



Appendix I1

EPCOR WATER SERVICES INC.

SIRP Strategy

February 16, 2021

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Stormwater Integrated Resource Plan (SIRP) Strategy Summary

1.0 INTRODUCTION

1. EWSI's Stormwater Integrated Resource Plan (SIRP), presented to the City of Edmonton Utility Committee and City Council in 2019, is a \$1.6 billion system wide integrated approach which will be completed over the next 20 to 30 years to mitigate flood risk by reducing the health and safety, financial and social risks of flooding with lower overall capital investment than compared to traditional engineering approaches, through the incorporation of green infrastructure and operational programs that support building community resiliency and leveraging advanced technologies to better manage stormwater volumes during storm events. In addition to \$1.6 billion in capital expenditures, annual operating costs for SIRP include an average of \$2.2 million per year for EWSI's operational activities plus the backwater valve subsidies which are forecast to increase over a 20 year period from approximately \$0.8 million per year to \$1.76 million per year. The SIRP program proposed through the SIRP can be classified into the following five themes of investment: (i) SLOW; (ii) MOVE; (iii) SECURE; (iv) PREDICT; and (v) RESPOND.

2. Implementation of SIRP began in 2019 and since that time has been funded by the SIRP Non-Routine-Adjustment (NRA) to stormwater rates that was approved by City Council and became effective January 1, 2020. EWSI is proposing to continue to implement SIRP in stages at each successive PBR period. This approach will provide Utility Committee and City Council with the opportunity to review the SIRP performance and proposed strategy at the time of each PBR renewal.

3. EWSI's SIRP Strategy includes the proposed capital and operational program investments to mitigate flood risks across the city of Edmonton by using a mix of grey (SIRP – MOVE trunks and tunnels) and green (SIRP – SLOW dry ponds and low impact development (LID)) infrastructure installed both in public right-of-way or on City-owned or EPCOR-owned land. The SIRP approach is to capture the stormwater volumes in dry ponds prior to reaching the storm trunk network to provide additional capacity in the pipes in the immediate path of the storm. The addition of LID throughout the catchment area will further retain these volumes and reduce the impact on the entire pipe network as storms travel across the community. The SIRP Strategy does include tunnels, trunks and sewer separation in locations where there is limited space to install additional ponds or LID components to fully capture the expected water volumes during a major storm event.

4. Due to the topography of the urban environment there exists numerous low or sag locations throughout the city of Edmonton. The SIRP Strategy prioritizes investment in low-lying sag locations because there is potential for water to pool in these areas during major storm events. The objective is to redirect stormwater to dry ponds and LID in order to reduce peak flows to the stormwater system. Under the SECURE theme, SIRP will rehabilitate the grey infrastructure in these sag locations to reduce inflow and infiltration and includes an enhanced building flood proofing program for the properties adjacent to these localized sag areas to further protect the property from damage. The SECURE theme also includes improvements to the existing outfalls and control gates to secure the pipe network and properties from river flooding during high water level events. The PREDICT theme includes adding monitoring and real time controls to transition the entire stormwater system (including both pipes and ponds) into a “smart” system. This will aid in improving response times to major storm events and will allow for real time management of flow volumes between adjacent stormwater retention locations. Finally, the RESPOND theme includes the development of emergency response stations located throughout the city. These stations will be outfitted with emergency response equipment such as portable flood barriers, pumps and hoses to allow for efficient deployment during a major flooding event.

5. Table 1.0-1 provides a summary of the proposed capital expenditures within the 2022-2024 PBR term under each of these themes. Business cases have been provided as well for the specific projects/programs that support the SIRP Strategy that have a total expenditure at the project/program level greater than \$10 million. For details on these SIRP programs over \$10 million, refer to the Drainage Business Cases in Appendices H14, H15, H16, and H17.

Table 1.0-1
SIRP Projects/Programs Capital Expenditures (2019-2024)
(\$ millions)

Theme	A Project/Program	B 2019	C 2020	D 2021	E 2022	F 2023	G 2024	H 2022-2024 PBR Total	
1	SIRP Dry Pond Program ¹	0.4	8.5	3.0	15.8	18.1	26.5	60.4	
2	SLOW	SIRP LID Program	0.1	3.7	6.5	7.8	15.8	53.1	
3		Other projects < \$10 million	0.9	2.5	7.1	6.6	0.9	1.2	8.7
4	MOVE	Kinnaird Sewer Separation	0.2	2.3	10.2	4.1	0.0	0.0	4.1
5		Other projects < \$10 million	0.2	1.7	0.0	0.0	0.0	0.0	0.0
6	SECURE	SIRP Proactive Manhole Relining Program	0.0	1.4	7.0	6.1	6.2	6.4	18.7
7		SIRP Proactive Pipe Relining Program	0.5	0.9	5.2	7.5	7.6	7.8	22.9
8		Outfall and Control Gates Program	0.0	0.0	0.1	2.0	3.4	4.1	9.5
9		Other projects < \$10 million	0.0	0.0	0.0	0.0	3.5	3.6	7.2
10	PREDICT	Other projects < \$10 million	0.0	0.3	1.5	2.2	3.1	3.3	8.6
11	RESPOND	Other projects < \$10 million	0.2	0.4	1.7	3.9	4.2	4.3	12.4
12	Total		2.5	21.7	42.3	56.0	62.8	86.7	205.6

¹Included within SIRP Dry Pond is approximately \$38.3m for investment in drainage pipes that aligns with the SIRP MOVE theme (with \$4.6M over the 2019-2021 period)

2.0 SLOW

6. One of the larger investment categories of the SIRP strategy is the “SLOW” theme. The slow theme involves slowing the entry of stormwater into the drainage network by absorbing it in green infrastructure and holding it in ponds, creating space in the collection system during storm events. Green infrastructure includes both dry ponds and LID. Dry ponds are designed to capture the large intensity rainfall events and hold the water within the neighbourhood until after the storm event has ended and then slowly release the water into the adjacent trunk networks. LID installations are designed to capture the lower intensity stormwater volumes that occur around the periphery of the large storm and have the ability to capture, absorb, slow and filter stormwater before it flows into the sewer system, groundwater or surface waters. LID installations also provide water quality enhancement for the primary storm events that do occur throughout the year helping EPCOR to meet the environmental regulations surrounding discharges to the rivers and creeks in Edmonton. The slow theme is the largest area of investment and is estimated to include \$470 million in dry ponds and \$480 million in LID over the 20-year SIRP plan.

SIRP Dry Ponds Program

7. EWSI has identified 31 locations across the city where dry ponds should be considered to support flood mitigation in a community. The final siting, sizing and design will be part of a coordinated discussion between EWSI and the City and working closely with local communities. EWSI has developed the dry pond schedule over the next 20 years assuming that typically there will be 6 active pond projects per year (2 in planning, 2 in design and 2 in construction). This timing aligns with the recently approved Federal Government Disaster Mitigation and Adaptation Fund (DMAF) grant of \$44 million supporting construction of 13 dry ponds over the next 10 years.

SIRP Low Impact Development (LID) Program

8. SIRP includes wide scale implementation of LID throughout the entire city to reduce the peak stormwater flows that are entering the storm pipe network and pooling at low areas on the city streets. A feasibility study identified over 80,000 potential locations where LID could be installed to control stormwater runoff. EWSI plans to implement four types of LID: bioretention basins, box planters, rain gardens and tree soil cells. LID has the ability to support the capture, detention and retention of large stormwater events. In 2020, EWSI added the Greened Hectare as a new PBR performance metric and target to measure its performance in implementing LID. An increase in LID through the City of Edmonton will also result in improved performance on the total loadings to the river and the combined sewer overflow reduction strategies. LID has also been shown to reduce the impacts of drought and heat wave, two other climate scenarios that Edmonton will be required to adapt to in the coming years.

3.0 MOVE

9. The move theme involves moving excess water away from areas at risk, quickly and efficiently through both stormwater tunnels, trunks and sewer separation. The SIRP proposed investment in tunnels, trunks and sewer separation is estimated at \$300 million over 20 years. The proposed capital investment in tunnels, trunks and sewer separation was developed by first assessing the flood mitigation that would be obtained by investing in dry ponds and LID as an initial option in the communities at higher risk of flooding. Depending on the volumes of water to be managed over the range of storm scenarios and volumes of water that could be diverted to either a dry pond or LID in the neighbourhood, this determined the residual amount of water that needed to be managed using a piped network solution of tunnels, trunks and sewer separation. For the 2022 to 2024 PBR term, the infrastructure investments identified in the SIRP-

MOVE theme are aligned with the SIRP-SLOW initiatives and captured in the SIRP Dry Pond and SIRP LID Program business cases.

4.0 SECURE

10. There are three components to the SECURE theme: (i) addition of outfalls and control gates and improvements to existing gates; (ii) reduction of inflow and infiltration (I&I); and (iii) an enhanced building flood-proofing program to protect individual properties in higher risk areas against sewer backups. The SIRP Strategy includes a \$30 million investment in outfalls and control gates, a \$100 million investment in I&I reductions and a \$60 million investment in enhanced flood proofing over the 20-30 year period. EWSI is also expanding the backwater valve subsidy program increase to support the targeted installation of an additional 40,000 backwater valves in homes immediately adjacent to localized sag areas where stormwater will continue to pool due to the topography of the city. EWSI will continue to invest in the Backwater Valve Subsidy Program with a subsidy amount of \$800 per property for backwater valve installation for eligible properties. This program has been supported by the utility since 2004 and is consistent with programs offered in other communities across Canada.

Outfalls and Control Gates Program

11. Additional control gates will be added to existing outfalls located within the river valley to provide additional protection to the residential homes located within these areas from river water backing up through the pipe network. EWSI will initially focus on the conversion of existing gates from manual to automatic controls which will improve response time to close the gates prior to a flooding event and open gates once the river levels have receded. EWSI is planning to install the proposed automatic controls and new outfalls over the next 12 years due to the higher damage risk exposure for river valley neighbourhoods. Exact timing for installation of the new gates will be dependent on obtaining the necessary regulatory approvals for construction and completion of the archaeological assessments and indigenous consultations required when constructing within the River Valley. Some outfall control gates will be partially funded by Federal DMAF grant programs.

Inflow and Infiltration (I&I) Reductions

12. I&I occurs when inflow flood waters enter the piped network either through openings in manhole lids or through cracks in the manhole frames and in the pipe network when the soils are fully saturated. Minor leaks on these pipes can induce a high volume of infiltration into the pipe

network when the soils are fully saturated with water. SIRP includes implementation of increased maintenance and repair on drainage infrastructure that is at higher risk of exposure to flooding in numerous sag locations along the road network. EWSI plans to invest \$2 million per year to upgrade 500 manholes per year in local sag areas over the next 10 years. These upgrades include sealing manhole barrels, installing new manhole covers and completing drainage pipe rehabilitation to reduce I&I. The longer term approach to manage and reduce the stormwater pooling in these locations is addressed in the capital investments in dry ponds, tunnels and sewer separation and LID elements being proposed. The manhole sealing is a method to bring partial risk reduction over a shorter time frame. The SIRP Proactive Manhole Relining Program and SIRP Proactive Pipe Relining Program documents provide additional detail on the planned implementation of this aspect of SIRP-SECURE for the 2022-2024 PBR term.

Enhanced Building and Flood Proofing Program

13. EWSI's analysis of the localized sag areas with higher flooding risk has identified that there are approximately 6,000 properties (including 2,500 in the river valley neighbourhoods) that have a higher flooding risk due to being adjacent to areas where the water in the road could pool at depths above the 1 meter depth during an extreme storm event. There are an additional 40,000 properties with a mid-high exposure risk where ponding in the road network could be between 0.35 and 1 meter depth during these extreme events. The dry ponds, LID and tunnels, trunks and sewer separation projects proposed will reduce the flooding depths at these locations. However it will take many years to install all of these flood mitigation components under the SIRP Strategy. Even with all of the planned flood mitigation efforts under SIRP, these homes will continue to have flood risk exposure from storms due to the topography of the land adjacent to these homes. Therefore, EWSI is providing capital and operational funding to support and encourage flood proofing on private property as the least cost approach to reduce flooding risks in the short term for these high risk locations.

14. As part of the SIRP Strategy, the Enhanced Building Flood Proofing Program will be available to residential, multifamily and commercial properties in the higher risk locations. This program provides both funding expertise beyond what is provided by the existing residential backwater subsidy program to assist property owners in identifying flooding risk on their property. Under SIRP, \$60 million will be invested over 20 years for the Enhanced Building and Flood Proofing Program to support correction of lot grading on public-owned portion of the parcel and repairs to public-owned portion of drainage service lines in conjunction with the property owner implementing these improvements on the privately-owned portion of the service

line. Properties with reverse driveways in higher risk flood locations will also have outreach to determine reconfigurations required to reduce exposure to damages during flooding events. This is based on an estimated \$10,000 per property for improvements made on the publicly owned portions of the drainage system for the highest risk locations (6,000 properties). Individual property owners would be required to fund any additional improvements required on the privately-owned portion of their parcel or service line.

5.0 PREDICT

15. Under the predict theme, EWSI will predict and manage the movement of stormwater through implementation of smart sensors and technologies that integrate into the collection system. EWSI estimates total investment in \$70 million in monitoring and controls under SIRP over 20 years. The SIRP Strategy includes the conversion of the existing stormwater pipe and pond network into a smart network with increase situational awareness of real time storm tracking and ability to respond to major storm events through the diversion of stormwater where the controls exist. Leading utilities are now implementing systems that allow the stormwater network to respond in real time to changing weather events. The capital plan for SIRP includes the installation of permanent early warning systems at 20 locations identified as being at higher risk of flooding with depths where there is a higher risk to public safety. EWSI is working with City of Edmonton Roadways Operations to finalize the designs and timing for installation for each of these locations. EWSI is implementing a SIRP Dashboard in 2021 to integrate the current multiple monitoring and control systems in place with the GIS tools. This tool will also be set up to incorporate the addition of real time data from third party sensors, such as weather radar stations and will allow for additional sensors throughout the network on pipes, ponds and underground storage locations to increase ability to respond to flooding events in real time.

6.0 RESPOND

16. The respond theme will enable EWSI to effectively respond to flood events through fast rollout of flood barriers, traffic diversions, and public communications to protect life, safety and property. EWSI and the City of Edmonton Emergency Management group currently have in place formalized protocols for response to flooding events which were developed in 2009. The Office of Emergency Management takes the lead role in the flooding event response and EWSI provides support through the deployment of personnel and temporary barriers (sand bags) to control water volumes. The SIRP Strategy includes a \$45 million investment over 10 years to modernize

emergency response equipment to ensure effective response to flooding events at emergency response locations within the river valley and at other high risk locations.

17. These staging locations would consist of a building structure on City owned land and be equipped with portable flood barriers, pumps and hoses that could be deployed efficiently in the event of a river flooding risk. Sandbags are expected to still be part of the flood response solution, but rather than storing filled sandbags in the open air, it is proposed that an automated sandbag filling machine be acquired and that the bags alone be stored in a weather-resistant location. The SIRP approach broadens the role of the traditional stormwater utility from one that focuses primarily on the installation of pipes to move stormwater, to one where the utility is an active participant in the response to the flooding event and proactively develops emergency response protocols in advance of the flooding events to support the Office of Emergency Management who leads the response efforts.

7.0 SIRP MAJOR ACCOMPLISHMENTS 2019-2020

18. Since the implementation of SIRP in 2019, EWSI has completed the accomplishments listed in Table 7.0-1.

Table 7.0-1
SIRP - Major Accomplishments 2019-2020

SIRP Theme	A Accomplishment
1 SIRP - General	<p>EPCOR participated in numerous industry initiatives within the water and insurance sectors to share the SIRP strategy and the risk focused approach to reducing flooding impacts in a community.</p> <p>Technical outreach training was also provided to the major consulting firms within the Edmonton region and with multiple City of Edmonton departments to explain the SIRP strategy and how to incorporate the new risk based approach in future designs for the community.</p>
2 SLOW - SIPR Dry Ponds Program	<p>All 31 proposed new dry ponds were submitted into the City of Edmonton Open Spaces Repurposing Phase 1 review procedure and initial assessments were completed to confirm that all can proceed to Phase 2 reviews. One pond location had the recommended timing for implementation shift and another location the City of Edmonton was able to identify an alternative location for the pond that better met the community and EWSI flood mitigation needs.</p> <p>In addition to the future ponds proposed by SIRP the dry ponds that were previously initiated by the Drainage department continued as planned with design underway or construction</p>

SIRP Theme	A Accomplishment
	<p>completed or substantially completed for a number of ponds including Tawa, Malcolm Tweddle, Steinhaurer, Park Allen and Hurstwood.</p> <p>The ponds planned for construction in the current and upcoming PBR are progressing through the Phase 2 reviews to confirm sizing, configuration and amenity needs with the City and adjacent communities.</p>
<p>3 SLOW - SIRP LID Program</p>	<p>LID Design standards were developed and approved through consultation with the City of Edmonton and the development community. Previously LID installation information was only available as a guideline requiring additional engineering and consultant reviews prior to construction. The introduction of LID formally into the design and construction standards reduces the costs for all future implementations.</p> <p>LID was designed and installed as part of Building Great Neighbourhoods along with Imagine Jasper Avenue projects during the 2020 construction season. This allowed both EPCOR and City of Edmonton construction groups to identify opportunities to streamline construction processes and address concerns from the contractors and adjacent community with neighbourhood scale LID installations.</p> <p>A number of commercial properties were also approached to allow implementation of LID on their properties to support community flood risk mitigation. This program will move to construction phases in 2021.</p> <p>Greened Hectare as a performance measure was implemented along with the development of a calculator tool for industry and EPCOR to assess the number of greened hectares their proposed LID installation provides.</p> <p>EWSI continues to work closely with the City of Edmonton Infill development team to identify opportunities and barriers to LID installation in redeveloping areas of the City.</p>
<p>4 SIRP - MOVE</p>	<p>With the COVID-19 restrictions limiting the ability to move forward with activities related to in home property specific enhanced flood proofing, the focus shifted to developing strategies to reduce the historical on-going flooding risks related to ditches and swales.</p> <p>Working closely with the City of Edmonton, EWSI identified historical surface flooding locations associated with ditches and swale flooding. Through this review a number of locations requiring regrading and culvert upgrades were identified. Ownership of culverts under roadways and private driveways was confirmed and responsibilities for maintenance are being articulated in the Operations Service Level Agreement between the City and EWSI which is expected to be completed in Q2 2021. Both the City and EPCOR are working closely in 2021 to leverage the recently announced Municipal Stimulus funding grant to upgrade the ditches and swales in the Mistatim area in particular.</p>

SIRP Theme	A Accomplishment
	<p>A ditches and swales maintenance guidance document was prepared and new equipment requirements and a proposal for maintenance schedules required for vegetation management in ditches was developed.</p> <p>A formal process was developed to manage and track any new ditches and swales flooding concerns, as historically these were only addressed each season.</p> <p>EWSI supported the industrial area servicing review being led by the City of Edmonton in particular for the areas not currently with full infrastructure servicing.</p> <p>EWSI completed a detailed review of the partially separated sewer areas to identify quick win reconfigurations to reduce stormwater entry into the combined system if there was an adjacent storm pipe, and identify locations where catch basins connected to sanitary pipes lead to increased flooding risk in neighbourhoods.</p> <p>Pipes required to support the ponds moving into the detailed design phase were identified and included in the capital programs for these specific locations.</p>
5 SECURE - Outfall and Control Gates Program	<p>The locations for the proposed outfall gates were confirmed along with discussions on method to manage the installation of these gates.</p> <p>Two approaches for construction were considered; do all at once with a single contract covering the entire river valley locations, or do river valley neighbourhood. From this review it was determined to start with the existing gates in the Cloverdale neighbourhood to confirm control logic requirements and then approach the remaining as a single contract to complete construction.</p> <p>Outreach was also done to City of Calgary that have also recently installed these types of gates to leverage their learnings during implementation.</p>
6 SECURE - I&I reduction	<p>The topographical sag locations across the City of Edmonton were reviewed and all manholes and pipes requiring relining were identified and prioritized completion in the coming years.</p> <p>More than 290 manholes have been relined in 2020.</p> <p>Detailed I&I monitoring, smoke testing and modelling analysis was completed for the northwest areas contributing excess storm flows into the NEST sanitary trunk system. Detailed community outreach plans are in development for the neighbourhoods showing higher levels of infiltration after a major storm event. Direct inflow connections due to storm pipes connected to sanitary pipes were confirmed as not a contributing factor to the flooding risks in these locations,</p>

SIRP Theme	A Accomplishment
	<p>Additional analysis was completed on the sanitary system coming from southwest Edmonton to confirm that Inflow/infiltration levels from new subdivisions are lower than the current design standards, providing the opportunity to reduce the size of new infrastructure trunks to support growth in the region. This finding will be captured in the development of the SanIRP and has impact on the timing of the SSSF trunk segments.</p>
<p>7 SECURE - Enhanced Flood Proofing Program</p>	<p>Due to COVID-19 the in-home flood inspection program was paused in March of 2020 and resumed using alternative virtual technology later in the summer until the second wave of restrictions were put in place requiring the program to pause again. This reduced the number of full in-home inspections from what was planned at the start of the year.</p> <p>EWSI also saw decreased uptake from the home owners that completed their inspection to have the additional plumbing work completed to install the backwater valve and obtain the subsidy. Additional outreach is underway with these customers to better understand why they have not installed the backwater valve as recommended.</p> <p>EWSI hired a new manager for the flood inspection team and will manage this program as well as the root intrusion programs for EPCOR providing the customers with a single point of contact for support on drainage issues related to their property.</p> <p>The manager and all of the flood inspectors completed the formal flood inspection trainer program as endorsed by the Intact Center for Climate Adaptation.</p> <p>A detailed review of reverse slope driveways within the river valley neighbourhoods was initiated and alternative approaches to sandbags are being assessed for each individual property in the Provincial designated flood way and flood fringe regions.</p> <p>EWSI supported the City of Edmonton Climate Change team Green leagues program with presentations on flood risks in the community and how to access the flood inspection services from EPCOR. We will continue to support this program as it rolls out across multiple community leagues allowing us to leverage this forum with the Edmonton Federation of Community Leagues to build community resiliency to flooding events.</p>
<p>8 PREDICT</p>	<p>The SIRP Dashboard project was initiated and a formal RFP process was completed and vendor selected at the end of 2020. The Dashboard will be operational mid 2021.</p> <p>Capital projects to add additional flow and level monitors were initiated with acquisition starting in 2021.</p>

SIRP Theme	A Accomplishment
	<p>Underpass warning systems were design and implemented in conjunction with the City of Edmonton at Whitemud Drive/Gateway Boulevard and 63 Avenue/Gateway Boulevard. The remaining underpass locations for warning systems were confirmed.</p> <p>A detailed analysis of the geyser location at 30th avenue and Calgary trail was completed and the probable root cause of the geyser has been determined to allow for the implementation of mitigation measures through the SIRP-SLOW and SIRP-PREDICT within the two basins directing stormwater to this location has been confirmed.</p> <p>Updated IDF curve analysis was completed based on an additional 5 years of rain gauge data in the Edmonton region. Consultation with the City and UDI to update the design standards based on this new information will occur in 2021.</p>
9 RESPOND	<p>EWSI presented to the Fire Chief and Deputy Fire Chiefs the SIRP strategy in late 2019 and provided information on flooding risks specific to each fire station in the City.</p> <p>EWSI in 2020 completed a flood risk assessment review of all 1300 City owned properties and provided this information back to the City Risk Management and Asset management teams to allow them to assess mitigation measures for these locations. Additional coordination will occur in 2021 to provide our expertise in mitigating these risks going forward.</p> <p>Similar analysis was completed for Water Services and EPCOR Electricity Distribution and Transmission (EDTI). Water Services was able to secure grant funding to implement flood protection measures at their facilities and purchased additional equipment to protect high risk electrical equipment. EDTI has also incorporated flood mitigation measures into their future capital planning.</p> <p>Analysis is currently being completed for the Edmonton Public School Boards to inform their emergency response protocols and to allow for identification of opportunities to align the SIRP-SLOW and SIRP SECURE initiatives not only for property protection but to also identify opportunities to incorporate these initiatives into the curriculum at each school. This work was initiated prior to COVID-19 and delayed due to resources focused on this response.</p> <p>Due to COVID-19 outreach to other critical sectors was delayed as emergency response resources within EWSI were focused on the immediate response requirements to keep the essential utility and employees working in the community.</p>



Appendix I2

EPCOR WATER SERVICES INC.

CORe Strategy

February 16, 2021

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1.0 INTRODUCTION

1. Over the past decade, residents of Edmonton have reported over 10,000 instances of odours related to the sanitary and combined sewer network. To develop a robust strategy to address odour issues, EWSI has conducted public consultation, engaged with community members across the city, conducted advanced sewer air monitoring campaigns and expanded its sewer asset inspections. The assessment has determined that odours is a precursor to the more serious corrosion and premature failure of sewer assets. EWSI has thus produced a Corrosion and Odour Reduction (CORe) Strategy that focuses on preventing the formation of hydrogen sulphide (H₂S) gas, which will reduce community odour impacts and lengthen the life of sewer network assets. In addition to the odour impacts the H₂S gases are extremely corrosive to the sewer trunk network which can result in major system failures as impacts to roads above the pipes. The corrosion is typically at locations of major flow intersections or drop structures and typically on the crown of the pipe where the gases accumulate. When corrosion results in a complete loss of the pipe structure the above soil enters the pipe creating a void which impacts above road stability.

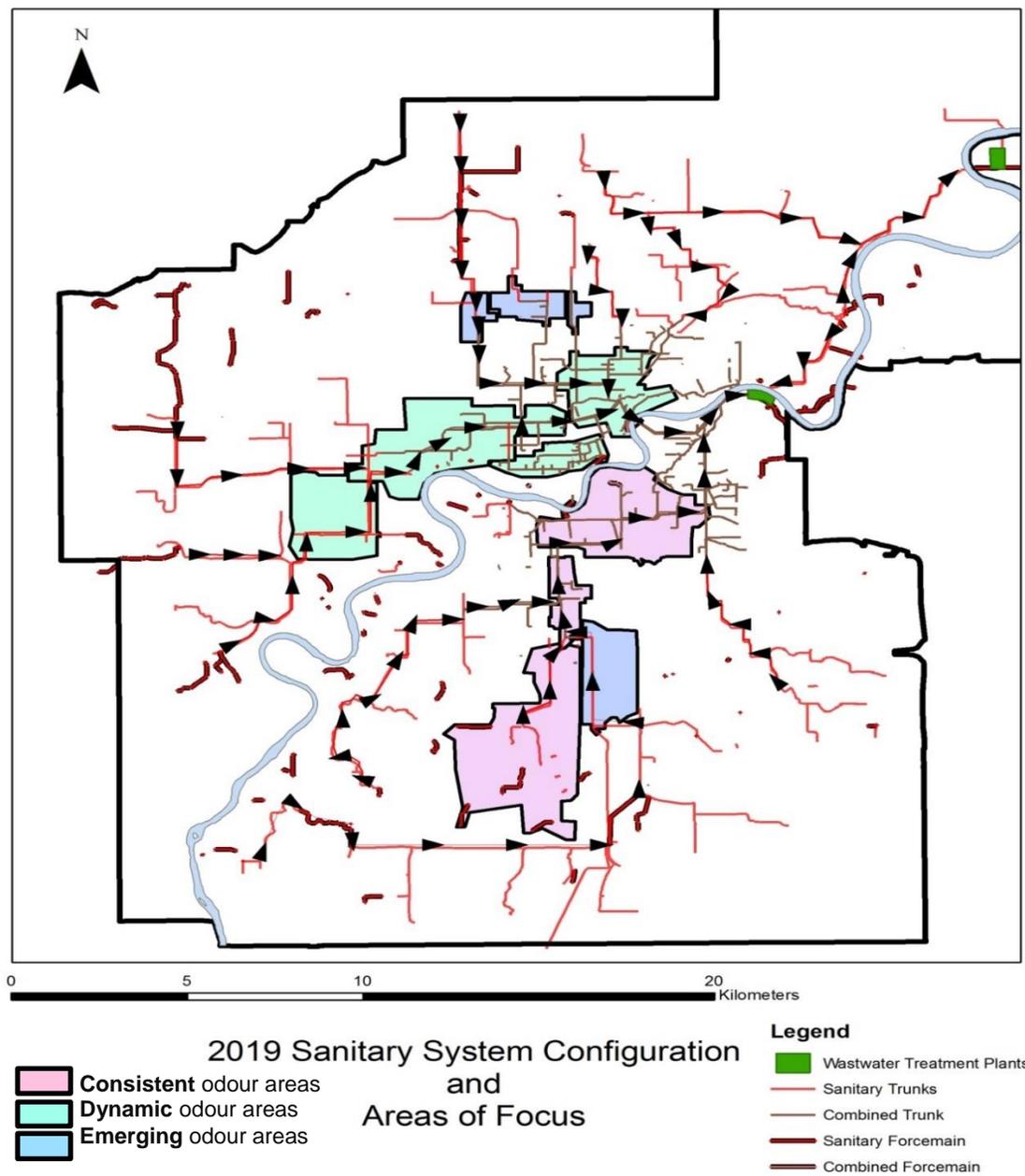
2. EWSI presented its CORe Strategy to Utility Committee on June 24, 2019. The CORe Strategy was developed using similar principles and approaches to EWSI's Stormwater Integrated Resource Plan (SIRP) to determine an optimized mix of operational and capital solutions to reduce corrosion and odour. The CORe Strategy includes roughly \$200 million capital investment and \$18 million in operating expenditures to address early action items over the period of 2019 to 2026. Implementation of CORe began in 2019 and since that time has been funded by the CORe Non-Routine-Adjustment (NRA) to sanitary rates that was approved by City Council and became effective January 1, 2020. EWSI is proposing to continue to implement CORe in stages at each successive PBR period. This approach will provide Utility Committee and City Council with the opportunity to review the CORe performance and proposed strategy at the time of each PBR renewal.

3. Previous odour mitigation plans focused on reducing community impacts by controlling and treating sewer gas releases across the City. EWSI recognizes that the H₂S created in septic areas of the sanitary network is also significant because of its impact on sewer asset condition and employee safety. H₂S gas is extremely reactive with metals and concrete. Its presence causes assets to corrode and fail before the end of their expected service life. As a result, the focus was enhanced to also include: (i) elimination and/or reducing the sources for the formation of H₂S in

the sewer system because H₂S causes corrosion in the sewer system; and (ii) management of the odour as the gas escapes from the system.

4. The current CORE Strategy differs from previous plans by segregating the city into areas with consistent odour issues, those with dynamic odour issues and those with emerging odour issues (refer to Figure 1.0-1) rather than focusing on reducing community impacts by controlling and treating sewer gas releases across the City as proposed in the previous odour mitigation plans. EWSI is implementing different approaches for each area to ensure that causes of the odour are fully understood and to ensure that capital projects will provide sustainable relief. Odours within different areas have distinct causes and require a different mix of solutions. By incorporating the additional information from the more recent assessment into the strategy, CORE expands the previous plan by focusing on preventing the formation of H₂S gas, which will reduce community odour impacts and lengthen the life of sewer network assets. This strategy will address the worst areas first and will also provide the most cost-effective solution.

**Figure 1.0-1
Odour Areas of Focus in the City of Edmonton**



5. EWSI’s CORE Strategy includes the capital and operational program investments to focus on preventing the formation of H₂S gas by keeping the wastewater moving, adding chemical treatment, and expanding inspections and cleaning. Construction and rehabilitation of tunnels and the provision of improved access points for both inspection and cleaning purposes can eliminate the obstacles to flow and significantly reduce deposits of sediment and fats causing H₂S

gas formation. Pump station enhancements can also reduce wastewater stagnation time at the station and can further inhibit H₂S gas formation by adding chemical treatment to the system.

6. Another focus for CORE is to adapt the system using real-time monitoring technologies and improved inspection data. Sewer trunks are 30 to 40 meters underground. Those built before 1990 generally do not meet current standards for access. Approximately 80 km of trunk lines are currently beyond the reach of inspection technologies and do not allow inspections to identify whether H₂S is forming and causing corrosion and odour issues, or whether the line contains sags or deposits of sediment/fat that require cleaning and may cause odour or operational issues in the future. Adapting the system can be accomplished by expanding inspection and reporting data, developing real-time monitoring capability, and advancing modelling and mitigation research.

7. The CORE Strategy also recognizes that sewer gases will be venting out of the system as part of the normal process of moving wastewater through the system. Although it may be impractical to stop such venting in the system, venting locations can be controlled in order to reduce community impacts. Odours venting can be controlled by reducing air pressure in the sewers, adding containment structures, and providing controlled release points.

8. EWSI's investments in CORE can be classified into four themes: PREVENT, OPTIMIZE, MONITOR and CONTROL. Details on the specific activities within each theme are provided further below. Table 1.0-1 provides a summary of the proposed capital expenditures over 2020 to 2024 under each CORE theme. Business cases are included in this Application for the specific projects/programs that support the CORE Strategy that have a total capital expenditure at or above \$10 million (refer to Appendices H2, H3, H4 and H5). Since the CORE Strategy was first presented to Utility Committee on June 24, 2019, EWSI has expanded the PREVENT theme to include the rehabilitation projects required due to high levels of H₂S, which induces corrosion and causes odours. These additional rehabilitation projects primarily include those within the CORE Large Trunk Rehabilitation Program which are required primarily to prevent further corrosion and to extend the lives of large trunks as well as some other smaller rehabilitation projects.

Table 1.0-1
CORe Projects/Programs Capital Expenditure Forecast
(2020-2024)
(\$ millions)

Theme	A Category	B	C	D	E	F	G	H
		2020	2021	2022	2023	2024	2022-24 PBR Total	NRA
1	CORe Duggan Tunnel Project	0.6	4.5	11.7	19.2	25.4	56.3	Yes
2	Prevent CORe Access Manhole Program	6.4	6.3	6.2	5.0	6.7	17.9	Yes
3	CORe Large Trunk Rehabilitation Program*	25.8	33.2	21.0	32.7	25.3	79.0	
4	Optimize CORe Pump Station Enhancement & Treatment	0.1	1.8	1.0	1.1	0.6	2.7	Yes
5	Monitor CORe Monitor Project	-	0.3	0.3	-	-	0.3	Yes
6	Control CORe Drop Structure Modification Program	0.5	9.7	6.1	8.9	7.0	22.0	Yes
7		CORe Odour Ventilation Program	0.0	0.2	0.5	1.5	0.2	2.2
8	Total	33.4	56.0	46.8	68.4	65.2	180.4	

*The CORe Large Trunk Rehabilitation Program is being initiated in 2022. Prior to 2022, these large trunk rehabilitation projects are completed as individual projects.

2.0 PREVENT

9. One of the larger investment categories of the CORe Strategy is the “PREVENT” theme. Under this theme, the objectives is to prevent the formation of H₂S gas in the sewer system and to eliminate significant deposits of sediments and fats through the construction of bypass tunnels and improved access points for both inspection and cleaning purposes. The PREVENT theme involves the elimination of known obstacles in moving sewage flow through the construction of the CORe Duggan Tunnel Project and the provision of access points for both inspection and cleaning purposes. The PREVENT theme is the largest area of investment in the early action period of 2019 to 2026.

10. The PREVENT theme investments in the 2022-2024 PBR term includes the CORe Large Trunk Rehabilitation Program. Large trunk rehabilitation is required to mitigate the risk of H₂S gas causing corrosion of large trunks and shortening the useful life of these major assets in the sanitary and combined systems. To prevent further corrosion EWSI is proposing to rehabilitate or replace large trunks that are at high risk of failure due to H₂S corrosion to extend the life of these assets. The new access manhole installed in Duggan allowed EWSI to inspect downstream of the Duggan Pump Station. The inspection identified advanced trunk deterioration due to corrosion as shown in Figures 2.0-1 and 2.0-2. It demonstrates the urgent needs to address corrosion deterioration especially in trunk sewers.

Figure 2.0-1
Duggan Tunnel - Missing Wall in the Trunk Sewer



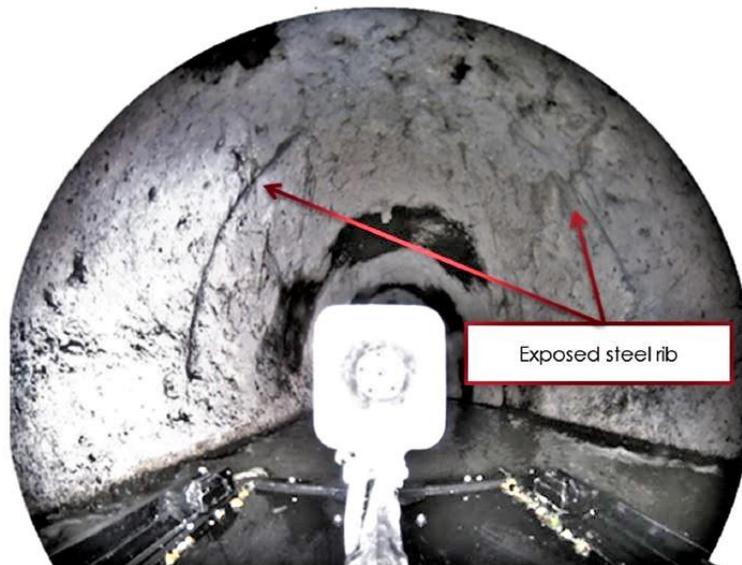
Figure 2.0-2
Duggan Tunnel - Close-up Missing Wall



11. Advanced corrosion and deterioration was also found in the concrete sanitary tunnel along 99 Avenue in west Edmonton. 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 2.0-3 below. The deterioration was caused by H₂S gas, which 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.

Figure 2.0-3
Deteriorated Condition of the 99 Avenue Trunk



12. Another example of trunk sewer deterioration due to corrosion is in the Mill Creek area. 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 2.0-4 and 2.0-5 below show the poor to very poor conditions at the junction of Reaches 40 and 49.

**Figure 2.0-4
Large Void Upstream of Reach 49**



**Figure 2.0-5
Severe Corrosion in Manhole 246631
At Junction of Reach 40 and 49**



CORe Duggan Tunnel Project

13. The \$86 million CORe 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 CORE 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 trunk will create a gravity-flow system that eliminates the need to operate the existing Duggan Pump Station. The CORE 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.

CORE Access Manhole Program

14. The CORE Access Manhole Program is a critical component of the CORE Strategy under the PREVENT theme. The CORE Access Manhole Program is an annual program that initiates projects to construct access manholes in major trunk lines. There are approximately 170 km of sanitary and combined large trunk sewers (1,200 mm diameter and large) 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 for safe inspection and cleaning purposes. To date, six access manholes have been completed and a further thirteen access manhole projects have been initiated and are proceeding towards or undergoing construction. 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. The forecast total program capital expenditures during 2022-2024 is estimated at \$17.9 million.

CORE Large Trunk Rehabilitation Program

15. The CORE Large Trunk Rehabilitation Program focuses on the rehabilitation of large trunk sewers greater than or equal to 1,200 mm in diameter. The CORE Large Trunk Rehabilitation Program is a new program which will be initiated in 2022 and is a key component of CORE Strategy. During 2018 to 2020, EWSI estimates its capital expenditures on discrete large trunk rehabilitation projects are approximately \$70 million. In addition, EWSI has spent approximately \$12 million on addressing unplanned trunk failures over the same three year period. 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 trunk locations requiring immediate rehabilitation work at critical locations. EWSI has forecasted total program capital expenditures for this program during 2022-2024 PBR term at \$79.0 million. This program includes two large discrete projects: the Mill Creek Combined Trunk Reach 49 and the 99 Avenue and 151 Street Trunk Sewer Rehabilitation Project at an estimated cost of \$28 million and \$30 million respectively during the 2022-2024 PBR term. The other large trunk rehabilitation projects

within this program will address trunk repairs required with an imminent risk of failure and by prioritizing the projects based on risks.

3.0 OPTIMIZE

16. In the sewer system wastewater flows become stagnant for a variety of intentional and unintentional reasons. Sanitary wastewater can intentionally be held for multiple hours at pumping stations, storm surge storage areas and at flow control structures. The purpose for the OPTIMIZE theme is to improve pumping operations to reduce the stagnation time in a pump station and reduce the opportunity for H₂S generation by adding chemical treatment to the system. Table 3.0-1 provides a list of pump stations that are mentioned in the original CORE Strategy presented to Utility Committee in 2019 as candidates to be optimized and their status.

**Table 3.0-1
CORE OPTIMIZE Pump Stations**

	A	B	C
Pump Station Name	PS #	Odour Region	Implementation Status
1 Kaskitayo	104	Consistent	2019-2021
2 Blackburne	169	Consistent	2019-2021
3 Twin Brooks	163	Consistent	2019-2021
4 Westbrook	102	Consistent	Candidate for 2022
5 Walterdale	121	Consistent	2023
6 Cloverdale	171	Consistent	2023
7 Cameron Heights	197	Dynamic	2021
8 St. Georges Crescent	112	Dynamic	Removed from scope, analysis confirmed low flow, low hydraulic retention time, anticipated low H ₂ S
9 William Hawrelak Park	108	Dynamic	Removed from scope-analysis confirmed low flow limiting risk to cause odours
10 Quesnell Heights	212	Dynamic	Removed from scope – testing confirmed no H ₂ S
11 Buena Vista	120	Dynamic	Removed from scope – testing confirmed no H ₂ S
12 Laurier Heights	111	Dynamic	Removed from scope – testing confirmed no H ₂ S
13 Wolf Ridge Estates	151	Dynamic	Removed from scope – analysis and testing confirmed very low hydraulic retention time, no H ₂ S
14 Fort Edmonton Park	101	Dynamic	Removed from scope- analysis confirmed flow too low
15 South Westridge	110	Dynamic	Awaiting monitoring data
16 Trumpeter Station	213	Dynamic	2020-2021
17 Clifton Place	113	Dynamic	Candidate for 2023
18 Starling Station	217	Dynamic	2021
19 Hawks Ridge	223	Dynamic	Candidate for 2022-2023
20 NC1	188	Emerging	Station operation optimization occurred in 2020 as part of detailed review of flooding risks along NEST system. Pumping capacity increased and operational procedures updated.
21 SESS	185	Emerging	2024
22 Elsinore	162	Emerging	2021
23 Dunluce	130	Emerging	Under Review, Candidate for 2022

Pump Station Name	A PS #	B Odour Region	C Implementation Status
24 Baranow	202	Emerging	2021
25 South Edmonton Common	193	Emerging	Under Review, Candidate for 2023
26 Mistatim	218	Emerging	Candidate for 2022-2023
27 Wedgewood	155	Dynamic	Under Review for 2023-2024
28 Eastgate	141	Dynamic	Under Review for 2023-2024
29 Beverly	182	Dynamic	Under Review for 2023-2024
30 Edgemont	220	Dynamic	Under Review for 2023-2024
31 Brander Gardens	103	Dynamic	Under Review for 2023-2024

17. Operationally there are opportunities to improve pump station and storage area operations to reduce storage times and inspection and cleaning can be employed to target blockages and sediment. By removing impediments to flow and keeping wastewater moving, sewer odours can be drastically reduced. A number of projects have been initiated to improve the pumping operations at pump stations since 2019 under the CORE Pump Station Enhancements Program. During the 2022-2024 PBR term, the total capital expenditures for pump station improvements is estimated to be \$2.7 million.

4.0 MONITOR

18. The MONITOR theme is to improve EWSI's understanding on the H₂S generation mechanism within the sewer system by using real-time monitoring technologies and improved inspection data. Such knowledge can help EWSI to identify and understand present and future problem areas along with the effectiveness of the remediation measures. This theme will be implemented under the CORE Monitor Project which will be coordinated with the SIRP PREDICT theme and involves using real-time monitoring technologies to improve wastewater management. Both CORE MONITOR and SIRP PREDICT themes will be coordinated in using the same common platform to capture and store the monitoring and sensor data, and in deploying the same IT portal tools for individuals to access and analyze the sensor data. Adapting the system can be accomplished by expanding inspection and reporting data, developing real-time monitoring capability, and advancing modelling and mitigation research. Permanent monitoring locations will be developed and will be installed to connect to the Drainage SCADA system. The total expenditure on EWSI's CORE Monitor Project will be \$0.3 million in the 2022-2024 PBR term.

5.0 CONTROL

19. The purpose for the CONTROL theme is to control the release of air from the sewer system by reducing air pressure in the sewers, adding containment structures, and providing controlled release points in areas with lower community impact. Odours are pushed out of the sewers when

the air inside the sewer is pressurized and there is an opening to the atmosphere. The major component for this theme is to retrofit existing drop manholes with proper ventilation systems. Other containment work will include the installation of flaps, ventilation units, and sealing manholes. EWSI is forecasting capital expenditures under this theme to be \$24 million during the 2022-2024 PBR term in the CORE Drop Structure Modification Program (\$22 million) and in other containment projects (\$2 million).

CORE Drop Structure Modification

20. The CORE Drop Structure Modification Program is a critical component of in the CONTROL theme 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. 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.

6.0 CORE ACCOMPLISHMENTS 2019-2020

21. Since the implementation of CORE in 2019, EWSI has achieved the major accomplishments detailed in Table 6.0-1 below.

**Table 6.0-1
CORE - Major Accomplishments 2019-2020**

CORE Theme	A Accomplishment
1 CORE General	<ul style="list-style-type: none"> Developed the Sewer Hotspot performance matrix and reported on the progress. Updated the Strategy with the 4 themes: PREVENT, OPTIMIZE, MONITOR and CONTROL. This will allow the implementation effort of the CORE Strategy through alignment and synergies to other initiatives.
2 PREVENT - CORE Duggan Tunnel Project	<ul style="list-style-type: none"> Performed extensive analysis to compare different construction and alignment alternatives and confirmed the cost effective approach for this project. Initiated the project in 2019 and the project is currently in design phase.
3 PREVENT CORE Access Manholes Program	<ul style="list-style-type: none"> Completed 6 access manholes. 13 additional access manholes are being designed and constructed in 2021. access manholes were installed in the Brookside neighbourhood and these access manholes were used to facilitate the repair and bypassing required for the trestle across Whitemud Creek (Trestle No.7).

COPe Theme	A Accomplishment
4 PREVENT - COPe Large Trunk Rehabilitation Program	<ul style="list-style-type: none"> • To reduce the risk of imminent trunk failure, local repair of the two large holes (at Reaches 41 and 49) was completed in early 2020 to avoid trunk failure. • The first stage to rehabilitate the trunk at 99 Avenue and 151 Street started in 2020 and is expected to be completed in mid-2022. • Confirmed the deteriorated conditions for the following locations: <ul style="list-style-type: none"> – 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. – Numerous instances of material loss throughout the tunnel at 151 Street between 93 Avenue and 99 Avenue, and four holes identified in the crown region of the tunnel. – Portions of the divider wall (membrane) in the 1,650 mm diameter double barrel pipe along 116 Street and 108 Avenue were missing. – With the completion of the access manholes, a major defect along the trunk downstream of the Duggan Pump Station was identified. The rehabilitation work for this major defect is on-going. • Other significant trunk rehabilitation projects that were completed: <ul style="list-style-type: none"> – 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 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. – Significant corrosion was discovered at the Goldbar Utilidor north chamber and extensive effort was done to clean the debris and rehabilitate the chamber. – Trestle No.7 pipe runs along the trestle east to west across the Whitemud Creek at approximately 56th Avenue failed during rainstorm event in July 2020. The steel pipe was found to be significantly weakened due to corrosion. The repair effort is on-going. – A subsidence occurred over the 1,500 mm trunk along 61 Avenue at 109 Street due to missing pipe wall and severe corrosion in the area. Extensive effort is being expended to rehabilitate the trunk.
5 OPTIMIZE	<ul style="list-style-type: none"> • Initiated the projects to optimize the pump stations at Kaskitayo, Twin Brooks and Blackburn. • Additional pump stations are being initiated including Pembina and Mistatim. • Collaborated with University of Alberta to conduct field research on chemical dosing. Preliminary results are available.
6 MONITOR	<ul style="list-style-type: none"> • During the summer and fall of 2019 odour monitoring was completed at 26 locations. The monitoring included gas phase monitoring and liquid grab samples for lab analysis. • Historical data has been collected and reviewed to determine its quality and reliability. In many instances, the pre-existing data can be effectively used in place of dedicated monitoring. • 10 low level H₂S data loggers (sub 2 ppm) for ambient surface trend monitoring and 10 liquid phase total sulfide monitors are being purchased.

CORe Theme	A Accomplishment
7 CONTROL - CORe Drop Structure Modification Program	<ul style="list-style-type: none"> • Initiated 6 drop structure modification projects which are currently under design and construction. • Installed a vortex drop structure in Lauderdale area and the effectiveness of this structure is being evaluated. There is some potential for using this vortex system as an alternative for future drop structure modification.
8 CONTROL - Other Containment	<ul style="list-style-type: none"> • Confirmed the deficiencies at Station PW #901, located at 963-167 Avenue NE. A project will be initiated to build ventilation and air treatment system of enough capacity to maintain internal air phase H₂S concentration below occupational health and safety exposure limits. • Conducted a Management of Change process to optimize the design for one-way flaps. • Completed a review of 5 odour control facilities and concluded that the two dormant stations at King Edward Park and Kenilworth can be abandoned in place.