close-out					X		X		X

4.0 ALTERNATIVES ANALYSIS

25. I/I can cause drainage system failures and flooding. Alternatives to I/I reduction initiatives include do nothing. As part of the approved SIRP initiatives, do nothing is not a feasible alternative because these areas will continue to have flooding issues.

26. The focus for this program is to reduce the I/I through manholes by relining them at a cost of $4000 to $5000 per manhole. Several alternatives to relining manhole were considered for reducing the I/I:

Alternative 1: Replace Manhole

27. Replacing manholes will be more costly and is estimated to double the cost of relining. Depending on the vertical depth, the cost to replace a standard manhole ranges from $15,000 to $30,000.

Alternative 2: External Wraps

28. Wraps are a flexible and adhesive butyl material with an abrasion resistant backing. Installation of wraps require excavation and is usually more expensive than relining. The cost for excavation, restoration and external wraps is approximately $10,000 per manhole.

Alternative 3: Manhole Plugs

29. These are typically a simple rubber or plastic plugs, sometimes with a metal clamping core, that limit inflows through the venting and lifting holes of the cover only and do not address inflows around the cover-frame interface and are therefore not a reasonable alternative. In addition, the plugs are frequently displaced or broken by traffic or snowplows.

30. Relining manholes is the recommended method to reduce I/I into the sewer system based on the cost, effectiveness, and no disruption of the ground surface. Selected manholes will be inspected first and relining will be completed only if such works were not done previously at these locations. In addition, after field inspection and condition assessment, manholes with severe structural defects will be addressed prior to relining if required. As there are many products available in the market, the most suitable method for relining and sealing will be finalized at the procurement stage.

5.0 COST FORECAST

31. Program costs are estimated based on previous projects of similar types such as the 2019 Manhole Relining and Insert Project and the 2020 Proactive Manhole Sealing Project. Comparison of various relining materials and insert bowls were conducted prior to the implementation of the Proactive Manhole Relining program. The comparison included product costs, specifications, service life, durability, and the need for maintenance. Some products were tested in the field to determine whether there are any issues associated with operation or maintenance. Only those products approved by EWSI's operation team were selected for the annual program. The cost estimate provided in this program is based on the actual spending on similar relining works completed in previous projects.

32. The project scope is well defined, and cost breakdown estimates were developed as follows:

- Contractor costs are based on historical data from similar projects completed in the past. The majority of work will be done for standard manholes and large variations of cost are not expected.
- In-house hours are based on historical data from similar projects completed in the past.

33. Table 5.0-1 provides the capital expenditure forecast for this program for the 2022-2024 PBR term.

Table 5.0-1
Proactive Manhole Relining Program
Capital Expenditure Forecast (2022-2024)
($ millions)

		A **2022**	B **2022**	C **2024**	D **Total**
	Direct Costs				
1	Contractors	5.57	5.68	5.80	17.05
2	Internal Labour	0.36	0.37	0.38	1.11
3	Vehicles and Equipment	0.12	0.12	0.12	0.35
4	**Sub-total Direct Costs**	6.05	6.17	6.29	**18.51**
5	Indirect Costs	0.06	0.06	0.07	0.19
6	**Total Capital Expenditures**	6.11	6.23	6.36	**18.71**

34. EWSI takes a number of steps to minimize the level of these capital expenditures. These include:

- All activities related to project management, design, drafting, construction coordination and inspection, and as-built recording will be undertaken internally by EWSI, eliminating the need for external consultants. The actual construction, including surface restoration, will be completed by one of EWSI's long term construction contractors.
- Contracted services are performed by pre-qualified external contractors and done on a competitive unit priced basis, using comprehensive engineering packages to ensure cost and scope control.
- The installations will be consistent with EWSI's construction standards which will minimize stock requirements and speed up design and construction.
- Where possible, work will be coordinated with other projects or maintenance activities to minimize costs.
- Every project scope is evaluated to improve economy of scale and to eliminate future throw-away of infrastructure.
- All force accounts are documented and reviewed by several EWSI representatives to ensure the additional cost is justified under the terms of the contract.

6.0 RISKS AND MITIGATION PLANS

35. Table 6.0-1 provides a summary of the key risks associated with executing this program and EWSI's plans to mitigate these risks.

Table 6.0-1
Key Risks and Risk Mitigations

	Risk	A Mitigation Plan
1	Health and Safety – High I/I can cause flooding and sewer backup which pose as a drowning and health risk to residents.	Proactive relining manholes will reduce the amount of I/I and the associated risk of flooding and sewer backup.
2	Environmental - High I/I can cause flooding and sewer backup which can release untreated sewage into the environment and violate the Approval-to-Operate	Proactive relining manholes in the high risk area will reduce the amount of I/I and the associated risk of flooding and sewer backup.
3	Execution Risk - Using equipment such as jackhammers when replacing manhole structure may expose workers to silica dust, which over prolonged exposure can lead to silicosis. This condition is serious and can increase the individual's risk of developing cancer among other diseases.	EWSI will use appropriate kind of respirator to filter out silica (and other harmful substances) particles suspended in the air as well as using mechanized equipment so that workers are not directly exposed to the dust.
4	Financial - Liner not properly cured resulting in rework and extra cost to the project.	Contractors will submit the quality assurance/quality control plan including curing and temperature duration, confirm types of curing using and add clause for contractor to include monitoring for curing time and temperature.
5	Customer Disruptions - Risk of odour release impacting the public/residents.	EWSI will use non-odour releasing products; continuously monitor odour and assess the area during construction. EWSI will ensure coordination so the manholes are not opened for extended periods of time.

Appendix H17

EPCOR WATER SERVICES INC.

Drainage Services
SIRP Proactive Pipe Relining Program
Business Case

February 16, 2021

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1.0 OVERVIEW

1. The Stormwater Integrated Resource Plan (SIRP) identifies that there are a number of neighbourhoods at risk of basement flooding due to sewer surcharge during heavy storm events. One of the main causes of sewer surcharge is stormwater entering the sanitary or combined sewer systems through inflow and infiltration (I/I), especially from surface ponding areas. I/I is an issue because it reduces the capacity of the collection system which could lead to basement flooding due to sewer backup. The flood risk will remain high if the pipe relining work is not done as it may cause basement flooding for a large number of properties located in low lying areas during heavy to extreme rainfall events. In some cases, I/I can also cause untreated sewage discharge to the environment which is in violation of the Approval-to-Operate and could possibly result in a fine.

2. As one of the initiatives to reduce the risk of basement flooding due to I/I , this annual program has been initiated as a new program to focus on relining sanitary and combined sewer pipes in surface ponding areas. These low lying areas have a higher risk for I/I to occur due to cracks and open joints in sewer pipes. Through this program, the volume of stormwater entering the sanitary and combined sewer networks will be reduced.

3. During the 2022-2024 PBR term, EWSI plans to complete relining of 60 km of sanitary and combined sewer pipes with diameters of 750 mm or less, with observed I/I defects (assuming 2,550 metres needing open cut repair first) and 6 km of service line relining.

4. This program is categorized as reliability / life cycle replacement and is one of the SIRP programs to reduce flood risk in Edmonton. EWSI has forecasted total program capital expenditures during 2022-2024 at $22.91 million. This is a new program initiated in 2020 to proactively address local sewers with I/I defects. Previously, sewers were rehabilitated based on structural defects through the different local sewer rehabilitation programs such as neighbourhood renewal.

2.0 BACKGROUND/JUSTIFICATION

5. EWSI presented the Stormwater Integrated Resources Plan (SIRP) to the City of Edmonton Utility Committee and Council in 2019 as part of its non-routine adjustment application, following EWSI's October 2018 presentation of the SIRP Risk Framework Methodology. SIRP is a system wide integrated approach to mitigate flood risk by reducing the health, safety and social risk of flooding with lower overall capital investment than compared to traditional engineering

approaches. SIRP recommended a five theme strategy for flood mitigation (SLOW, MOVE, SECURE, PREDICT and RESPOND) that included a mix of grey (trunks and tunnels) and green infrastructure (dry ponds, low impact development) components. The SIRP Proactive Pipe Relining Program is a critical component of the SIRP Strategy under the SECURE theme.

6. SIRP identifies that there are a number of neighbourhoods at risk of basement flooding due to sewer surcharge during heavy storm events. One of the main causes of sewer surcharge is stormwater entering the sanitary or combined sewer systems through inflow and infiltration (I/I), especially from surface ponding areas where excessive runoff generated from rainfall exceeds the design inlet capacity of nearby storm catch basins. I/I is an issue because it reduces the capacity of the collection system which could lead to basement flooding due to sewer backup. Without this investment in proactive pipe relining program, EWSI faces a number of risks including: health and safety risk to the EWSI staff and to the public if the area is flooded due to high I/I and causes spilled sewage and basement backups; environmental risks due to potential floods and sewage spills to the local environment or water bodies; and financial risks associated with costly emergency repairs to failed drainage infrastructure and potential claims from customers with flooded basements.

7. As one of the initiatives to reduce the risk of basement flooding due to I/I , the Proactive Pipe Relining Program has been initiated to focus on relining sanitary and combined sewer pipes in surface ponding areas. Prolonged surface ponding over low lying areas leads to a higher risk for I/I to occur through cracks and open joints in sewer pipes. Through this program, the volume of stormwater entering the sanitary and combined sewer networks will be reduced. Other EWSI capital programs and maintenance activities that will also reduce I/I include:

- Proactive Manhole Relining Program coordinated with the Drainage Neighbourhood Renewal Program for recently completed neighbourhoods;
- opportunistic manhole and catchbasin repairs completed by Operations; and
- relining pipes in other ponding areas with known I/I defects based on EWSI's annual closed circuit television (CCTV) inspections.

8. Traditionally, pipe relining is done on a reactive basis when there is sewer backup or basement flooding reported and the structural condition for the pipe is found to be deteriorated enough for relining. Similar to the sewer reline in the Neighborhood Renewal Program and arterial road drainage projects in the Arterial Road and Drainage Coordination Program, this Proactive Pipe Relining Program reduces the risk of sewer backup and basement flooding due to excessive I/I entering the sanitary and combined sewers at known surface ponding areas.

9. Approximately 1,300 km of sanitary and combined pipes with varying diameters are located in low lying areas in the city of Edmonton. Surface ponding over the low lying areas occurs when runoff exceeds the design inlet capacity of nearby catch basins. The completion target for the overall Proactive Pipe Relining Program is approximately 500 km of the total 1,300 km over the next 20 years. EWSI is planning to complete 60 km of sanitary and combined pipes during the 2022-2024 PBR term. The 60 km of sanitary and combined pipes are selected based on pipe diameters equal to or less than 750 mm and located in areas with ponding depth greater than the allowable 0.3 m. Relining or rehabilitation works for pipes larger than 750 mm diameter will be completed under the Sewer Trunk Rehabilitation program. Table 2.0-1 below provides the total number and length of sanitary and combined sewer pipes in low lying areas.

Table 2.0-1
Overall Sanitary and Combined Sewer Pipes in Low Lying Areas

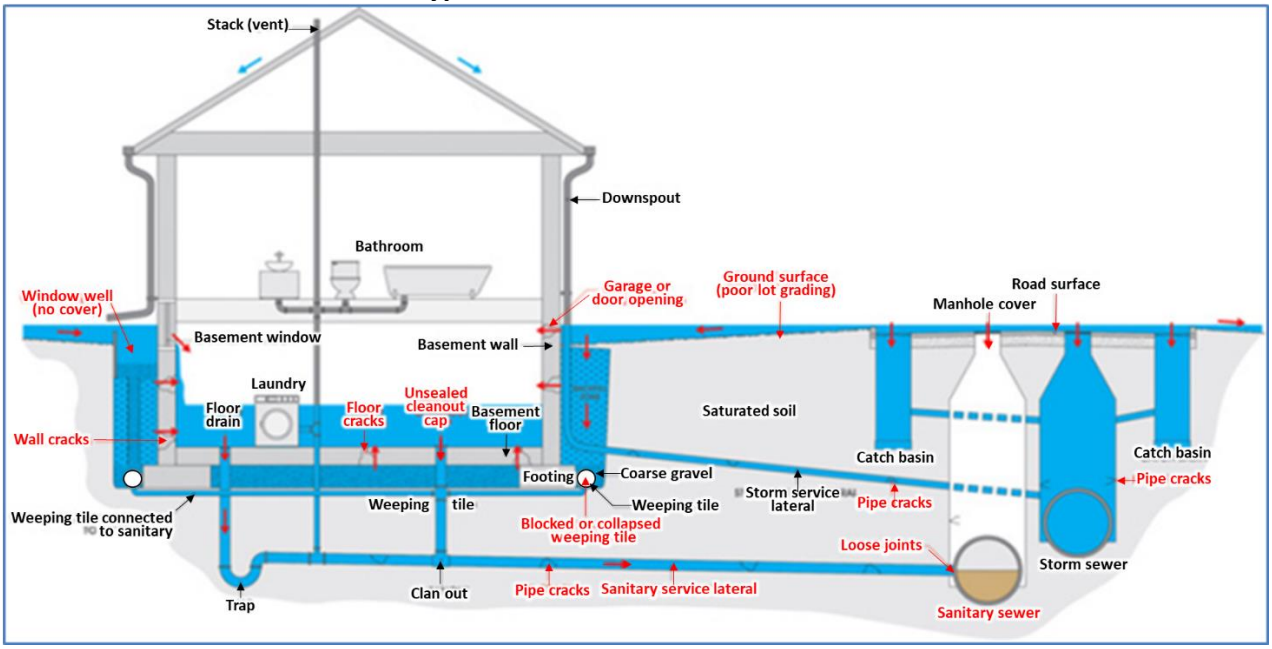
	A	B	C	D
	Pipes with any Diameters, and any Ponding Depth > 0m		**Pipes with Diameter ≤ 750mm, and Ponding Depth > 0.3m**	
	# of pipes	**Total Length (km)**	**# of pipes**	**Total Length (km)**
1 Sanitary	12,525	970	4,832	370
2 Combined	5,059	341	2,004	128
3 **Total**	**17,584**	**1,311**	**6,836**	**498**

10. The consequences of not completing this program includes:

- Health and Safety Risk – Excessive I/I could pose a safety risk to the EWSI staff who operate and maintain the drainage infrastructure. There is also a safety risk to the public if the area is flooded due to high I/I causing spilled sewage and basement backups.
- Environmental Risks – Excessive I/I could lead to floods and sewage spills to the local environment or water bodies.
- Financial Risks – Emergency repairs to failed drainage infrastructure are more costly. High I/I can also lead to flooding which are costly to manage and clean up, and can lead to claims from customers with flooded basements.
- Service Disruption Risk – High I/I could lead to neighbourhood flooding especially for customers in localized sag areas. The higher flood risk in localized sag areas is illustrated in Figure 2.0-1 below from the CSA Standard Z800-18 – Guideline on Basement Flood Protection and Risk Reduction. The figure illustrated the different paths where stormwater can enter a property during a flooding event. The longer the duration that the water pools on the road surface the higher the risk that the water will access the sanitary pipes and/or foundation drains of properties without

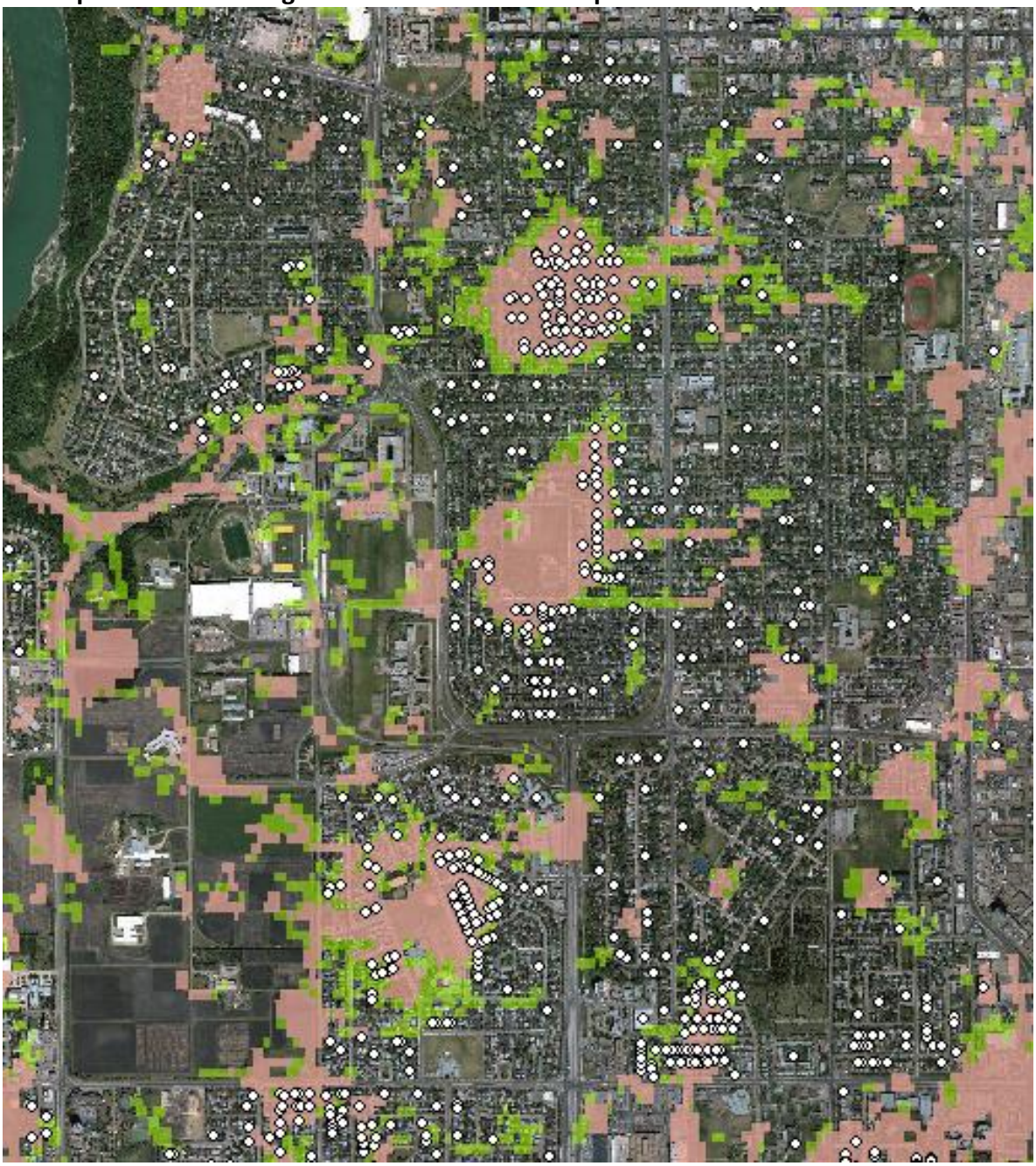
adequate flood proofing and enter the building. Hence the focus for SIRP on programs to reduce the risk of water ponding in these localized sag areas during a storm event.

Figure 2.0-1
Typical Household Connections



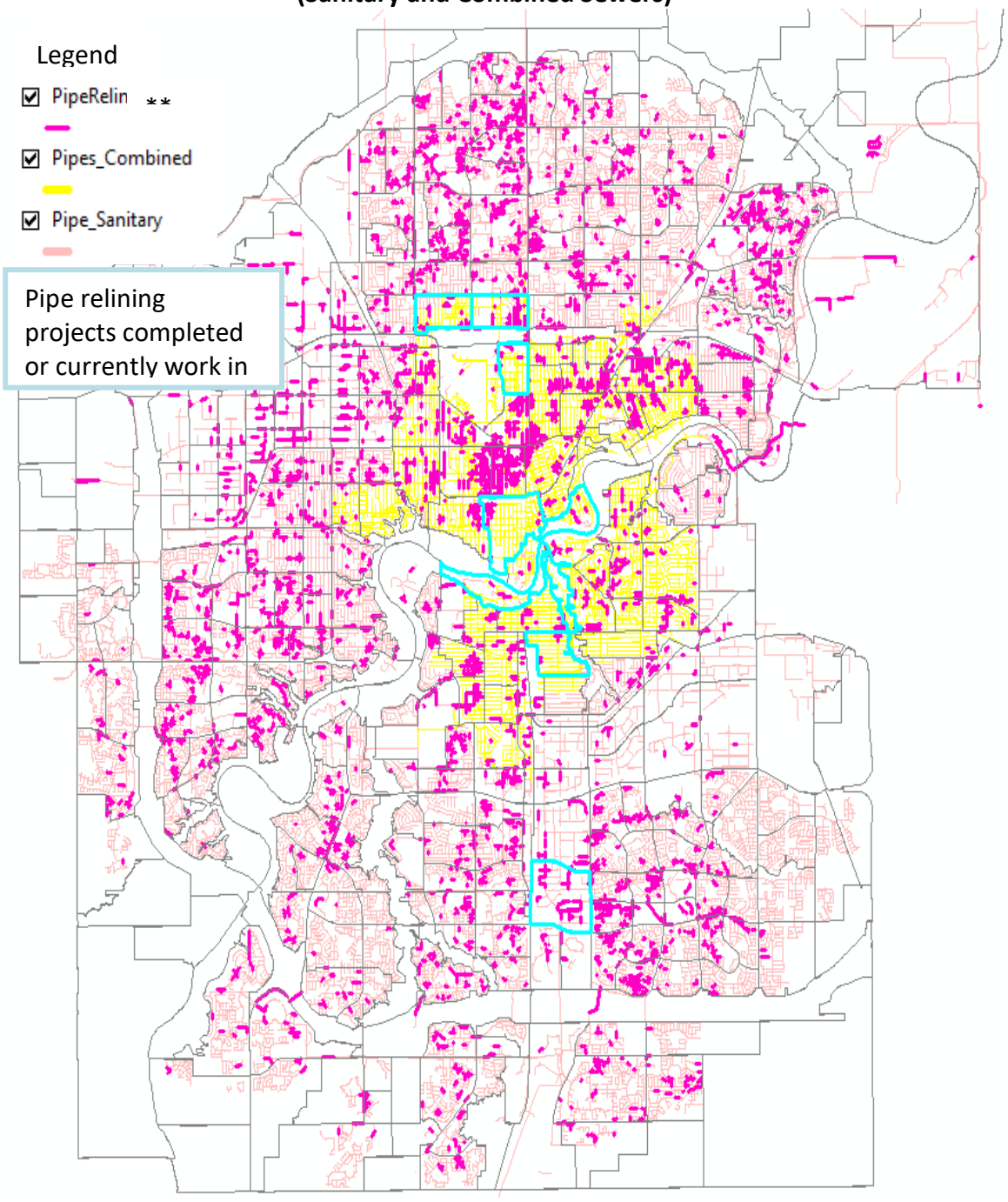
11. The higher risk of ponding to properties was evident from the risk analysis of the stormwater sub basins where water was predicted to pond on the roads after a storm event. Historical basement flooding records for Edmonton confirmed this increased risk level as shown in Figure 2.0-2. Figure 2.0-2 identifies customer calls to 311 to report flooding events (during 2003-2016) in white dots compared to the pink and green areas which represents the ponding area identified by the insurance industry pluvial flood modelling using federal topographical maps under different storm intensities. There are strong correlation of locations of predicted ponding locations with historical basement flooding records indicating I/I is a strong driver in causing basement flooding.

Figure 2.0-2
Comparison of Ponding Areas from Insurance Maps with 2003-2016 Basement Floods



12. Figure 2.0-3 below provides a map of all of the identified proactive pipe relining projects within the city of Edmonton.

Figure 2.0-3
Map of Proactive Pipe Relining Projects
(Sanitary and Combined Sewers)



** for surface ponding greater than 0.3m and pipe diameters equal or less than 750mm.

3.0 PROGRAM DESCRIPTION

13. The focus of this program will be on the selected neighborhoods that are not currently included on the Drainage and City's neighbourhood renewal list within the next 5 to 10 years. Areas are selected according to the SIRP risk ranking and located at low lying areas with surface ponding of greater than 0.3 m. The SIRP risk ranking is developed based on a combination of risk levels from 4 different areas: Health and Safety, Environmental, Financial and Social. Each storm sub-area is assigned one of the 8 risk groups (A to H) under 4 risk levels (High, Medium High, Medium, Medium Low to Low). EWSI plans to complete relining of 60 km of sanitary and combined sewer pipes with diameters of equal or less than 750 mm with observed I/I defects (assuming 2,550 metres needing open cut repair first) under this program for the 2022-2024 PBR term. In addition, EWSI plans to complete 6 km of service line relining under this program for the 2022-2024 PBR term.

14. The scope of this program for 2022-2024 includes:

- review existing CCTV inspection reports of sanitary and combined pipes in low lying areas to confirm the suitability for relining. This process is required to identify if open cut repairs are required prior to relining due to structural damage of the pipe section;
- clean all pipes and carry out CCTV inspections to identify any structural damage, if needed, prior to relining ;
- repair severe structural defects prior to relining if needed (an estimate of 2,550 m of point repairs by open cut for 2022-2024);
- reline an estimate of 60 km of sanitary and combined pipes with diameters of equal or less than 750 mm at low lying areas with surface ponding of greater than 0.3 m;
- reline service line as needed up to the property line (an estimate of 6 km of service lines for 2022-2024);
- temporary bypass pumping during relining of the pipes; and
- restore all service connections.

15. Table 3.0-1 provides a summary of the criteria and rationale used to determine which projects are eligible for inclusion under the Proactive Pipe Relining Program.

Table 3.0-1
Criteria for inclusion in the Proactive Pipe Relining Program

	Criteria	A Rationale
1	Any SIRP sub basin identified as at risk of sewer backup and basement flooding	Reduce risk of sewer back up and basement flooding
2	Not included in the current Drainage and City's neighbourhood renewal list	Supplement to the neighbourhood renewal program
3	Identified sag location	Location of water ponding contributing to I/I in the sub basin
4	Sanitary and combined sewers	Reduce I/I in the sanitary and combined system to reduce risk of system overloading, sewer back up and basement flooding
5	Site selection in conjunction with the proactive manhole relining in ponding areas as much as possible	It could reduce site set up cost

16. Manhole relining and lateral connections relining are out of scope for this program as this work is included in other EWSI capital programs. This program is a supplement to the current Neighbourhood Renewal Program. Similar projects will be coordinated with the Neighbourhood Renewal Program in future years. Relining options will be identified and assessed through the design stage of the program.

17. Advanced notification will be provided to all impacted customers of the proposed construction work. The service connections in the relined sewer pipes will be immediately restored once the curing process is complete. There are no planned abandonments or retirements for this project.

18. This is an annual program to reline sewer within the ponding areas. The program is targeting the relining of about 20 km of sewer pipes each year (total 60 km in 3 years). The delivery method has been divided into four stages as shown below, including tasks to be completed by internal resource and external contractors. This project will be delivered by a design bid build method.

19. The delivery method has been divided into four stages:

- Initial Review and Checking: Database review, previous rehabilitation works, pipe sizes, depth, abandonment, etc. This will be completed by in-house resources.
- Condition Assessment: Review existing CCTV inspection reports, and carry out new CCTV inspections, if needed, to confirm the suitability for relining. This can be completed by in-house resources or external contractors.

- Pipe Rehabilitation: Up to 20% of the selected pipes may require repairs based on CCTV investigation. The work will be contracted out to external resources. EWSI does not currently have the equipment and expertise in relining to rehabilitate sewer pipe within the projected schedule.
- Pipe Relining: Preparation of drawings will be done in-house, relining works will be contracted out to external resources.

20. Table 3.0-2 below provides the schedule for the Proactive Pipe Relining Program.

Table 3.0-2
Proactive Pipe Relining Program Schedule
2022-2024

	Project Phases	A 2020 2021	B 2022 Q1/2	C 2022 Q3/4	D 2023 Q1/2	E 2023 Q3/4	F 2024 Q1/2	G 2024 Q3/4	H 2025 Q1/2	I 2025 Q3/4
1	Initiation/Approvals	X								
2	Preliminary Design		X		X		X			
3	Detail Design		X	X	X	X	X	X		
4	Procurement			X		X		X		
5	Construction			X	X	X	X	X	X	X
6	Commissioning					X		X		X
7	Close-out					X		X		X

4.0 ALTERNATIVES ANALYSIS

21. A do-nothing alternative was considered for this project. Not pursuing I/I reduction poses a risk of continued flooding to the impacted residents. Significant I/I defects could also lead to failure of the sewers, resulting in a significant service disruption to customers. Unplanned emergency repairs also tend to be more costly than a planned approach.

22. Another construction alternative is to install new pipe and replace the existing sewer with an equal or larger diameter pipe. In general, installing new pipe is more costly than relining and new installation may not be effective in preventing I/I. For example, the unit cost for relining a 600 mm diameter pipe is about $500/m, and the unit cost for installing a new 600 mm diameter pipe is about $7,500/m. Therefore, in this example, the unit cost for new pipe installation is about 15 times (or 1500%) higher than the relining works.

5.0 COST FORECAST

23. Project costs are estimated based on previous projects of similar types such as the 2020-2021 Proactive Pipe Relining- Sanitary and Combined Project. EWSI compared various

relining materials prior to the implementation of the Proactive Manhole Relining Program. The comparison included product costs, specifications, especially on the service life and durability. Only those products approved by EWSI's operational team were selected for this annual program. The cost estimate provided in this program is based on the actual spending on similar relining works completed in previous projects, scheduling of major works in each program by phases and optimization of internal and external resources. Table 5.0-1 provides the capital expenditure forecast for this program for the 2022-2024 PBR term.

24. The program cost breakdown estimates were developed based on the EWSI's unit prices and also:

- Contractor costs are based on historical data from similar projects done in the past. Majority of works will be done for standard circular shape pipes and large variations of cost are not expected for these annual programs.
- In-house hours are based on historical data from previous similar projects.

Table 5.0-1
Proactive Pipe Relining Program
Capital Expenditure Forecast
2022-2024
($ millions)

		A **2022**	B **2023**	C **2024**	D **Total**
	Direct Costs				
1	Contractors	6.84	6.98	7.12	20.94
2	Internal Labour	0.45	0.46	0.47	1.38
3	Vehicles and Equipment	0.11	0.12	0.12	0.35
4	**Sub-total Direct Costs**	**7.41**	**7.56**	**7.71**	**22.67**
5	Indirect Costs	0.08	0.08	0.08	0.24
6	**Total Capital Expenditures**	**7.49**	**7.64**	**7.79**	**22.91**

25. EWSI takes a number of steps to minimize the level of these capital expenditures. These include:

- All activities related to project management, design, drafting, construction coordination and inspection, and as-built recording will be undertaken internally by EWSI, eliminating the need for external consultants. The actual construction, including surface restoration, will be completed by one of EWSI's long term construction contractors.

- Contracted services are performed by pre-qualified external contractors and done on a competitive unit priced basis, using comprehensive engineering packages to ensure cost and scope control.
- The installations will be consistent with EWSI's construction standards which will minimize stock requirements and speed up design and construction.
- Where possible, work will be coordinated with other projects or maintenance activities to minimize costs.
- Every project scope is evaluated to improve economy of scale and to eliminate future throw-away of infrastructure.
- All force accounts are documented and reviewed by several EWSI representatives to ensure the additional cost is justified under the terms of the contract.

6.0 RISKS AND MITIGATION PLANS

26. Table 6.0-1 provides a summary of the key risks associated with executing this program and EWSI's plans to mitigate.

Table 6.0-1
Key Risks and Risk Mitigations

	Risk	A Mitigation Plan
1	Health and Safety – High I/I can cause flooding and sewer backup which pose as a drowning and health risk to residents.	Proactive pipe relining will reduce the amount of I/I and the associated risk of flooding and sewer backup.
2	Environmental - High I/I can cause flooding and sewer backup which can release untreated sewage into the environment and violate the Approval-to-Operate.	Proactive pipe relining in the high risk areas will reduce the amount of I/I and the associated risk of flooding and sewer backup.
3	Execution Risk - Working in confined space without proper equipment, training, or permit results in injuries and potential fine from Occupational Health and Safety.	EWSI will ensure contractors meet EPCOR safety standards and that contractors provide and follow all work safety plans including emergency response and rescue plan.
4	Financial - Liner not properly cured resulting in rework and extra cost to the project.	EWSI will require contractors to submit the quality assurance/quality control plan including curing and temperature duration, confirm types of curing using and add clause for contractor to include monitoring for curing time and temperature
5	Customer Impacts - Risk of odour release through opening manholes during relining operations.	EWSI will use non-odour releasing products, continuously monitor odour and assess the area during construction. EWSI will ensure coordination so the manhole are not opened for extended periods of time.

Appendix H18

EPCOR WATER SERVICES INC.

Drainage Services
Small Trunk Rehabilitation Program
Business Case

February 16, 2021

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1.0 OVERVIEW

1. The Small Trunk Rehabilitation Program focuses on rehabilitating small trunks ranging in diameter from 600 mm to less than 1200 mm. They are gravity fed and are used to convey flow from local drainage pipes to larger trunks throughout the system. In the City of Edmonton's drainage system, there are 1,261 km of small trunks (storm, sanitary and combined), of which approximately 66 km are rated as being in poor and very poor condition.

2. Failure of a small trunk may lead to health and safety risks to the public associated with subsidence on roadways. Environmental risks include potential sewage spills into the local environment, including rivers, creeks, and stormwater management facilities. Failure of small trunks can also disrupt large service areas impacting many customers and cause sewer back up into customer's basements. When a small trunk fails, EWSI must complete emergency repairs, which cost more and are more disruptive to traffic and the public than proactive rehabilitation.

3. The Small Trunk Rehabilitation Program is a program that focuses on rehabilitation (relining or replacement) of damaged and failed small trunks to mitigate these risks. Under this program, small trunks are inspected and ranked in terms of condition and risk ranking to prioritize their rehabilitation. The Small Trunk Rehabilitation Program is a new program initiated in the 2022-2024 PBR term to address risk of failure of small trunks. Previously, small trunk rehabilitation was combined with large trunk rehabilitation or completed on a reactive basis through standalone projects. Small trunks have been separated out as they are a separate asset class where the process for inspections, the type of rehabilitation and the methods of construction differ from large trunks. Initiating a program for small trunk rehabilitation will allow for systematic and proactive upgrades to these assets based on risk so that EWSI can rehabilitate before a major failure occurs.

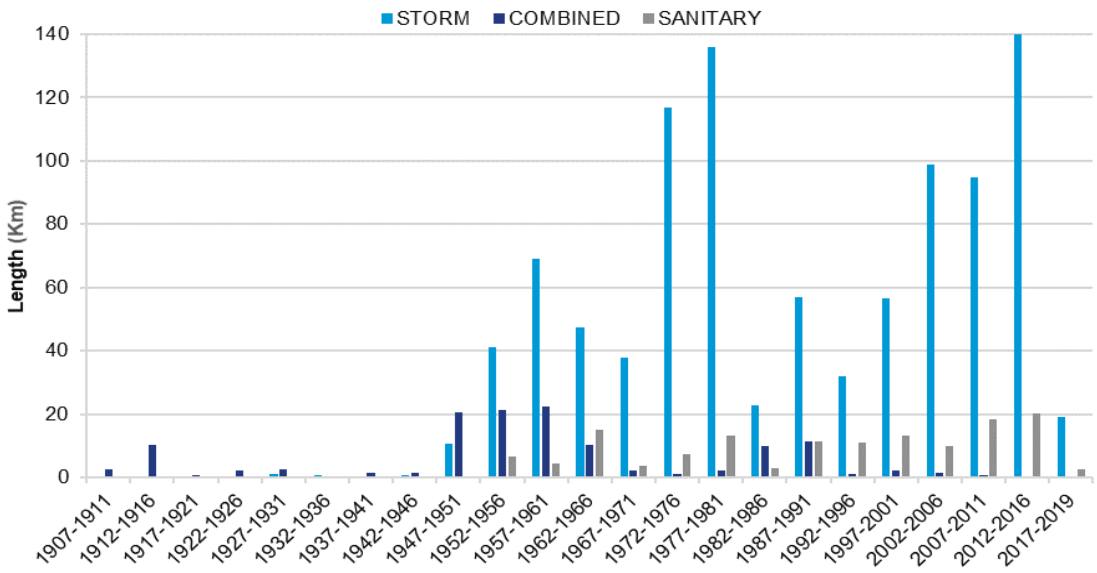
4. During the 2022-2024 PBR term, EWSI expects to complete approximately 10 km of inspections, 5 km of trunk relining and 400 m of small trunks replacement within the Small Trunk Rehabilitation Program. The inspections will focus on the areas which EWSI plans to complete rehabilitation. To ensure the most efficient use of funds within this program, EWSI aims to complete relining where possible as it is far less costly at approximately $3,000 per meter compared to open cut replacements for spot repairs which average $5,000 per meter. However, replacement is required when the pipe has deteriorated so much that it has sags, localized failures, or collapsed. This program is categorized as reliability and life cycle replacement and is

one of the Drainage System Rehabilitation programs. EWSI has forecast $18.8 million capital expenditures for this program during the 2022-2024 period.

2.0 BACKGROUND/JUSTIFICATION

5. The Small Trunk Rehabilitation Program focuses on the rehabilitation of small trunks ranging in diameter from 600 mm to less than 1200 mm. They are gravity fed and are used to convey flow from local drainage pipes to larger trunks throughout the system. Small trunks also include pipes on the trestles across the city. In the City of Edmonton drainage system, there are 1,261 km of small trunks (storm, sanitary and combined) constructed over the past 100 years to varying standards and specifications. Figure 2.0-1 below shows the year of construction for small trunks, indicating that the majority were constructed since the 1950s. The average age of small trunks is 35 years. The useful life for small trunks is dependent on waste type, pipe material and other factors. In general, it is expected to be 75 years for combined and storm pipes, and 60 years for sanitary pipes.

Figure 2.0-1
Small Trunks
Year of Construction



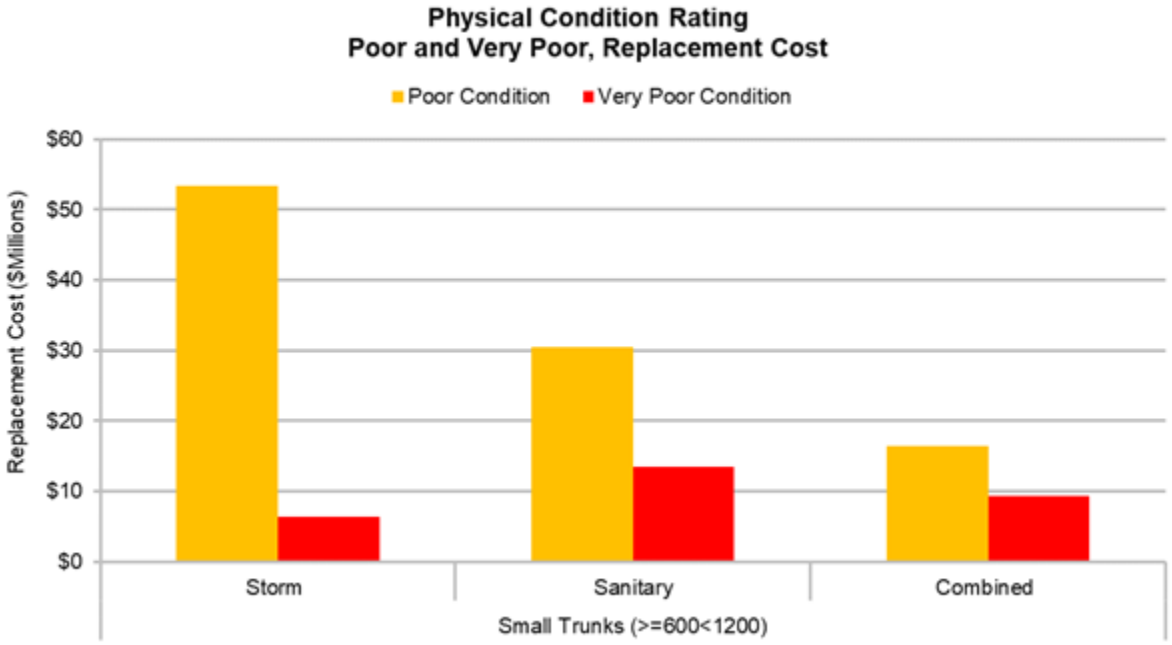
6. As the system ages, the risk of failure and collapse of these small trunks will increase. There is currently about 66 km of small trunks rated as being in poor and very poor condition. The definition of poor and very poor condition is as follows:

- Poor condition – major deterioration evident, extensive ongoing maintenance and/or operational "prop up" actions are required to keep the element operational; and

- Very Poor Condition – element deteriorated to such an extent that it is generally inoperable or unsafe, history of failures, immediate need to replace most or all of the element.

7. As of 2019, assets within the poor and very poor categories have an estimated replacement cost of $130 million, representing approximately 66 km of small trunks within the City of Edmonton. The chart shown in Figure 2.0-2 indicates the replacement value of storm, sanitary and combined small trunk infrastructure in poor and very poor physical condition, based on a system-wide deterioration model. Rehabilitation and replacements that are completed through renewal will positively affect the condition ratings and, therefore, reduce the number of poor and very poor condition trunks.

Figure 2.0-2
Small Trunks Physical Condition Rating



8. EWSI uses a risk-based approach to target the highest risk assets first for rehabilitation. As with other critical asset types, small trunks are prioritized based on risk. There are several risks associated with the deterioration and failure of small trunks:

- Health and Safety Risk – failure of a small trunk could cause a subsidence on roadways which poses a safety risk to the public, as shown in Figure 2.0-3 below. The release of hydrogen sulfide gas (H_2S) can also be a risk when working on sanitary or combined pipes. Over the past few years, we have at least 4 significant failures in the small trunk

system including the Lauderdale combined trunk, the trestle in Clareview Sanitary System, the trestle at Whitemud Creek and the sanitary trunk at Calder.

Figure 2.0-3
Image of Roadway Subsidence

- Environmental Risk – Failure of a sanitary or combined small trunk could cause a sewage spill to the local environment or water bodies.
- Customer Disruption Risk – Failure of small trunks can cause disruption to large service areas impacting many customers, and can also cause sewer back up into customer's basements. Failed trunks also lead to emergency repairs, which are more disruptive to high traffic roadways and therefore to the public.
- Financial Risk – Emergency repairs of failed small trunks are more costly than proactive rehabilitation. Typically an emergency repair will require more open cut replacement, which is more expensive than relining. By doing the rehabilitation work proactively through relining there are significant cost savings. As an example, the Lauderdale project was estimated to cost $7.5 million for emergency repairs due to severe deterioration, bypass requirements roadway restoration. Whereas relining of a small trunk project of this size could be completed for about $3 million.

9. As the small trunks age, it is important to prioritize inspections and renewals to deal with structural condition issues and mitigate the risks identified above. The Small Trunk Rehabilitation Program aims to improve the conditions of the asset, which will, therefore, reduce the risk of failure for these assets. This program supports EWSI's asset management objectives by

identifying emerging asset risks through inspections and managing them appropriately, reducing risk exposure. Since much of the pipe material is concrete, several failure modes and defects would require attention, such as wall loss due to corrosion, joint separation, fractures, breaks and holes. Figure 2.0-4 below shows some typical deterioration found within small trunks such as visible steel reinforcement, corrosion, concrete wall loss, and a PVC material change which may indicate a past failure.

Figure 2.0-4
Deterioration of Small Trunks

10. Over the last 25 years, the amount of fully rehabilitated small trunks from manhole (MH) to MH is represented in Table 2.0-1 below. Relining can be done when the pipe has deteriorated but is still structurally intact. Replacement is required when the pipe has deteriorated so much that it has sags, localized failures, or collapsed. Typically, relining would be the full pipe from MH to MH. Open cut replacement is often just a spot repair. Relining is less costly at $3,000/m versus open cut averaging about $5,000/m.

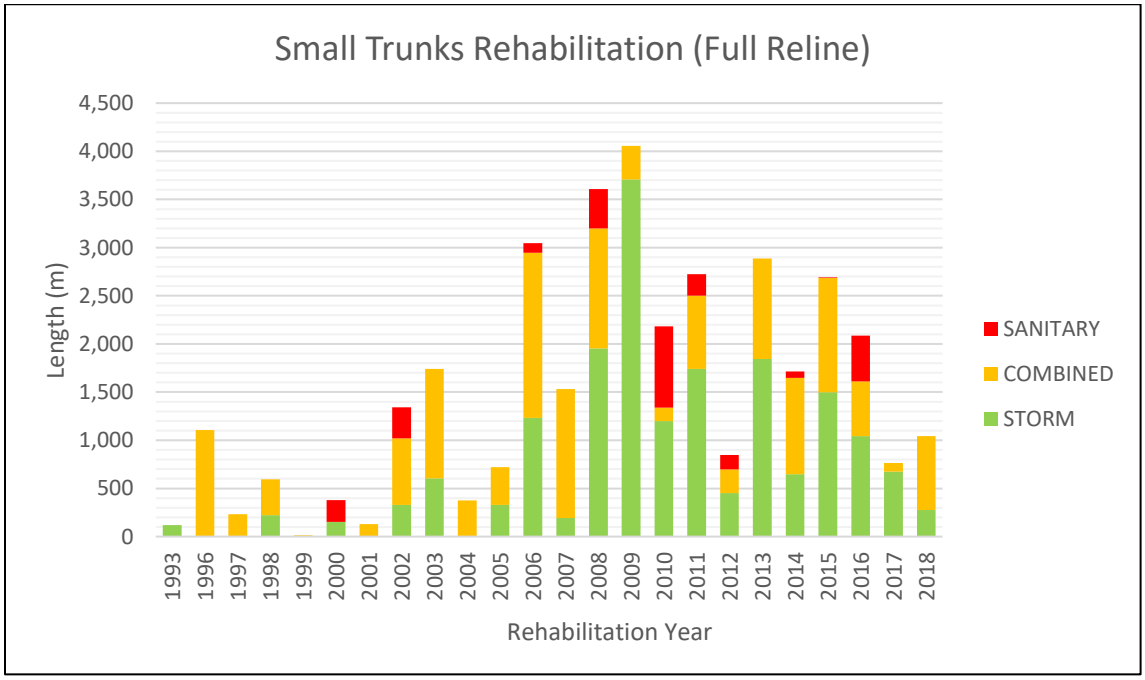
Combined pipes have the highest percentage of rehabilitation versus total length per waste type, but overall only 2.85% of the total small trunks have been rehabilitated, as summarized in Table 2.0-1. On average, 1.5 km of small trunks have been fully relined each year. Higher amount years (2006-2011) have been in the range of 2 to 4 km, when small trunks were the focus under the former Trunk Sewer Rehabilitation Program.

Table 2.0-1
Historical Small Trunks Rehabilitation
(1993-2018)

	Type	A Total Length (km)	B Full Reline (km)	C Average Age at Reline	D % of Total
1	Storm	992	18.2	50	1.8%
2	Combined	129	14.9	64	11.6%
3	Sanitary	140	2.8	46	2.0%
4	**Total**	**1,261**	**36**	**-**	**2.9%**

11. Historical small trunk rehabilitation is presented on an annual basis in Figure 2.0-5 below.

Figure 2.0-5
Historical Small Trunks Rehabilitation
1993-2018



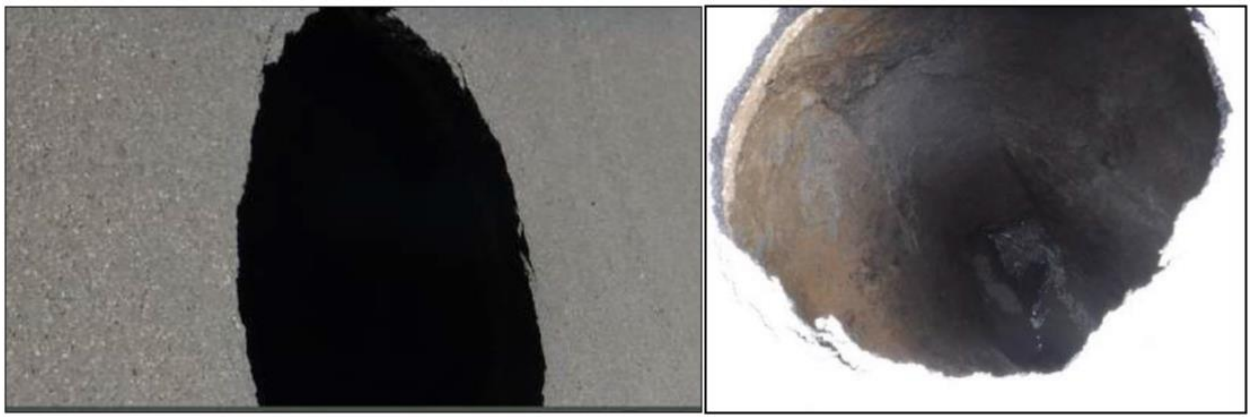
*Note: There were no records of rehabilitation in 1994 and 1995.

12. There are currently two small trunk rehabilitation projects underway that provide good examples of the type of projects, the needs, and the importance of timely assessment and implementation of corrective actions of small trunk deficiencies.

13. The Lauderdale Combined Trunk, consisting of 750 mm and 900 mm diameter reinforced concrete pipes, had a history of issues from 2014-2016, including sinkhole and spot repairs. The project was initiated in 2017, and then inspected with multi-sensor inspection (MSI) in 2018. A

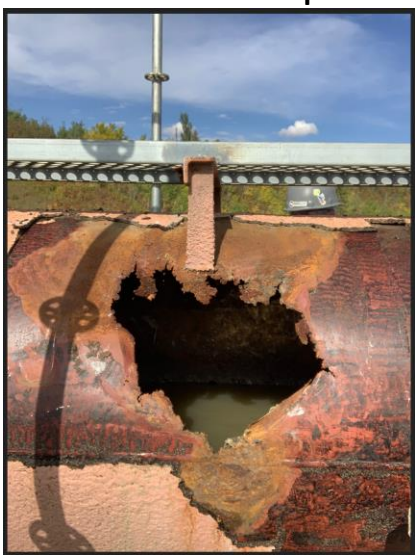
sinkhole developed in 2019 before the project could be completed. This led to an increase in scope, with project costs estimated at $7.5 million. The scope includes 770 m of reline and 50 m of replacement. Figure 2.0-6 shows the sinkhole found in Lauderdale taken from the street level.

Figure 2.0-6
Pictures of Sinkhole at Lauderdale



14. The Clareview Sanitary Trunk Rehabilitation Project includes relining of approximately 650 m of 900 mm-1,050 mm reinforced concrete, and replacement and rehabilitation of approximately 70 m of 900 mm steel pipe on Trestle No.3. This project was initially assessed in 2017 and initiated for a rehabilitation project. Replacement of the steel pipe was found to be required as the pipe is fully deteriorated, and several holes have developed. In accordance with regulatory reporting requirements, EWSI reported the condition of the trestle to Alberta Environment and Parks given the potential for untreated wastewater to spill out to the environment from these holes. Overall the project cost for the relining and trestle pipe replacement is estimated at $7 million. Figure 2.0-7 shows one of the corroded and failed sections from the steel pipe on the trestle after the protective coating was removed.

Figure 2.0-7
Failed Section from the Steel Pipe on the Trestle



15. The Small Trunk Rehabilitation Program will focus on rehabilitating small trunks rated as poor and very poor. The program will contribute to an improvement in the asset conditions and a reduction in risk. For the 2022-2024 PBR term, EWSI plans to rehabilitate 5.4 km of small trunks (storm and sanitary trunks). This would result in a direct reduction of the small trunks in poor and very poor condition by 8.2%.

16. Table 2.0-2 provides the Small Trunk Rehabilitation Program's quarterly schedule for the 2022-2024 PBR term. Initiation and approvals will be completed in late 2022 in order to start design and some construction in 2023. Construction will carry into 2024 and be completed by year-end.

Table 2.0-2
Small Trunks Rehabilitation Program Schedule
2022-2024

	Project Phases	A **2022 Q3**	B **2022 Q4**	C **2023 Q1**	D **2023 Q2**	E **2023 Q3**	F **2023 Q4**	G **2024 Q1**	H **2024 Q2**	I **2024 Q3**	J **2024 Q4**
1	Initiation/Approvals	x	x								
2	CCTV Inspections		x	x							
3	Design			x	x	x	x				
4	Procurement					x	x				
5	Construction					x	x	x	x	x	x
6	Commissioning										x
7	Close-out										x

3.0 PROGRAM DESCRIPTION

17. The scope of work for this program will include relining and replacement of small trunk sewers. Some closed-circuit televising (CCTV) inspections may also be required depending on the selected locations for renewal. CCTV will be reviewed and coded by the Inspection Assessment team based on the Pipe Assessment Certification Program (PACP) Ranking System, as shown in Table 3.0-1. PACP is the North American standard for pipe defect identification and assessment, providing standardization and consistency to the methods in which pipe conditions are identified, evaluated and managed.

Table 3.0-1
PACP/MAP Condition Grading

A		B
Grade		**Definition**
1	5	Most significant defects
2	4	Significant defects
3	3	Moderate defects
4	2	Minor to moderate defects
5	1	Minor defects

18. Over the course of the 2022-2024 PBR period, 5.4 km of small trunk sewer (including trestles) will be renewed. This estimate assumes that 5 km will be renewed through relining, and 400 m will be replaced. This work may also include rehabilitation of trestle structures if required and will also include some MH renewal. Initial plans for this program have been developed based on condition rating, past inspection and repair data, projected conditions of this asset type over time and risk assessment. The criteria for small trunk renewal is shown in Table 3.0-2.

Table 3.0-2
Selection Criteria for Small Trunk Rehabilitation

	Selection Criteria for Renewal	A Definition
1	Pipe Sizes	600 mm to less than 1,200 mm
2	Non-linear Assets	MHs, Trestle Structures
3	Drainage Asset Condition	Poor and very poor condition (modelled), likelihood of 4 and higher (EPCOR Matrix), pipes with inspections having defects of 4 or 5 severity as per PACP, MHs and Trestles with inspections assessed to be in poor or very poor condition, or known issues
4	Operational Issues	Sags, inflow/infiltration, sediment
5	Risk Level	High, Medium-High
6	Synergy with Other Projects	Coordination potential with other EPCOR projects

4.0 ALTERNATIVES ANALYSIS

19. An alternative to this program is to do nothing and not rehabilitate any small trunks. If nothing is done, the infrastructure will be at risk of eventual failure, especially the sanitary and combined trunks made of concrete and steel, as they can be subject to significant corrosion from H_2S. Failure of storm trunks may result in subsidence, blockages and flooding. Although the advantage of doing nothing may be short-term cost savings, more expensive repairs will result from emergencies and customers will experience loss of service. Due to aging and deterioration of drainage infrastructure, unexpected failures may occur that disrupt sewer services to homeowners, cause roadway subsidences, or accidental sewage releases to the ground or river. It is more expensive to fix an unexpected failure than to address it proactively. As mentioned before, typical planned relining is at $3,000/m. Unplanned emergency replacements require open cut spot replacement which averages about $5,000/m.

5.0 COST FORECAST

20. The program cost estimates for the 2022-2024 PBR term are shown in Table 5.0-1. They are based on historical information such as past inspection costs, past design costs and past construction costs of similar small trunk projects such as Lauderdale and CST, including emergency repairs that have occurred within the last few years. Assumptions for the 2022-2024 PBR term are as follows:

- 5 km of full relining completed;
- 400 m of full replacement completed;
- relining and replacement will be completed by external contractors;
- geotechnical investigations will be completed by external contractors; and

- any required inspections will be completed by internal resources.

Table 5.0-1
Small Trunk Rehabilitation Program
Capital Expenditure Forecast
2022-2024
($ millions)

		A **2022**	B **2023**	C **2024**	D **Total**
	Direct Costs:				
1	Contractors	0.06	4.24	11.10	15.40
2	Internal Labour	0.03	0.21	0.27	0.50
3	Vehicles and Equipment	0.00	0.02	0.02	0.03
4	Contingency	0.01	0.77	1.96	2.74
5	**Sub-total Direct Costs**	**0.10**	**5.23**	**13.35**	**18.68**
6	Capital Overhead and AFUDC	0.00	0.04	0.05	0.09
7	**Total Capital Expenditures**	**0.10**	**5.27**	**13.39**	**18.76**

21. EWSI takes a number of steps to minimize the level of these capital expenditures. These include:

- EWSI has taken advantage of vendors to effectively manage the supply, quality and construction of required equipment. As such, EWSI has minimized the need to stock much of the required equipment, reducing the overall costs of all installations and upgrades. Projects will be procured competitively across pre-qualified contractors.
- To ensure receiving coordinated results of adequate quality level, project management, preliminary and detailed design, drafting, stakeholder notification, construction coordination, inspection, and as-built recording will be undertaken internally by EWSI. The actual construction, including surface restoration, will be completed by one of EWSI's pre-qualified construction contractors. Environmental and geotechnical assessments will be completed externally as required.
- Contracted services are performed by pre-qualified external relining or open-cut contractors and done on a competitive unit priced basis, using comprehensive engineering packages. The procurement package also considers the requirements to protect nearby underground infrastructures, perform safe and adequate quality construction work and complete appropriate traffic accommodation strategies to ensure that cost and scope are controlled.
- The installations will be consistent with EWSI's construction standards, which will minimize stock requirements and expedite design and construction.

- Where possible, work will be coordinated with other projects or maintenance activities to minimize costs.
- Every project is evaluated individually to determine the appropriate construction method to meet requirements at the lowest cost.
- Every project scope is evaluated to improve economies of scale.
- The project manager will carefully review any change requests.

6.0 RISKS AND MITIGATION PLANS

22. Table 6.0-1 provides key risks and mitigation plans associated with this program.

Table 6.0-1
Key Risks and Risk Mitigations

	Risk	A Mitigation Plan
1	Execution Risks – Utility conflicts, unexpected scope increases, bad soil conditions, new road restoration requirements, and conflicts with other construction projects in the area.	EWSI will circulate all projects through the Utility Line Application (authorization for utility installations within public road right of way) system. EWSI will deal with force accounts (additional work not within the original scope in the contract) on an individual basis and ensure inspectors are recording all delays and force accounts.
2	Financial – Potential trunk failure could result in more costly emergency replacement. Increase to overall construction prices based on market conditions.	This program will reduce the risks of trunk failure and the associated emergency replacement costs. EWSI will include contractors early on in the process, clearly identify scope requirements and evaluate options such as bundling multiple project scope or using a design-build approach when efficiencies can be identified.
3	Health and Safety – Failed small trunks could result in sinkholes on busy roadways and a safety risk to pedestrians and motorists. Failed trestle pipes could result in collapse above public trails and result in danger to the public	This program will reduce the risks of small trunk failures and the associated occurrence of sinkholes or trestle pipe collapse.
4	Environment – Failed small trunks can allow the release of untreated sewage into the environment which violates the Approval-to-Operate.	This program will reduce the risks of small trunk failures and the associated environmental risks.