Report to Utility Committee
March 22, 2019

EPCOR WATER SERVICES INC.

Lead Mitigation Strategy
Business Case

Table of Contents

Appendices

1.0 EXECUTIVE SUMMARY

1. On March 8, 2019, Health Canada will release a new Guideline for Canadian Drinking Water Quality ("GCDWQ" or "guidelines") proposing to reduce the maximum acceptable concentration ("MAC") for lead in drinking water from the current 10 µg/L (micrograms per Litre) to 5 µg/L. The guidelines will shift the point of compliance to be water samples collected **at the customer's tap** within the home or building (as opposed to points in the municipal water distribution system). EWSI has determined that although the change will not immediately impact compliance with provincial drinking water regulation, EWSI will not be able to comply with the intent of the proposed lead guideline in the Edmonton water system.

2. Currently, EWSI's drinking water does not contain detectible amounts of lead when it leaves the water treatment plant and lead levels in samples collected from the municipal distribution system piping are also less than detection.

3. There are, however, two potential sources of lead that can that can result in lead being detected in the drinking water at the customer's tap:

i. ***Lead Service lines*** (LSLs) that supply many homes built in the 1950's or earlier. EWSI estimates that at the end of 2018 there are approximately 4,450 homes supplied through LSLs (1.6 % of the 270,00 homes in Edmonton). Of these, 2,350 have lead present on both the utility-owned and privately-owned portions of the service line, 750 have lead present only on the utility-owned portion and 1,350 have lead present only on the privately-owned portion. EWSI's sampling and testing at over 4,000 homes with LSLs in the older parts of the city indicate that about 2,000 or 46% of these homes will have lead concentrations that are above the proposed Health Canada MAC when sampled at the tap.

ii. ***Plumbing Components Containing Lead*** such as lead-tin solder and brass fixtures. Lead-containing household plumbing fixtures are still available for sale in Edmonton, so even newer homes may have lead exceedances. EWSI's sampling and testing at 883 other homes across Edmonton indicate that approximately 8.5% of all other homes have lead concentrations that are above the proposed Health Canada MAC when sampled at the tap. The homes that tested above the proposed MAC in this random sampling program are distributed throughout the city in both older and newer neighborhoods. Extrapolation of this data suggests that potentially customers in 23,000 homes across all areas of the city and possibly several thousand more in the more than 70 communities in the regional water system supplied with EWSI water could be exposed to drinking water with lead concentrations exceeding the proposed Health Canada MAC.

4. Since 2008, EWSI has been communicating with customers with lead service lines on an annual basis to help them monitor and mitigate lead levels. EWSI's current lead program involves:

i. Annual notification of residents in homes with LSLs;

ii. Offering free water sampling and testing for lead at the tap;

iii. Supplying free point-of-use filters as a temporary measure to address high lead in these homes;

iv. Tips on improvement water quality at the tap; and

v. Education to encourage property owners with LSLs to replace their privately-owned portion of the water service line to their home (currently the customer bears the full cost replacement of their private portion).

5. EWSI currently replaces the utility owned-portion of the LSL in emergencies (when the pipe fails), during water main renewal projects or when the customer has initiated a replacement of their portion of the LSL.

6. Under the current lead programs alone, EWSI will not be able to meet the intent of the proposed Health Canada MAC, both in homes with LSLs and in other homes across the city due to the presence of lead-containing plumbing components.

7. EWSI has developed a new ***Lead Mitigation Strategy*** to proactively meet the intent of the proposed new Health Canada Guidelines. The goals are to ensure compliance with the proposed guideline in all homes with LSLs and to minimize the risk of exposure to lead associated with plumbing components in home Edmonton and across the region. The key elements of EWSI's proposed *Lead Mitigation Strategy* include:

i. ***Adding a lead Inhibitor (orthophosphate) to Drinking Water***: Orthophosphate creates a protective coating on the inside of lead pipes and plumbing that that prevents lead from leaching into drinking water. It is commonly used for this purpose by water utilities across North America and the United Kingdom. It has no impact on the taste or odour of drinking water. It is naturally present in food and is a common additive to beverages and considered to be a safe additive. New orthophosphate dosing infrastructure will be in place at the two water treatment plants by the end of 2020.

ii. ***Elimination of Partial Lead Service Line Replacements / Utility Funding of Private Portion Replacements***. EWSI is proposing to end its current practice of replacing just the utility portion of a lead service line while leaving the private portion in place as it can elevate lead levels at the tap. Replacement of the private portion by a homeowner is uncommon owing to the high cost

($7,500). On a go-forward, basis, EWSI is proposing to replace the private portion any time it replaces the utility portion. Both the utility and private portion replacements will be funded through water utility rates.

iii. ***Accelerated Replacement of High Priority Lead Service Lines / Utility Funding of Private Portion Replacements.*** EWSI is proposing to accelerate the replacement of any lead service lines (private and utility portions) that have been identified through testing as having lead levels in excess of the new Health Canada Guideline after the implementation of orthophosphate. Both the utility and private portion replacements for these "High Priority" LSLs will be funded through water utility rates.

8. Addition of the lead corrosion inhibitor, orthophosphate, will provide protection against lead release into drinking water from all sources, including LSLs and plumbing components, at the tap and will be effective throughout all of Edmonton and the more than 70 municipalities supplied through the regional water system. Orthophosphate has been used successfully by numerous utilities in Canada, the US and the UK for lead control was recommended to EPCOR by an independent consultant study conducted in 2014. EWSI conducted its own independent pilot-scale test to verify the effectiveness of orthophosphate for the Edmonton water. Based on this testing, EWSI estimates that the addition of 1 mg/L orthophosphate (P) to Edmonton drinking water will reduce the concentration of lead from all sources (LSLs, plumbing, fixtures) by at least 80% within a one-year period. Implementation of orthophosphate will require construction and operation of phosphoric acid dosing facilities at both the Rossdale and E. L. Smith water treatment plants.

9. For orthophosphate addition, EWSI has considered the environmental impact of increased phosphorus loading to the wastewater treatment plants and the possibility of increase phosphorus loading to the North Saskatchewan River. The two wastewater treatment plants in the region (EWSI's Gold Bar wastewater treatment plant and the Alberta Capital Region wastewater treatment plant) will be able to remove the additional phosphorus loading by adjusting their treatment process. The potential increase in phosphorus loading to the North Saskatchewan River (through land and storm sewer runoff) will be in the range of 5% to 16% depending on the assumptions considered. Additional environmental monitoring is proposed to confirm the actual increase in loading.

10. Elimination of the current practice of partial LSL replacements in Edmonton will involve full replacement of both the utility portion and the private portion of the LSL following all LSL replacements of any utility portion LSLs for emergency repairs and during water main renewals. Currently EWSI replaces only the utility portion of the LSL during these activities and the private portion is left in place. These partial LSL replacements are not effective at decreasing lead levels at the tap and often result in a significant increase in lead levels at the tap due to physical disturbance of the LSL. EWSI currently completes 86 partial (utility portion) replacements a year on average.

11. Acceleration of full (utility portion and private portion) replacements for High Priority LSLs will be completed over a 5-yr period. Based on testing at homes with LSLs, and assuming an 80% reduction

in lead concentration within one year of orthophosphate dosing, EWSI estimates there will be 356 High Priority homes identified. This includes homes with lead present on the utility portion of the service line only, the private portion only or on both utility and private portions.

12. In the proposed strategy, the cost of replacement of the private portion of the LSL when it is replaced by EWSI contractors at the time of replacing the utility portion, will be funded through an increase in water rates applicable to all city of Edmonton water ratepayers. EWSI considers the funding of the private portion to be prudent for two reasons. First, just replacing the utility portion and not also replacing the private portion of a LSL can result in elevated levels of lead in drinking water. Second, replacement of the private portion by homeowners solely for health-related reasons is very low (as few as 10 per year) because of the high cost ($7,500).

13. As soon as possible in 2019 but subject to receiving NRA approval, LSL replacements that are either High Priority or completed for emergency repairs or as part of EWSI's water main renewals will be managed and funded under EWSI's Lead Mitigation Strategy. This means that the homeowner is responsible for replacement of those LSLs with lead present only on the private portion that do not qualify as High Priority homes. EWSI will continue to monitor these homes to ensure they remain below the Health Canada MAC. If they exceed the MAC they will be categorized as High Priority and replaced under the program. Otherwise they will be replaced over the coming decades as neighbourhoods are redeveloped. Replacement of plumbing components is also considered the responsibility of the homeowner. Eventually, these sources of lead will be eliminated too through area redevelopment, infill replacements and home upgrades.

14. EWSI compared the proposed Lead Mitigation Strategy to four other alternatives including: (A) continuing with the current program alone, (B) adding orthophosphate, (C) adding orthophosphate and eliminating partial LSL replacements (D) adding orthophosphate, eliminating partial LSL replacements and accelerating replacement of High Priority LSLs and (E) adding orthophosphate and full replacement of all LSLs over 15 years. Table 1.0-1 below compares the proposed Lead Mitigation Strategy (Alternative D) with the four other alternatives modeled.

Table 1.0-1

Lead Mitigation Strategy Alternative Analysis Summary

		A Current Program	B + Ortho-phosphate	C + Eliminate Partial LSL Replacements	D + Accelerated Replacement of High Priority (PROPOSED)	E + Replace all LSLs over 15 years
1	Estimated # Homes Testing with LSLs Testing > 5 ug/L at 2025:	1,800	315	280	-	-
2	Estimated # Homes Total Testing > 5 ug/L at 2025	23,000	5,500	5,500	5,500	5,500
	Cost of Program (NPV of Revenue Requirement in $M):					
3	Total Revenue Requirement	28.2	55.3	66.4	72.5	86.6
4	Increase from Current Program	-	27.0	38.2	44.2	58.4
5	Maximum Monthly Residential Bill Impact: ($/customer/month)	-	$0.34	$0.56	$0.67	$1.10

15. Rows 1 and 2 of Table 1.0-1 provide the estimated number of homes with LSL and of all other homes across the city with lead levels at the tap estimated to be above the Health Canada MAC (High Priority) by the year 2025 (five years following start of EWSI's Lead Mitigation Strategy) under each of the alternatives considered. Rows 3 and 4 present the total and incremental cost of the program to EWSI's ratepayers in terms of the net present value of revenue requirement in $ millions. Row 5 presents the maximum monthly bill impact for a residential customer.

16. Alternative D was selected because this alternative will ensure compliance with the intent of the proposed Health Canada lead guideline for all homes with LSLs by 2025 and will reduce the risk of lead exposure in all other homes across Edmonton and the region in a cost effective manner.

- The proposed alternative (D) will eliminate the number of LSL homes exceeding the proposed MAC of 5 ug/L and will reduce the number of **all homes** across the city testing greater than the proposed MAC from 23,000 (8.5%) to 5,500 (2%) due to lead-containing plumbing.

- Implementing both a lead corrosion inhibitor (orthophosphate), eliminating the practice of partial LSL replacements, and accelerating the replacement of high priority LSLs is in alignment with Health Canada's direction to make every effort to "maintain lead levels in drinking water as low as reasonably achievable".

- This option will result in an NPV of $44.2 million above the cost of the current lead service line replacement program NPV of $28.2 million. The calculated NPV includes the capital cost to build orthophosphate dosing facilities at each of the two water treatment plants, the operating costs for orthophosphate addition, the cost of additional phosphorus removal at the Gold Bar wastewater treatment plant, the capital costs for carrying out full LSL line replacements (utility portion and the private portion) and the associated operating cost for testing, project coordination and customer communication. Over the life of this program, the maximum impact

of this alternative on the average monthly residential water bill is $0.67, a 1.3% increase over the today's average residential water and wastewater bill of approximately is $53 per month.

17. Prior to end of 2019, EWSI intends to file an application with the City Manager seeking a Non-Routine Adjustment ("NRA") to water rates beginning in 2020 to cover the average annual increase in revenue requirement of approximately $1.1 million per year necessary to implement its proposed Lead Mitigation Strategy for the three remaining years of the current PBR term (2019-2021). The costs associated with this program exceed the $500,000 annual revenue requirement threshold to be eligible for City approval as a NRA. With the upcoming changes to Health Canada's Guidelines for Drinking Water Quality and the eventual changes to Alberta regulations to enforce the new Health Canada MAC, the program will also meet the NRA criteria set out under the EPCOR Water Services and Wastewater Treatment Bylaw 17698. The NRA increases the average monthly bill for the residential water customer by $0.40 per month beginning April 1, 2020.

18. In Alberta, Alberta Environment and Parks ("AEP") regulates water treatment systems through operating approvals and has the sole authority to approve or mandate the water treatment additives and sets the dosing and monitoring requirements. EWSI currently holds an approval under the AEP EnviroVista program. This outcome-based approval allows EWSI to modify how it treats the water in the Edmonton as long as a set of final outcomes is met and the AEP Standards and Guidelines for Water Works Systems (2012) are followed. This approval, which expires in May 2021, provides EWSI the freedom to add orthophosphate to the water. Nevertheless, EWSI will be seeking a formal authorization to add orthophosphate in advance of 2021. AEP does not currently dictate replacement of LSLs.

19. EWSI has consulted with AEP and Alberta Health Services and they have both provided letters of support for EWSI's proposed Lead Mitigation Strategy attached in Appendices A-1 (Alberta Health) and A-2 (Alberta Environment and Parks). AEP has indicated that they will require drinking water utilities across the province to address the issue of lead and meet the proposed new Health Canada Guideline in 5 years.

20. EWSI has also conducted consultation with customers on the addition of a lead inhibitor to the drinking water and on the replacement of LSLs. EWSI has developed a customer communication strategy to support orthophosphate dosing, encourage the replacement of remaining private portion only LSLs (where the utility side has already been replaced) and to encourage customers to replace lead-based plumbing and fixtures with lead-free components. Key messaging includes:

- When drinking water leaves EPCOR's water treatment plants and flows through the municipal water mains it contains no measureable level of lead.
- Lead service lines are a common source of lead. Another source can be a customer's private in-house plumbing, including old solder and brass plumbing fixtures.
- Water at the tap in these homes has the potential to exceed the maximum acceptable concentration for lead in drinking water set by Health Canada.

- Nothing has changed overnight with Edmonton drinking water. There is no immediate health risk, but the lead issue must be addressed over time.
- With the new guideline, Health Canada has set more challenging targets for lead in drinking water in order to improve overall health of Canadians
- Customers should be aware of the issue, especially in LSL homes, and can take immediate measures to reduce risk such as flushing their taps after the water has been stagnant or use of a filter.
- This new guideline, once announced, will enhance public health protection, and as Edmonton's water provider, EPCOR supports the change as it aligns with its efforts to reduce lead exposure from drinking water as much as possible.

21. The proposed Lead Mitigation Strategy aligns with the City's "The Way We Live" strategic plan objectives to protect the public health of Edmontonians by delivering basic public health services including safe drinking water.[1]

22. EWSI has prepared this Lead Mitigation Strategy Business Case to provide the Utility Committee with: (i) background on the upcoming regulatory changes for lead in drinking water (section 2.0); (ii) the current state of lead in drinking water in Edmonton (section 3.0); (iii) an overview of the potential strategies for reducing lead in drinking water (section 4.0); (iv) EWSI's proposed Lead Mitigation Strategy (section 5.0); and (v) EWSI's alternative analysis which provides a financial evaluation of the proposed Lead Mitigation Strategy compared to four alternatives (section 6.0). A contextual analysis of lead mitigation strategies in other communities is provided in Appendix B. EWSI's operational plan for the proposed Lead Mitigation Strategy is provided in Appendix C. A summary of the risks and risk mitigation plans of the proposed Lead Mitigation Strategy is included in Appendix D. A communication plan is provided in Appendix E.

23. EWSI is not seeking explicit Utility Committee or City Council approval of the EWSI's Lead Mitigation Strategy. Specifically, EWSI is not seeking approval from City of Edmonton to add the lead inhibitor orthophosphate to the water. That approval must come from the provincial drinking water regulator, Alberta Environment and Parks. EWSI welcomes feedback prior to its proceeding with a Non Routine Adjustment funding application to the City Manager under the Wastewater Treatment Bylaw 17698.

[1] Objective 4.3.1, The Way We Live Edmonton's People Plan, The City of Edmonton.

2.0 BACKGROUND – DRINKING WATER REGULATIONS

2.1 Health Effects of Lead in Drinking Water

25. Lead has been used in plumbing for centuries because of its malleability, low melting temperature and resistance to corrosion. While these characteristics, as well as its low cost, made lead well-suited to this application, linkages between lead in drinking water and health problems were first recognized in the late 19th century. Since that time, public health regulations around the world have been introduced to limit exposure to lead in drinking water. Since lead has no taste, colour, or odour and there is a general lack of information on building materials used in homes it is possible for people to consume lead unknowingly.

2.2 Sources of Lead in Drinking Water

26. When water flows through pipes that contain lead, this heavy metal can dissolve and leach into the water. In a 2013 study,[2] Alberta Health Services estimated that drinking water accounts for 10-20% of lead exposure in children and adults, and 40-60% in infants consuming formula made with drinking water containing lead. The primary source of lead in drinking water is from lead service lines ("LSLs"). The service line is the section of small diameter pipe that conveys water from the municipal water main beneath the street or alley to the home. A variety of materials have been used historically for service lines including lead. LSLs were used in water systems throughout Europe, the UK and North America up until the 1950s. Therefore, although the number of LSLs remaining in service and the levels of lead concentrations vary widely, almost all major cities in North America have LSLs in their water systems.

27. Other sources of lead in Edmonton's drinking water include lead solder used in household plumbing until 1986 when it was prohibited under the National Plumbing Code of Canada, and high lead content household plumbing fixtures, particularly those with brass components. Although the Canadian Standards Association ("CSA") and Canadian Institute of Plumbing and Heating standards reduced the allowable lead to from 8% to 0.25% in 2014, this low lead requirement is not enforced in Edmonton and it is still possible to purchase high lead content plumbing fixtures at local hardware and plumbing supply stores. Accordingly, even recently-constructed homes may have lead containing plumbing fixtures. In the US in 2014, a revision to the Safe Drinking Water Act restricted the allowable lead content in potable water fixtures to 0.25%. It has been speculated that stock of potable water plumbing fixtures that are were no longer legal for sale in in the US were diverted to Canada where the regulations mandating low lead content are less clear and not enforced.

28. Lead from service lines and plumbing systems leaches into drinking water through corrosion of the metal. Corrosion rate and the resulting lead concentrations are affected by factors such as: the age and condition of lead piping and fittings; use of lead-containing solder; the stagnation time of the water;

[2] Lead and Drinking Water from Lead Service Lines, Alberta Health Service, 2013

water temperature and chemistry (pH, alkalinity, natural organic matter, disinfectant type, etc. [3]). The interaction between these factors is complex and utilities may continue to observe the dissolution of lead in service lines despite maintaining proper alkalinity and pH for corrosion control. There is also evidence that low water usage resulting from water efficiency and conservation initiatives can cause increased concentrations of lead in drinking water due to increased stagnation time of the water in pipes.[4]

2.3 Drinking Water Regulations

29. In 1992, Health Canada's Guidelines for Canadian Drinking Water Quality ("GCDWQ") established a MAC for lead in drinking water of 10 µg/L (10 micrograms per litre or parts per billion). In January 2017, Health Canada's Federal-Provincial-Territorial Committee on Drinking Water issued a technical document[5] assessing available information on lead and requesting public consultation in anticipation of updates to the GCDWQ. The new guideline, expected on March 2, 2019, will reduce the Health Canada MAC for lead in drinking water to 5 µg/L, reflecting current research showing that exposure to even small amounts of lead can be harmful to human health. The updated guideline is also expected to state that "*every effort should be made to maintain lead levels in drinking water as low as reasonably achievable*".

30. The proposed Health Canada guideline technical document on lead makes the following statement about reducing lead in drinking water:

> *Considering that lead levels at the consumer's tap may be significantly higher than levels at the treatment plant or in the distribution system, strategies to reduce exposure to lead will need to focus on controlling corrosion within the distribution and plumbing systems and on removing lead-containing components, such as lead service lines, from these systems. … An exceedance of the proposed MAC should be investigated and followed by the appropriate corrective actions. These actions include, but are not limited to, resampling, public education, removal of lead service lines and corrosion control measures.*[6].

31. Besides reducing the MAC, Health Canada's new guidelines are expected to require changes to the process for measuring lead levels. Health Canada's existing guidance, issued in 2009, presumes that the compliance point is water in the municipal distribution system and recommends flushing of faucets prior to sampling to avoid plumbing effects on sampling results. Under the new guidelines, compliance monitoring will be conducted ***at the consumer's tap***, without flushing. Further, priority for sampling is

[3] Chloramine is increasingly used in municipal water treatment facilities as a disinfectant in place of free chlorine due to increasing concerns about disinfection by-products from free-chlorine and because chloramine is more likely to be present at the point of use. This is an important factor in large regional water distribution system such as the Edmonton Regional System and as such, EWSI currently uses chloramine in its water treatment process.
[4] Final Human Health State of the Science Report on Lead, Health Canada, Feb 2013
[5] Lead in Drinking Water, Document for Public Consultation, Federal-Provincial-Territorial Committee on Drinking Water, Health Canada, January 2017
[6] Page 3, Lead in Drinking Water, Document for Public Consultation, Federal-Provincial-Territorial Committee on Drinking Water, Health Canada, January 2017

given to identifying homes with LSLs. These sampling requirements will result in an increase in the observed lead level. They are specifically designed to measure the effects of lead release from LSLs and household plumbing and to be reflective of human exposure to lead from drinking tap water in the home.

32. Health Canada's proposed new lead guideline will have significant impacts on EWSI. Currently, EWSI can ensure safe drinking water within the municipal distribution system and up to the service connection except in the relatively small number of homes (about 1.1%) where the utility portion of the service line is made of lead. If EWSI replaced the utility portions of all LSLs in these homes, EWSI could ensure safe drinking water up to the service connection in all homes. However, even after replacing the utility portion of LSLs, EWSI cannot ensure the safety of the drinking up to the tap because of the presence of the private portion of LSLs and of lead-containing plumbing components within the customer premises. In other words, EWSI would not be able to ensure that the water in Edmonton meets the intent of the proposed Health Canada lead guideline.

33. Drinking water regulation in Canada is a provincial or territorial responsibility. Health Canada sets the GCDWQ, including the maximum acceptable concentration ("MAC") of lead in drinking water. These guidelines incorporated into AEP's Potable Water Regulation. The Approval to Operate granted to Edmonton Waterworks System by EWSI by AEP includes a requirement for compliance with the Potable Water Regulation which includes compliance to any new MAC's published in the GCDWQ. The current Approval to Operate, however, sets this MAC compliance requirement for water samples that are collected at random distribution locations and not at the tap. This is a critical distinction and means that EWSI will continue to technically comply with provincial regulation without necessarily complying with the intent of the new Health Canada lead guideline.

34. In Alberta, AEP regulates water treatment systems by granting operating approvals. AEP has the sole authority in the province to approve or mandate the water treatment additives, such as orthophosphate, and sets the dosing and monitoring requirements for municipal water systems. EWSI currently holds an approval under the AEP EnviroVista program. This outcome-based approval allows EWSI to modify how it treats the water in the Edmonton as along as a set of final outcomes is met and the AEP Standards and Guidelines for Water Works Systems (2012) are followed. This approval, which expires in May 2021 provides EWSI the freedom to add orthophosphate to the water. Nevertheless, EWSI wil be seeking a formal authorization to add orthophosphate in advance of 2021. AEP does not currently dictate replacement of LSLs.

35. AEP has established a municipal working group to address the proposed Health Canada lead guideline and specifically to develop guidelines for lead monitoring and regulatory requirements for minimizing lead concentrations in water sampled at the tap for drinking water systems in Alberta. EWSI is participating in that working group. Based on discussions with AEP, EWSI understands that the proposed Health Canada MAC for lead (including the requirement to sample at the tap) is not expected to become regulation in Alberta for at least five years. This provides municipalities across Alberta with time to develop and implement strategies for compliance with the new GCDWQ.

3.0 LEAD IN DRINKING WATER IN EDMONTON

36. There is generally no detectable lead in Edmonton drinking water when it leaves the water treatment plant and the level of lead in random samples collected from municipal distribution system piping contain is well below both the current and proposed Health Canada MAC. Sources of lead in drinking water consumed by EWSI customers include lead service lines ("LSLs") and lead-containing plumbing materials such as lead-tin solder and brass fixtures.

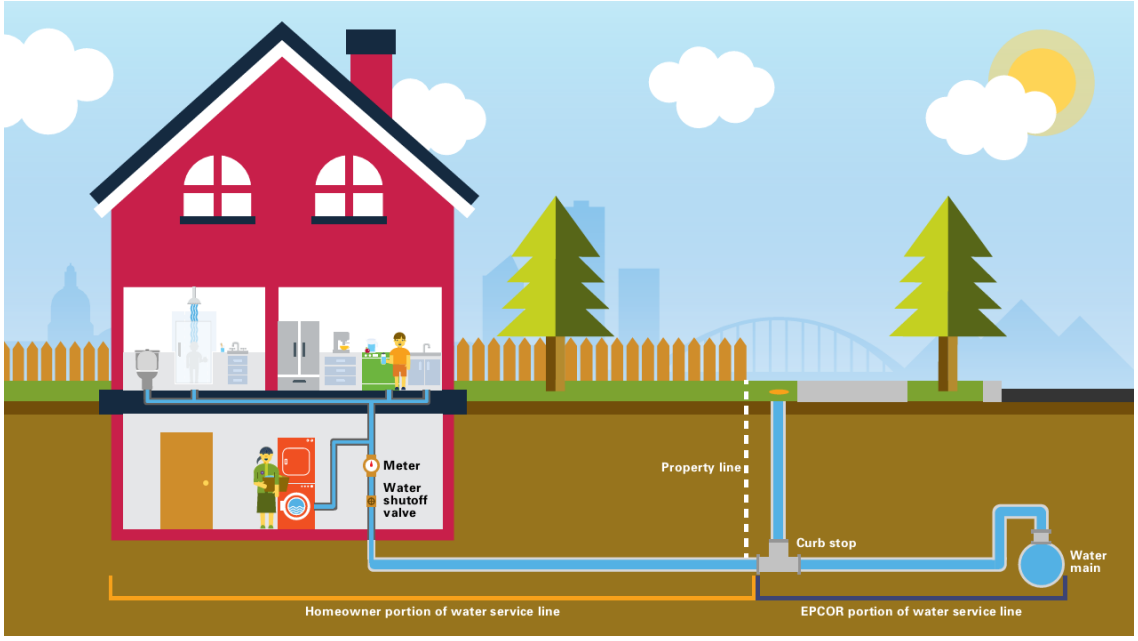
37. Since 2008, EWSI has obtained water samples at the tap from over 4,000 residential properties with LSLs. Sampling results indicate that 46% of the homes with LSLs were above the proposed Health Canada MAC of 5 µg/L of lead when sampled at the tap.

38. During 2015-2018, EWSI also completed random sampling of drinking water at the tap for 883 residential properties across Edmonton. These random samples are intended to assess the average exposure of Edmontonians to lead from consumption of drinking water in the home. The results suggest that approximately 8.5% of random tap water samples collected from homes from across the city will exceed the Health Canada MAC due to lead plumbing and fixtures. Extrapolation of this data suggests that people living in as many as 23,000 homes in Edmonton and possibly several thousand more outside of Edmonton in the regional water system that receive EWSI water could be exposed to drinking water with lead concentrations exceeding the proposed Health Canada MAC.

3.1 Lead Service Lines in Edmonton

39. Figure 3.1-1 shows a typical residential service line in Edmonton. The service line consists of two portions. The portion of the service line from the water main to near the property line (the "utility portion") is owned by EWSI and the portion from the property line to the water meter in the home or building (the "private portion") is owned by the property owner. This split ownership of service lines is common to most cities in North America.

Figure 3.1-1
Ownership of Water Service Lines in Edmonton



40. As summarized in Table 3.1-1 below, EWSI estimates that as of the end of 2018 there are approximately 4,450 water service lines with lead on the utility side only, the private side only or on both sides. This represents about 1.6 % of the estimated 270,000 residential service lines in Edmonton. The breakdown between utility side only, private side only and both sides is provided in the table.

Table 3.1-1
EWSI Estimates of Lead Service Lines in Edmonton (2018)

		A Utility Portion	B Private Portion	C Total
1	Full	2,350	2,350	2,350
2	Utility-portion only	750		750
3	Private-portion only		1,350	1,350
4	**Total LSLs**	**3,100**	**3,700**	**4,450**
5	**% of All Residential Services**	**1.1%**	**1.4%**	**1.6%**

41. While EWSI's records concerning material on the utility portion of the service line are reasonably good, records concerning materials on the private portion are not generally available and, as a result, have been estimate from available records, field reconnaissance notes and industry data

42. Since 2008, EWSI has replaced an average of 141 utility portion of LSLs per year and abandoned an additional 17 LSLs each year. Of the 141 utility portion of LSLs replaced annually, approximately:

i. 49 per year are replaced on an emergency basis when a leaking service requires replacement;

ii. 37 are replaced under water main renewal programs; and

iii. 55 are customer driven. Customer driven means that EWSI has replaced the utility portion of the LSL because the customer has replaced the private portion and has requests replacement of the utility portion. Of these:

- 38 are customer replacements that occur in the current year often due to infill development where the customer has replaced the home, due to a leak on public property that has been repaired or for health reasons; and
- 17 account for a backlog of a customers that have replaced their LSL in previous years.

43. Abandonments occur when the house is removed entirely due to redevelopment.

44. At current replacement and abandonment rates, it will take EWSI approximately 20 years to eliminate the remaining 3,100 utility portion (2,350 both portions + 750 utility portion only) LSLs.

45. Under its existing programs, EWSI does not replace the private portion of the LSL. Currently, replacement of the private portion of the LSLs is voluntary and customers replace on average 38 private LSLs portion each year (described above). Most of these 38 LSL replacements occur in the course of infill re-development and replacement of the home and less than 10 per year are completed by the customer due to health reasons. EWSI believes that residential customers have been reluctant to replace the private portion of the LSL mainly due to cost.

46. In the absence of requirements for mandatory replacement, there is no readily determinable timeframe for replacement of private portions of LSLs. Given the estimated annual rate of replacement of customer replacement of private portions of LSLs of 38 per year and the estimated inventory of 3,700 it could take on the order of 100 years to eliminate all private LSLs.

47. Besides replacement of the utility portion of LSLs, EWSI's existing lead mitigation strategy that has been in place since 2008 includes:

i. annual notification of customers in homes with LSLs;

ii. testing of water at the tap in homes with LSLs;

iii. provision of point of use filters that remove lead to residents of homes with LSLs; and

iv. public education on measures to control lead at the tap.

3.2 Water Sampling Results in Edmonton

48. EWSI has conducted extensive testing for lead concentrations in Edmonton's drinking water. Between 2008 and 2018, water samples were collected at the tap from over 4,229 homes known to or likely to be serviced by LSLs. Between 2015 and 2018, EWSI conducted random sampling of 883 homes across the city of Edmonton. The findings of these two sampling programs are shown in Table 3.2-1. As

indicated in row 2 of the table, 45.8% of homes with known LSLs and 8.5% of all homes across the city had lead levels in excess of the proposed Health Canada MAC of 5 µg/L of lead when sampled at the tap.

Table 3.2-1
Estimated Number of Residential Homes above Health Canada MAC (2008-2018)

		A Homes Targeted With LSLs	B Random Homes Across the City
	Sampling Results:		
1	No. of Homes Tested	4,229	883
2	No. > 5 µg/L	1,397	75
	Extrapolation of Results:		
3	Total No. Residential Customers	4,450	270,000
4	% > 5 µg/L	45.8%	8.5%
5	**Est. Homes above MAC (row 3 x row 4)**	**2,038**	**23,000**[7]

[1]Total lead in 4 –L tap water samples collected from homes with LSLs after 30 min stagnation.
[2]Total lead in 1-L tap water samples after no stagnation in a random sample of homes largely without LSLs.

49. In row 5 of Table 3.2-1, EWSI has extrapolated the sampling results to estimate the total number of residential homes in Edmonton that will exceed the proposed Health Canada MAC of 5 µg/L. The results indicate that approximately 23,000 homes in Edmonton may not meet the new Health Canada Guideline. It should be noted that due to the nature of the random sampling conducted in these 885 homes, it is not possible to identify which 23,000 will exceed the proposed Health Canada MAC and it is likely that results in individual homes will vary considerably. Diagnostic lead testing in all 270,000 homes within the city of Edmonton is not practical. However, the random sampling provides an overall assessment of the probability of exposure to drinking water containing levels of lead exceeding the proposed Health Canada MAC for people living in Edmonton homes.

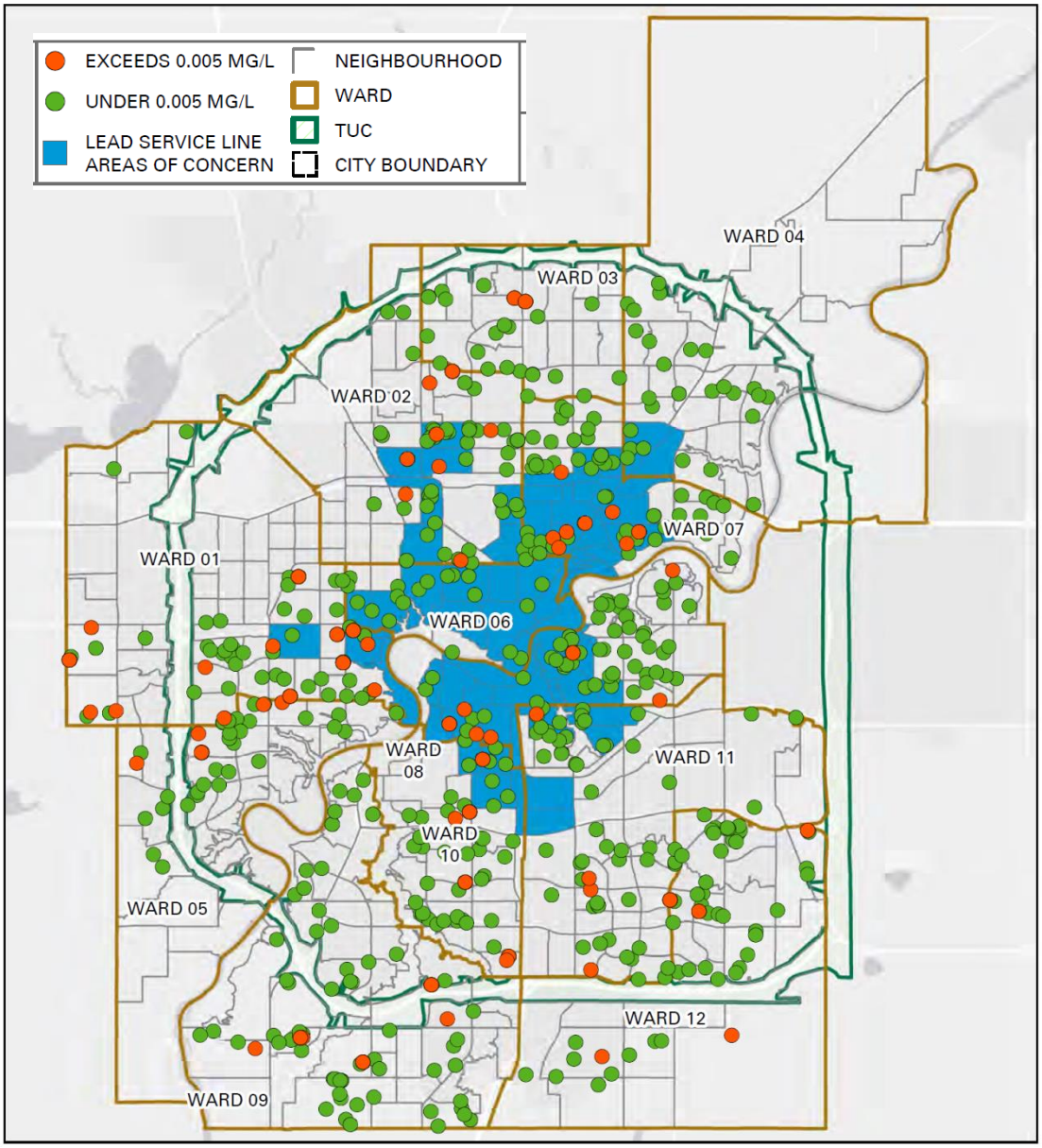
50. EWSI supplies water to 73 communities in the Edmonton Regional Water System. From discussion with the Regional Water Customer Group, EWSI believes there are no or few homes with lead service lines in these communities. The rate of lead MAC exceedances due to lead-containing plumbing components in these communities is likely to be the same as in Edmonton. Based on the size of relative populations served (942,000 in Edmonton and 335,00 in the regional communities), there may be another 8,000 homes in the regional communities that exceed the proposed lead MAC at the tap.

51. Figure 3.2-1, shows the distribution of the random home sampling results throughout the city. The area in blue represents neighbourhoods known to have LSLs.[8] The red dots outside the blue area represent the 8.5% of homes without LSLs that would not meet the new Health Canada MAC of 5 µg/L of

[7] To obtain the +/-27,000 estimate, EWSI did not sample all of its 270,000 customers in Edmonton as it is not practical to do so. The +/-27,000 estimate is an extrapolation based on EWSI's random sampling of 600 homes across the city of Edmonton which indicated that approximately 10.2% of these homes exceeded the new Health Canada MAC. Therefore, the estimated 27,000 homes cannot be readily identified.
[8] The blue area represent the neighbourhoods where LSLs are found, not all homes within these neighbourhoods are supplied through lead service lines.

lead when sampled at the tap. Most of these homes are in neighbourhoods built after 1950 and therefore would not have LSLs but may have lead-containing plumbing and fixtures.

Figure 3.2-1
Results of EWSI Random Sampling and Lead Testing at Homes Across Edmonton (2015-2018)



52. There has been indication that lead plumbing and fixtures in City of Edmonton schools are contributing to lead concentrations above the proposed Health Canada MAC. In 2017, Alberta Health Services conducted a study of 20 Edmonton area schools to assess water quality samples collected from taps and drinking water fountains. No schools in Edmonton are serviced by lead service lines and, as such, it is assumed the lead observed in the drinking water is associated with lead containing plumbing fixtures. Lead concentrations in water samples collected at the school taps were found to be greater

than in the samples collected from the distribution system. Lead concentrations were generally higher in the samples collected on Monday morning than in samples collected on Wednesday midday, suggesting stagnation was contributing to increased lead results in the water samples. If the Health Canada MAC is lowered to 5 µg/L as proposed, approximately 40% of the Monday morning samples and 20% of midday Wednesday samples would exceed the MAC.[9] Alberta Health Services is developing a plan to address the issue of lead in schools across the Province. The proposed EWSI Lead Mitigation Strategy will also mitigate lead levels in schools in Edmonton and in the region supplied with EWSI drinking water.

[9] Opportunities for Improving Drinking Water Quality in Large Buildings, K. Pinney et al, 2007

4.0 LEAD MITIGATION STRATEGIES

53. The selection of appropriate strategies for minimizing lead in water at the tap depends on many factors, including the characteristics of the water supply. EWSI has considered the following potential strategies for reducing lead in drinking water:

(i) Adding a lead corrosion inhibitor to drinking water supplies;

(ii) Removing lead sources from plumbing systems;

(iii) Using linings or coatings to enclose lead plumbing sources; and

(iv) Providing point of use filters to customers with LSLs.

4.1 Lead Corrosion Inhibitors

54. Lead corrosion inhibitors have been used by water utilities for more than 70 years to control lead release into water supplies and to prevent corrosion of iron pipe and other metals in the distribution system.[10] Of the medium and large utilities in the U.S., approximately 56% rely on a phosphate-based lead corrosion inhibitor in their water treatment processes.[11] Canadian Cities that report using phosphate-based lead corrosion inhibitors include Winnipeg, Hamilton, Toronto, Halifax and Saint John.

55. The most common lead corrosion inhibitors used by water systems are phosphate-based and are added to water to create the orthophosphate ion (PO_4^{2-}). The orthophosphate reacts with lead to form a protective coating of insoluble lead-phosphate mineral scale on the inside of lead service lines and household plumbing fixtures that act as a barrier, preventing lead from dissolving into the water. As a result, lead concentrations remain low as drinking water passes through the lines to the tap. The key to ensuring that orthophosphate reduces lead levels is to maintain proper orthophosphate concentration levels in the water in order to maintain the protective barrier. The optimum dose varies depending on the chemical characteristics of the particular water supply. Once orthophosphate dosing begins, it should not be discontinued because in the absence of orthophosphate, the water chemistry changes and the protective coating of insoluble lead-phosphate mineral scale begins to dissolve, allowing the sequestered lead to be released. The most notable example of the negative effects of discontinuing orthophosphate dosing was seen in Flint, Michigan. Flint changed its water supply from water provided by Detroit, which had orthophosphate added, to a local source which did not have a corrosion inhibitor. The result was a dramatic shift in water chemistry, allowing lead to leach back into the drinking water, negatively affecting the health of customers, particularly children.

[10] Orthophosphate will also help mitigate corrosion of other metallic piping such as iron and copper and, in some cases, may also mitigate concrete pipe corrosion. Orthophosphate can help prevent red water due to iron pipe corrosion.

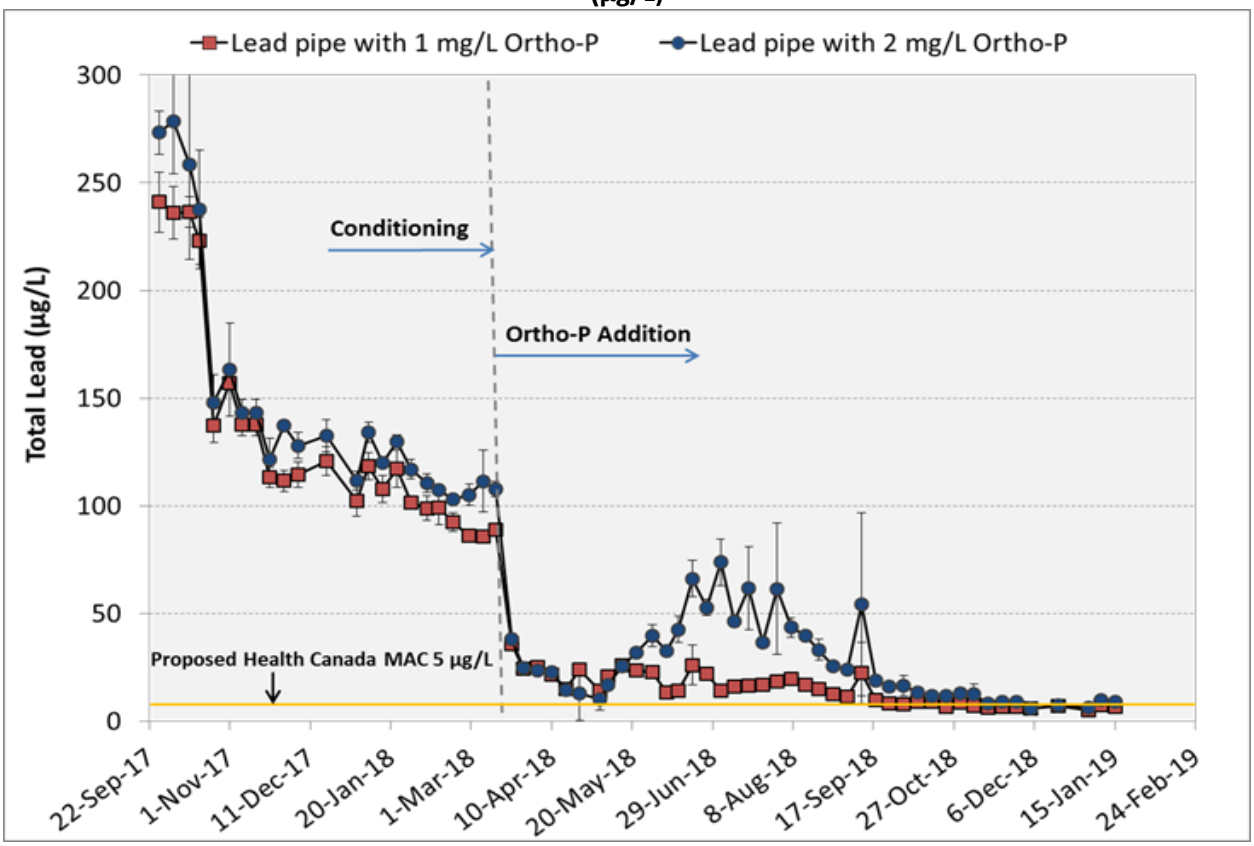
[11] McNeill, L.S., and Edwards, M. 2002. Phosphate inhibitor use at US utilities. Journal American Water Works Association, 94(7): 57–63.

56. In 2014, the Government of Alberta commissioned a study to evaluate the potential benefits of orthophosphate dosing on Edmonton's drinking water[12]. The study concluded that orthophosphate dosing would be a cost-effective strategy for reducing lead levels in Edmonton's drinking water and that a dose of 1.0 mg/L would result in an 80% reduction in lead concentration. These results are consistent with other jurisdictions that have introduced orthophosphate dosing.

57. EWSI undertook a pilot project at its E.L. Smith Water Treatment Plant between September 2017 and October 2018 to test the effectiveness of orthophosphate as a lead corrosion inhibitor in Edmonton's water. The lead release from lead pipes before and after orthophosphate addition at two dose levels (1 mg/L and 2 mg/L) is shown in Figure 5.1-1. Addition of phosphate at 1 mg/L (red line in Figure 5.1-1) and 2 mg/L (blue line in Figure 5.1-1) resulted in a 92% and 90% reduction, respectively, of lead release to the drinking water almost immediately after addition of orthophosphate began on March 13th, 2018. The 1 mg/L dose showed more promising results with a slightly greater (92%) lead reduction and more stable lead concentration, with less particulate lead release, than the 2 mg/L dose. The concentration of lead in these pipes decreased very rapidly when orthophosphate addition began, continued to decreased gradually with time and stabilized at about 6 µg/L was trending downwards slowly at the end of the study. The initial lead concentration prior to orthophosphate condition was very high (90-105 mg/L) in these pipes. Most LSLs homes in the field test much less than this (i.e. 95% test less than < 30 ug/L), so orthophosphate will be effective at reducing the lead levels to less than the proposed MAC of 5 ug/L in the majority of home with LSLs.

[12] Page 69, Optimization of plumbosolvency control using computational modelling techniques: a demonstration project for the Government of Alberta, working with the City of Calgary and EPCOR (Edmonton), WQM Associates Ltd, 2014

Figure 5.1-1
Results of EWSI Pilot Testing Orthophosphate Dosing on Lead Service Lines
Reductions in Total Lead Concentrations
(µg/L)



58. Adding orthophosphate to drinking water at the levels needed to inhibit lead concentrations has no impact on the taste or odour of drinking water and virtually no effect on the intake of dietary phosphorus. Phosphorus is an essential nutrient and is required by all cells for normal function. Phosphates, the source of dietary phosphorus, are naturally present in food and are a common additive to beverages. Health Canada's recommended dietary allowance ("RDA") of phosphorus ranges from 100 mg/day for infants less than 6 months, to 1,250 mg/day for children between 9 and 13, and 700 mg/day for adults, with tolerable upper intake levels ranging from 3,000 to 4,000 mg/day[13]. Optimal dosages of orthophosphates for inhibiting lead corrosion range 0.5 to 2.0 mg per litre of water, or between one-tenth of one percent and one-half of one percent of the RDA.

59. Based on the results of EWSI's research, testing, and analysis, adding orthophosphate to Edmonton's drinking water will provide a significant reduction in lead levels measured at the tap. Orthophosphate addresses lead leaching into drinking water from lead plumbing and fixtures in the home, as well as from LSLs. Although these reductions are significant, orthophosphate on its own will

[13] Heath Canada Dietary Reference Intake tables https://www.canada.ca/en/health-canada/services/food-nutrition/healthy-eating/dietary-reference-intakes/tables/reference-values-elements-dietary-reference-intakes-tables-2005.html.

not reduce lead concentrations to the proposed Health Canada MAC in all homes with LSLs[14] and ongoing water sampling of LSL homes will still be required. Accordingly, while dosing of orthophosphate is an essential element of EWSI's strategy for reducing lead concentrations in drinking water, additional actions will be needed to remove sources of lead and achieve the proposed Health Canada MAC for lead in all residences with LSLs.

60. The effectiveness of corrosion control additives is highly dependent on the chemistry of the particular water supply. Variables such as pH, alkalinity, dissolved inorganic carbon, natural organic manner, oxidation reduction potential and disinfectant type must be considered. As noted earlier, the authors of study sponsored by Alberta Environment and Parks in 2014 recommended orthophosphate in the Edmonton water for reduction of lead release. This is consistent with the US EPA recommendations (US EPA 2016 *Optimal Corrosion Control Treatment Evaluation Technical Recommendations for Primacy Agencies and Public Water Systems*) for chemistry of the treated water in Edmonton. Other corrosion control alternatives were considered in the early stages based on review of literature and industry practices and were ruled out. These included (1) increasing pH (2) increasing alkalinity (3) addition of silicates and (4) conversion from a chloramine to free chlorine as the disinfectant in the distribution system. Each of these options is considered further below:

i. **Increasing pH:** The City of Ottawa has used a strategy based on increasing the pH of the water to reduce lead release. Increasing pH is not a viable option for the Edmonton water because of the moderate level of calcium and magnesium hardness in the water (about 165 mg/L as $CaCO_3$). Increasing the pH of the water further would result in a significant water quality problem associated with deposition of calcium and magnesium hardness scale on plumbing components, fixtures and equipment.

ii. **Increasing Alkalinity:** Increasing carbonate alkalinity can also result in reduced lead release for low alkalinity water (< 30 mg/L $CaCO_3$). The alkalinity of Edmonton water is already fairly high at 130 – 150 mg/L as $CaCO_3$ making this a poor candidate for lead control. Also, increasing alkalinity, like increasing pH, would increase the tendency to form hardness scale.

iii. **Addition of silicates:** Addition of silicate corrosion inhibitors is only recommended for lead control for low alkalinity waters. Silicate addition would also tend to raise the pH of the water which would result in formation of scale. In addition, there is a lack of research on the effectiveness of silicates as corrosion inhibitors and practical industry experience is limited.

iv. **Conversion of chloramine to free chlorine to increase the oxidation-reduction potential**: EWSI uses chloramine (a combination of free chlorine and ammonia) in the Edmonton water system as disinfectant in the distribution system. The other common form of disinfectant used in water systems is free chlorine. Research has shown that, all other things being equal, waters with free

[14] Lead Levels at the Tap and Consumer Exposure from Legacy and Recent Lead Service Line Replacements in Six Utilities, E.Deshommes and etal. (2018)

chlorine tend to result in less lead release from lead pipes compared to waters with chloramine. In addition, there have been some fairly high profile cases (i.e. Washington DC in the early 2000s) where municipalities have switched from free chlorine to chloramine for other reasons and observed an increase in lead release from lead service lines. The option of converting from chloramine to free chlorine in the Edmonton Water system to reduce lead concentrations at the tap was ruled out for the following reasons:

- Chloramine is very stable disinfectant compared to free chlorine and this property is critical for maintaining a disinfectant residual within the larger Edmonton regional water system. A minimum chlorine residual must be maintained to maintain water quality, protect public health protection and meet Alberta Environment and Parks operating approval requirements. Conversion from chloramine to free chlorine would require installation of multiple chlorine booster stations throughout the regional system to ensure safe chlorine residuals are maintained at each of the more than 70 communities served. The capital cost of booster stations would be higher than the capital cost of orthophosphate dosing infrastructure.

- Conversion from chloramine to free chlorine has not been used in the water industry as means of corrosion control to reduce lead concentrations and will likely not result in the desired reduction in lead concentration. Many utilities that use free chlorine disinfectant (the city of Winnipeg for example) have adopted orthophosphate as a corrosion control inhibitor to meet lead targets. Unlike orthophosphate, free chlorine is not stable in water distribution systems. It would be virtually impossible to ensure that lead pipe and plumbing components are uniformly exposed to the desired free chlorine concentration at all points in the system.

- Utilities that experienced increases in lead as a result of converting from free chlorine to chloramine have typically resorted to orthophosphate in the end. For example, Washington DC began orthophosphate addition following conversion from free chlorine to chloramine and this was effective at reducing lead levels at the tap.

- Conversion from chloramine to free chlorine would involve other significant changes to water quality including formation of health-related regulated disinfection by products (trihalomethanes and haloacetic acids) and would likely result in adverse impact on taste and odour.

4.2 Removal of Lead Sources

61. Like most utilities, EWSI has capital improvement programs that include the removal or replacement of the utility portion of LSLs. Research has shown, however, that partial LSL replacement is not effective in decreasing in lead levels when compared with full service line replacement (replacing both utility and private portions). In some cases, partial replacements may even increase drinking water

lead levels for some period of time after replacement, if lead scales or sediments containing lead in the privately owned portion of the LSL are disturbed or dislodged when the utility portion of the LSL is replaced[15]. Therefore, utilities have begun to discontinue partial LSL replacements and have adopted policies to replace the private portion of the LSL whenever the utility portion of an LSL is replaced.

62. Alberta Health Services currently recommends that utilities and homeowners plan to change lead pipes when levels are observed above 10 µg/L (the current lead MAC). EWSI expects that this recommendation will soon be revised to correspond to the new Health Canada MAC. Consistent with other jurisdictions, Alberta Health Services notes that partial replacements of service lines have been shown to be ineffective and can even increase lead concentrations in drinking water. Accordingly, Alberta Health Services recommends that both the private and utility portions of LSLs should be replaced to most effectively reduce lead levels in drinking water.[16]

63. Lead-containing plumbing and fixtures are also sources of lead in drinking water. Except for specific programs in some jurisdictions providing funding for replacement of high lead plumbing fixtures in schools, replacement of plumbing and plumbing fixtures is the responsibility of the customer. Education campaigns and coordination with local plumbing supply and plumbing fixture retailers can help encourage customers to replace these fixtures over time, but lead fixtures are expected to remain in service for many years. Accordingly, EWSI believes that the use of a lead corrosion inhibitor will still be required to meet the proposed Health Canada MAC in the majority of homes with lead-containing plumbing and plumbing fixtures.

4.2.1 Funding for Private Portions of LSL Replacements

64. The reported average total cost to replace a private portion of an LSL is about $5,000 in Canada. In Edmonton the average cost of the private portion is $7,500 because LSLs tend to be deeper. Costs and public awareness of the issue are significant barriers to LSL replacement and even with partial funding or financing assistance for private service line replacement in place, low participation by homeowners is observed[17].

65. EWSI has completed a contextual analysis of other communities across North America providing financial assistance to homeowners with private portion LSL replacement. EWSI was able to identify 19 (14 US and 5 Canadian) municipalities who provide such programs either on a mandatory or voluntary basis. The following summarizes EWSI's key learnings from this contextual analysis:

- **Mandatory Programs (10 of 19 utilities reviewed) –** More than half of the programs reviewed relied on mandatory LSL replacement programs through the implementation of bylaws or ordinances to achieve full replacement of LSLs in a shorter timeframe (12 years on average). These mandatory programs were used in communities where over 10% of customers have LSLs. Under these

[15] Final Human Health State of the Science Report on Lead, Health Canada, Feb 2013
[16] Lead and Drinking Water from Lead Service Lines, Alberta Health Service, 2013
[17] Canadian Water and Wastewater Association Letter to The Standing Committee on Transportation, Infrastructure and Communities, date June 27, 2017.

mandatory programs, customers were generally required to fund a portion of the LSL and are offered financing. Water service is threatened to be cut off if the homeowner does not comply.

- **Voluntary Programs (9 of 19 utilities reviewed) -** For voluntary programs where LSL replacement was not required under a bylaw, customers are generally required to fund all or a portion of the lead service line replacement. Voluntary programs tend to result in low customer participation rates (replacement of only about 10% of private LSLs in the first 10-15 years of the program, which would suggest a timeframe of over 100 years to replace all LSLs in these communities);

- **Municipally-owned Utilities (17 of 19 utilities reviewed)** – Municipally owned utilities, using either mandatory and voluntary approaches, funded between 25% and 100% of private portion LSL replacement costs from a variety of sources including government grants, capital and operating budgets, and through water rates with the remaining portion funded by customers. In many cases, customers are offered financing arrangements or charged a special assessment against property taxes to spread the cost over several years.

- **Privately-owned Utilities (2 of 19 utilities reviewed)** - The two privately-owned utilities funded 100% of private portion LSL replacement costs through water rates charged to all customers under voluntary programs. This approach was driven by administrative burden, costs, risks and low uptake associated with providing financing for customers to replace their private portion LSLs. In addition, private utility companies do not have the ability to implement special assessment against property taxes. The regulator in one case concluded that "*replacing a lead customer-owned service line at the same time as lead Company-owned service line is in the public interest… makes economic sense and greatly simplifies the replacement process*"[18] and funding through rates was not considered to "*pose a significant financial burden*"[19] for ratepayers.

66. Based on its review and analysis of the various funding strategies for replacing LSLs, EWSI is proposing to include the operating and capital expenditures to replace the private portion of the LSLs in its utility cost of service that is recovered through water rates.

4.3 Linings and Coatings

67. Pipe lining and coating technologies involve coating the inside of existing pipes to create a barrier between the lead pipe and the water and preventing the lead from leaching into the water system. While linings and coatings provide potential reductions in lead levels, EWSI ran its own pilot program in 2010 and found that pipe coatings were difficult to apply and the benefits compared to replacement were not clear. A more recent study from the Water Research Foundation concluded that linings were not recommended for general use by utilities and customers because: complete LSL

[18] P-2016-2577404, Petition of York Water Company for an Expedited Order Authorizing Limited Waivers of Certain Tariff Provisions and Granting Accounting Approval to Record Cost of Certain Customer-Owned Service Line Replacements to the Company's Services Account

[19] Document 256968, Par. 39-41, Nova Scotia Utility and Review Board

replacement is the priority and linings and coatings do not permanently address the problem; lifespan of the lining is unknown; high lead levels could recur in the future should the lining material deteriorate; and long-term water lead level testing and monitoring would need to be maintained and may warrant full LSL replacement in the future[20].

68. Not surprisingly given these drawbacks, EWSI did not identify any jurisdictions within Canada or the United States currently using coating and lining technologies. In fact, the State of Michigan has banned lining and coating technologies as an alternative to LSL replacement. EWSI also contacted Affinity Water, a privately-owed water utility in the United Kingdom, to understand their recent experience with lining technologies. Affinity Water noted that although pipe linings are beneficial in specific circumstances where it is difficult to complete full LSLs (e.g. when services pass under buildings), they have stopped using linings and are instead focusing on full replacement of LSLs because of operational issues, including lower customer satisfaction, longer service interruption time and similar overall costs to private LSL replacement.

69. Based on its research and analysis, EWSI has concluded that lining and coating technologies are not a viable alternative for reducing lead in drinking water in Edmonton because the technical and operational risks noted above are estimated to be greater than the potential benefits.

4.4 Point of Use Filters

70. The use of home filtration devices can serve as an interim solution to remove lead from drinking water until permanent solutions can be implemented. Health Canada recommends for best results, these devices be installed at the tap that is most commonly used for drinking water, certified to the NSF International standard (NSF 53) for lead removal and installed and maintained (or replaced) according to the instructions provided by the manufacturer.[21] Multiple municipalities provide free or discounted water filtration devices as interim solutions in homes where sampling results reveal elevated lead levels and where children are present.

71. EWSI currently provides free faucet-mount or pitcher style filters to residents in all homes in Edmonton where there is a record of a LSL. The residents are responsible for on-going replacement of the filter cartridges. While effective at removing lead, these filters are awkward to use, require on-going attention of the customers to maintain and are not consistent with the goal of providing safe drinking water at the tap at all times. EWSI considers the supply of these kinds of filters to be a temporary solution to high lead levels at the tap and will continue to supply point-of-use filters to residents of homes with LSLs, until the LSLs have been replaced. EWSI also evaluated other filter systems, specifically an under-the-sink mounted filter that was professionally installed by a plumber. The under-the-sink filter was effective at removing lead, however, it was administratively challenging for EWSI to manage and delays in arranging a filter installation with customers resulted in longer waits for customers.

[20] Evaluation of Lead Service Line Lining and Coating Technologies, Water Research Foundation, 2017
[21] Water Talk: Reducing your Exposure to Lead from Drinking Water, Health Canada 2016

Customers can always choose other in-home treatment solutions that match their needs but EWSI has concluded that continuation of its point-of-use filter program provides the best rapid and immediate measure for protecting customers from exposure to lead from LSLs.

5.0 PROPOSED LEAD MITIGATION STRATEGY

5.1 Overview

72. EWSI is proposing an enhanced Lead Mitigation Strategy to reduce lead at the tap and to ensure that safe drinking water is provided for all of its Edmonton and regional customers. The program consists of the following three main components that are described in more detail in the sections that follow:

i. ***Adding a lead Inhibitor (orthophosphate) to the Drinking Water***: This will control and reduce the release lead into drinking water from all sources, including LSLs and plumbing components, up to the tap. This will provide protection against lead release throughout all of Edmonton and the more than 70 municipalities supplied through the regional water system;

ii. ***Elimination of Partial Lead Service Line Replacements / Utility Funding of Private Portion Replacements*:** Eliminate the current practice of partial LSL replacements in Edmonton by ensuring full replacement of both the utility portion and the private portion of the LSL whenever the utility portion is replaced as a result of emergency repairs and water main renewals, including utility funding of the private portion replacement when completed by EWSI;

iii. ***Accelerated Replacement of High Priority Lead Service Lines / Utility Funding of Private Portion Replacements*:** Accelerate full LSL replacement (utility portion and private portion) in High Priority homes over a five-year period. High priority homes are defined as those where the concentration of lead at the tap is still greater the MAC of 5 ug/L after corrosion control is in place.

73. The environmental impacts of addition of orthophosphate to the drinking water for lead corrosion control, particularly the impact on the wastewater treatment plants in the region and the potential for additional phosphorus loading to the river, are considered in detailed in Section 5.2.3

74. The full replacement of LSLs in components (ii) and (iii) above means replacing both the utility portion and the private portion of the LSL. Replacement of the private portion of the LSL through EWSI's proposed Lead Mitigation Strategy will be managed by EWSI through private contractors. Full replacements will be facilitated by funding the operating and capital costs to replace both the private portion and the utility portion through an increase in rates for all of EWSI's Edmonton customers as further detailed in the Section 6. EWSI will not fund the replacement of LSLs with lead present only on the private portion unless they qualify as High Priority homes.

75. EWSI will continue with its efforts to annually notify customers in homes with LSLs, sample water at the tap in homes with LSLs, provide point-of-use filters to residents in homes with LSLs and provide public education on measures to control lead at the tap.

76. Stakeholder consultation with EWSI customers was carried out to determine EWSI Edmonton customers awareness and attitudes toward the subject of lead in drinking water and their potential reaction to the proposed strategy. The key regulatory agencies, Alberta Environment and Parks and Alberta Health Services, and the Regional Water Customer Group that represents the regional customers were also consulted. Section 5.7 provides further detail.

77. EWSI's operational plan is provided in Appendix C and its communication plan is provided in Appendix E to this business case.

5.2 Lead Corrosion Control

5.2.1 Implementation of Orthophosphate Dosing

78. EWSI is proposing to add 0.9 mg of phosphorus per litre of water ("0.9 mg/L as P") to Edmonton drinking water to reduce lead in all homes from all sources (LSLs, plumbing and fixtures) beginning in 2021 by constructing orthophosphate dosing facilities at both EWSI's E.L. Smith and Rossdale water treatment plants. EWSI's pilot study demonstrated that and orthophosphate dose of 1 mg/L was effective for reducing lead release from a LSL exposed to Edmonton drinking water. Another factor to be considered when selecting the target orthophosphate dose for system-wide corrosion control is that the current EPCOR Drainage Bylaw (18100) limits the concentration of total phosphorus in the discharges to the storm sewer system to 1.0 mg/L a P. Therefore, EWSI has selected an initial target dose of 0.9 mg/L orthophosphate to ensure that discharges from the water system due to routine distribution system flushing activities do not result in bylaw exceedances.

79. Orthophosphate dosing will begin in early 2021 following approximately two years for detailed design and construction of orthophosphate dosing facilities at both EWSI's E.L. Smith and Rossdale water treatment plants. The dosing systems will consist of phosphoric acid storage tanks, dosing pumps, associated piping, controls and buildings to house the equipment. These facilities will be constructed downstream of the high lift pumps, so that phosphorus is not released to the river during filter backwashing or other plant maintenance activities.

80. The dosing systems will add diluted (75%) phosphoric acid to the treated water in the water leaving the storage reservoirs at the plant. Although the conceptual design of the system is based on an initial target dose of 0.9 mg/L (as P), it is fully expected that further optimization will be required in the 1 to 3 year period following commencement of orthophosphate addition. The system, therefore, will be designed to be able provide for dosages between 0.5 mg/L and 2.0 mg/L to allow for optimization of the dose as needed with a long term goal of orthophosphate dosing at 0.7 mg/L (as P). Optimization will be based on continued monitoring for both lead and orthophosphate at the tap in homes across the city, both with and without LSLs.

5.2.2 Predicted Effectiveness of Orthophosphate

81. EWSI's pilot study demonstrated that a 90% reduction in the lead release from an LSL by exposure to orthophosphate does of 1 mg/L in a controlled experimental setting. For the purposes of

the proposed program, EWSI has assumed that an orthophosphate dosing 0.9 mg/L in practice will reduce lead concentrations by 80%. This assumption applies a margin of safety to the EWSI pilot study results and accounts for the uncertainty in extrapolating pilot results to field conditions. It is also consistent with the results of the 2014 Government of Alberta sponsored study that predicted an 80% reduction in lead release for this orthophosphate dose. This assumption will be revisited after the introduction of orthophosphate and the scope of the program will be adjusted as necessary. Based on reports and informal discussions with other utilities that have implemented orthophosphate for lead reduction, EWSI considers the likelihood of reductions in lead levels of less than 70% to be unlikely.

82. Table 5.1-1 below provides predictions of the number of LSL homes and all homes across Edmonton that will test above the proposed Health Canada MAC of 5 ug/L for lead at the tap following introduction of orthophosphate. These predictions were arrived at using the EWSI current database of testing in for lead at the tap at over 4,000 homes with LSLs and at over 883 random homes across the city and by applying different levels of lead reduction to the distribution of lead concentrations in those datasets. Predictions of the number of homes above the proposed Health Canada MAC varies widely based on the assumed level of reduction in lead release. For the chosen level of 80% lead reduction, EWSI predicts that the fraction of the 4,450 homes with a LSL exceeding the proposed lead MAC of 5 ug/L will decrease from 45.8% to 8.0%. That is 356 homes with LSLs will still test above the proposed lead MAC of 5 ug/L after orthophosphate addition at the proposed dose. For all homes across Edmonton, addition of orthophosphate will reduce the number of homes exceeding the proposed lead MAC of 5 ug/L at the tap due to lead release from plumbing components from 23,000 (8.5%) to 5,500 (2.0%).

Table 5.1-1
Prediction Number of Edmonton Homes Exceeding the Proposed Lead MAC After Orthophosphate Addition

	Exceeding Proposed Health Canada Lead MAC of 5 µg/L	A	B	C	D
		Homes with LSLs		All Homes Across Edmonton	
1	Current Program - No Orthophosphate	2,036	45.8%	23,000	8.5%
	Effect of addition of Orthophosphate				
2	90% Reduction in Lead	49	1.1%	1,500	0.6%
3	**80% Reduction in Lead**	**356**	**8.0%**	**5,500**	**2.0%**
4	70% Reduction in Lead	710	16.0%	8,900	3.3%
5	60% Reduction in Lead	1,078	24.2%	11,600	4.3%
6	50% Reduction in Lead	1,332	29.9%	13,800	5.1%

5.2.3 Mitigation of Potential Environmental Impacts of Orthophosphate

83. The Gold Bar wastewater treatment plant (WWTP) in Edmonton must meet total phosphorus limits for discharge of treated wastewater to the North Saskatchewan River. Addition of orthophosphate to the drinking water at the proposed dose of 0.9 mg/L (P) will result in an increase in phosphorus loading in the WWTP influent of about 12%. Currently, the Gold Bar WWTP relies primarily on the Biological Nutrient Removal (BNR) process to remove of phosphorus from the wastewater. In BNR, a

specific group of microorganisms remove phosphorus from the water by using it as food. The Gold Bar WWTP also has the capability to chemically remove excess phosphorus that is not removed by the BNR process by addition of alum. The phosphorus removed by these processes ends up in the biosolids and has potential nutrient value when the biosolids are applied to agricultural fields.

84. EWSI carried out an engineering analyses to determine the operational impact of the additional phosphorus loading to the Gold Bar WWTP . The goal is to maintain the current level of phosphorus in the treated wastewater discharged to the river (i.e. no increase in phosphorus loading to river). The analysis determined that the best approach to achieve this goal at the Gold Bar WWTP will be to maximize BNR capacity and remove any excess phosphorus by addition of alum. The Gold Bar WWTP can achieve this without any upgrades to the plant for the foreseeable future. The additional costs at Gold Bar will be mainly related to the cost of adding alum.

85. An additional effect is that some of the orthophosphate added to drinking water will be released to the North Saskatchewan River from storm and combined sewers, or from overland or groundwater flows[22]. EWSI estimates that the increase in total loading from these sources will result in between 5% and 16% increase in the phosphorus released to the North Saskatchewan River within the city between the months of May and September depending on the assumptions made. Additional phosphorus loading to the river could result in an increase in growth algae in the river during summer months, however, there is significant uncertainty around this prediction. EWSI will conduct additional environmental monitoring after the addition of orthophosphate to assess the actual increase in phosphorus loading to the river and the associated environmental impact if any.

86. To mitigate phosphorus release to the river directly from the Rossdale and E. L. Smith drinking water treatment plants, the orthophosphate will be injected into the water at a point downstream of the on-site treated water storage reservoirs where the water is enters the distribution system. This will eliminate phosphorus from the treatment plant filter backwash water supply systems and any phosphorus loading to the North Saskatchewan River via existing waste streams.

87. Orthophosphate added to the drinking water at the two WTPs in Edmonton will also be in the wholesale drinking water supplied by EWSI to the regional water service commissions and their customers. These customers will be able to benefit from the lead corrosion inhibition properties of the orthophosphate and will be allocated a portion of these costs (approximately $7 million in net present value).

88. Many of the communities served by the regional system discharge their wastewater to either the Alberta Capital Region Wastewater Commission (ACRWC) or to local wastewater treatment

[22] This includes orthophosphate in drinking water that is released to the river at the water treatment plants (i.e. for filter backwashing), through drinking water distribution flushing activities and other system losses, due to outdoor water use, combined sewer overflows and WWTP wet weather bypasses.

lagoons.[23] Lagoons in Alberta do not have total phosphorus limits. EWSI has informed ACRWC about the intent to dose orthophosphate. A similar engineering analysis as the one done for the Gold Bar WWTP was carried out by the ACRWC for their wastewater treatment plant. The conclusion of the ACRWWC analysis was similar to the Gold Bar WWTP analysis. The plant will be able to manage the 12% increase in phosphorus loading in the influent wastewater primarily by addition of alum to chemically precipitate the addition phosphorus. The additional costs incurred will include alum costs and trucking and disposal of additional biosolids.

5.3 Elimination of Partial LSL Replacements

89. To eliminate any future partial LSL replacements, EWSI will complete the replacement of the private portion at the same time as it replaces the utility portion of LSLs for all emergency replacements (to repair leaks) or replacements during the water main renewal programs.

90. Replacement of the utility portion of LSLs typically involves excavating to the water main in the street or the alley (approximately 3 m depth) and at the property line and replacing the utility owned section of the lead line with a copper line. Replacement of the private portion of the service line requires either fully excavating from the property line to the foundation of the home, or using directional drilling technology to route a new service line (either copper or plastic) up to the foundation of the home. Finally, the new service line is connected to the water meter within the basement or crawl space of the home by excavating a small hole[24] in the basement or crawl space pad. EWSI is proposing to employ contractors to carry out the service line replacement work and to adopt directional drilling wherever possible over open cut. Directional drilling will result in less disturbance of assets on private property such as lawns, gardens, patios, etc.

91. EWSI repairs and replaces the utility portion of LSLs on an emergency basis because they have failed and begin to leak. The annual amount of failures on lead services varies from year to year, but on average 49 LSLs fail annually. As these types of replacements are on an emergency basis and need to be completed in a timely manner to restore water to the residents, EWSI crews will replace the utility portion to expedite the repair. Once the utility portion of the LSL repair is complete, an external contractor will follow EWSI as soon as possible and complete the replacement of the private portion of the LSL to eliminate the risk of partial LSL replacements on a go forward basis. These complete LSL replacements can begin as early as 2019 for purposes of the financial assumptions in this business case, EWSI has assumed a 2020 start.

92. For the homes with LSLs that coincide with EWSI's Water Main Renewal programs, replacement of full LSL and utility-portion only LSLs will be completed by EWSI along with the water main replacement. This will eliminate the risk of partial replacements on a go forward basis during Water

[23] With the exception of the Town of Vermillion, which has a small mechanical plant that releases to the Vermillion River. EWSI is working with the Town of Vermillion to identify the effects of orthophosphate addition on the town's phosphorus discharge limit and applicable mitigation efforts.
[24] A typical hole is 1 foot in diameter.

Main Renewal projects. The number of LSL replacements completed as part of EWSI's Water Main Renewal program can vary from year to year depending on the locations of the renewals and how many LSLs are present. EWSI currently completes on average 37 replacements of the utility portion of the LSL during the annual water main renewal program. In the proposed program, the water main will be renewed and then the full LSL replacement will follow prior to final restoration of the site. These completed LSL replacements may begin as early as 2019 for purposes of the financial assumptions in this business case, EWSI has assumed a 2020 start.

93. EWSI abandons on average 17 utility portion of the LSLs per year typically when neighborhoods are redeveloped and old homes are replaced. When this occurs, the private portion of the LSL is usually abandoned as well. For the purpose of this analysis, EWSI assumed that abandonments will continue to occur at the average annual rate of 17 per year into the future.

5.4 Accelerated Replacement of High Priority LSLs

94. While adding orthophosphate will result in a significant reduction in the number of customers with lead concentrations above the Health Canada MAC, EWSI anticipates there will still be approximately 356 homes with LSLs that will exceed the proposed Health Canada MAC of 5 ug/L assuming an 80% reduction in lead levels (Table 5.1-1). These LSLs will designated as High Priority for replacement. Some of these will have lead material on both the utility and private portion of the service, some on the utility portion only and some on the private portion side only. Based on the information in Table 3.1-1 and applying the 80% reduction, the estimated breakdown of the 356 High Priority homes will be 188 full, 60 utility only and 108 private only, respectively. In other words, 248 (188+60) utility portion LSLs will be targeted for replacement and 296 (188+108) privately owned LSLs will be targeted for replacement.

95. Under the proposed Lead Mitigation Strategy, EWSI will prioritize and target complete replacement of the LSLs in these 356 homes over a five-year period from the commencement of the program. If these are replaced over a 5 year period, the annual replacement rate will be 71 homes in all, 50 (248/5) utility portion LSLs, 59 (296/5) private portion of LSLs and 38 (188/5) full replacements.

96. Rather than wait until 2021 and implementation of orthophosphate addition begins in 2021, EWSI will to begin identifying and replacing High Priority LSLs using the existing extensive database of lead testing in homes with LSLs. EWSI intends to replace these 356 High Priority LSLs in order of the predicted lead concentration with highest lead concentration homes targeted for replacement first. The homes will scattered across many different neighbourhoods so they will generally be completed one at a time. However, all efforts will be made to coordinate the replacement of High Priority LSLs with other construction work, including water main renewals and City of Edmonton neighborhood renewals. EWSI will also continue tap water sampling of known homes with LSLs to identify any that exceed the MAC in the future. Full replacement of High Priority LSLs may being as early as 2019 but for purposes of the financial assumptions in this business case, EWSI has assumed a 2020 start.

5.5 Funding of Full LSL Replacements

97. EWSI is proposing to fully fund the replacement of the private portion of all of the LSL replacements to implement the elimination of partial LSL replacements and accelerated High Priority LSL replacements. EWSI considers this a fair and reasonable approach to funding this program because: (i) providing clean and safe drinking water is essential to protecting the public health of all Edmontonians and aligns with the City's strategic objectives; (ii) continuation of partial LSL replacements has been shown to be ineffective and potentially counterproductive to reducing lead in drinking water; (iii) historically only about 10 residential customers chose to replace their private portion of the LSL each year as a proactive measure to address health concerns; (iv) LSLs tend to be located in lower-income neighbourhoods and replacing the private portion of LSLs may be cost-prohibitive for many of EWSI's customers; (v) research has shown that even when partially subsidized there is limited uptake (on average 10% over 10-15 years) by customers to replace their private portion of the LSL; and (vi) other regulators have supported funding replacement of private portion of LSLs through the water rates on the basis that it is in the public interest.

98. EWSI is proposing to include the capital and operating expenditures to replace the private portion of the LSLs replaced as part of this program in its regulated cost of service which will be allocated to water ratepayers in the same manner as costs associated with replacing the utility portion of the LSLs are allocated under the currently approved rates. Under this proposal, the funding to replace the private portions of the LSL would be obtained through a small incremental rate increase for all of EWSI's Edmonton customers as detailed in section 6.

99. EWSI carried out a pilot project in 2018 that involved full lead service line replacements at eight homes within the city. Based on the experience gained in this pilot, EWSI will engage private contractors to carry out the work replacement of the private portion the LSLs. EWSI construction crews will carry out the work of the replacement of the utility portion of the LSL. EWSI gathered additional information on the potential costs of the replacement of the private portion of the LSL through a Request for Information (RFI) issued in late 2018. Based on the information received, EPCOR estimates that the average cost of replacement of private portion of LSL will be $7,500. This includes the cost of an hydrovac excavation to confirm the service line material prior to the work commencing ($1,000). Based on years of replacement experience, EWSI estimates the cost of replacement of the utility portion of the LSL to be $14,500 on average including costs of excavation and site restoration.

100. EWSI considered providing partial funding of the estimated $7,500[25] capital cost of private LSL replacements and offering the homeowner financing for their portion of the costs. This strategy would require EWSI to establish and administer a financing program, which would create significant administrative burdens, and create the risk of excessive bad debts. As partial funding including financing

[25] Estimated cost of privately-owned LSL is obtained through averaging of results from a Request for Information (RFI) issued to contractors, described in Appendix C to this Business Case.

has a significant administrative burden and does significantly improve private side replacements, the partial funding option has not been given further consideration.

101. EWSI researched the availability of grants or other government funding opportunities to fund the replacement of private lead service lines in the City of Edmonton. Based on the results of the research and conversations with Alberta Infrastructure and Transportation and Alberta Municipal Affairs, no government funding options are available for the program at this time. ESWI will continue to monitor the Government of Alberta website for new funding opportunities.

5.6 Continued Replacement of Utility Portion of the LSL for Customer-Initiated Replacements

102. EWSI will continue to replace the utility portion of approximately 55 LSLs per year at EWSI's cost in cases where the customer has decided to replace and fund their private portion. Although many customers may choose to replace their private portion of LSLs at their own cost , EWSI is not proposing any funding for these costs unless the private portion replacement is driven by a utility portion replacement involving a repair or water main renewal. EWSI would also fund private portion replacements if they fall into the High Priority category based on lead test result. Outside of these circumstances, future replacement of these private portion of LSLs will continue to be voluntary and funded by customers. The rationale is that the application of orthophosphate will reduce the lead level in these homes to below the proposed MAC of 5 ug/L and will, therefore, have reduced the associated health risk.

5.7 Stakeholder Consultation

103. EWSI conducted research to understand how Edmontonians would likely respond to the proposed Lead Mitigation Strategy. The information gathered will inform EWSI's communication plan and messaging to customers. In fall 2018, EWSI worked with market research firm Stone Olafson to probe on customer views on lead in drinking water in Edmonton. EWSI carried out face-to-face interviews and an online survey of approximately 400 customers with both customers with and without LSLs. The feedback from this research has provided the following insights into EWSI's customer's views:

- **Water Quality Concerns** - The large majority of customers (89% of respondents) believe their water is safe and (79%) drink the tap water today. Lead is not a top-of-mind issue for customers and when asked about potential water issues, only 5% of respondents mentioned lead. When provided information about the new Health Canada guidelines for lead and the potential sources of lead in the water system (LSLs, plumbing and fixtures), 53% still consider their water to be safe; 32% plan to conduct research to learn more; 18% plan to start filtering their water; and 10% plan to contact EPCOR to get their water tested.

- **Lead Corrosion Inhibitor (Orthophosphate)** - The survey determined that 27% of respondents would support the addition of a lead inhibitor while 44% would support with more information, 19% would oppose it until they received more information and only 4% said they would oppose

it regardless of any further information. The remaining 6% had no opinion. Generally, respondents would support the addition with further information about the safety of the additive, long-term effects and more specific information about the additive and how long other cities have been using it.

- **Funding for a Lead Mitigation Strategy -** When customers were told that the homeowner is currently responsible for the cost of replacing their portion of the LSL, 23% of respondents said it should be the home owner's responsibility; 38% said it should be EPCOR's responsibility and 33% said it should be a shared responsibility.

104. Based on the outcome of this public consultation process, EWSI recognizes that introduction of the new drinking water additive combined with a new program to replace private portion of LSLs (for High Risk, water main renewals and repairs) will require a well-coordinated and sustained stakeholder engagement and communication strategy. EWSI has developed a customer communication strategy to support orthophosphate dosing, encourage the replacement of remaining private portion only LSL (where the utility side has already been replaced) and to encourage customers to identify and replace lead-based plumbing and fixtures. EWSI's communication plan is included in Appendix E. The key messages in the communication plan are:

- When drinking water leaves EPCOR's water treatment plants and flows through the municipal water mains it contains no measureable level of lead.

- Lead service lines are a common source of lead. Another source can be a customer's private in-house plumbing, including old solder and brass plumbing fixtures.

- Water at the tap in these homes has the potential to exceed the maximum acceptable concentration for lead in drinking water set by Health Canada.

- Nothing has changed overnight with Edmonton drinking water. There is no immediate health risk, but the lead issue must be addressed over time.

- With the new guideline, Health Canada has set more challenging targets for lead in drinking water in order to improve overall health of Canadians

- Customers should be aware of the issue, especially in LSL homes, and can take immediate measures to reduce risk such as flushing their taps after the water has been stagnant or use of a filter.

- This new guideline, once announced, will enhance public health protection, and as Edmonton's water provider, EPCOR supports the change as it aligns with its efforts to reduce lead exposure from drinking water as much as possible.

105. In February 2019, EWSI held discussions with senior officials from Alberta Health and Alberta Environment and Parks to communicate its proposed Lead Mitigation Strategy and obtain feedback. Both have both provided letters in support of the proposed Lead Mitigation Strategy which are attached in Appendices A-1 (Alberta Health) and A-2 (Alberta Environment and Parks).

106. In September 2018, EWSI presented the proposal to add orthophosphate to the drinking water in Edmonton and the regional water system the Regional Water Customer group as information.

6.0 FINANCIAL EVALUATION OF ALTERNATIVES

107. EWSI considered the following five alternatives for mitigating lead levels at the tap:

A. Current Program - continue to replace utility portion of LSLs under existing repair and maintenance programs, water main renewal ("WMR") programs, and water service replacement and refurbishment programs.

B. Current Program and Add Orthophosphate – Alternative A and add orthophosphate to drinking water beginning in 2021.

C. Add Orthophosphate and Eliminate Partial LSLs – Alternative B and replace (including utility funding) the private portion of the LSL whenever the utility portion of the LSL is replaced under existing repair and maintenance programs, and WMR programs.

D. Add Orthophosphate, Eliminate Partial LSL Replacements and Accelerate Priority LSLs Replacements - Alternative C and accelerated full replacement (including utility funding) of all High Priority LSLs. In this alternative, replacement of LSLs replacement is prioritized, so that all LSLs that test greater than the proposed MAC of 5 ug/L at the tap are replaced within five years. This alternative includes replacement of utility portion, private portion and full LSLs that are targeted as High Priority.

E. Add Orthophosphate and Replace All LSLs over 15 years - add orthophosphate to drinking water beginning in 2021, replace all High Priority LSLs within five years and replace all LSLs (utility portion and private portions) over a fifteen-year period fully funded through the regulated rate base. This option includes utility funding of private portion replacements.

6.1 Annual LSL Replacement Assumptions

108. The annual expected number of LSL replacements under these alternative programs, broken into utility portions (row 5) and private portions (row 11), is summarized in table 6.1-1 below.

Table 6.1-1
Annual LSL Replacements

		A Current Program	B + Ortho-phosphate	C + Eliminate Partial LSL Replacements	D + Accelerated Replacement of High Priority LSLs	E Replace all LSLs over 15 years
	Utility Portion LSL Replacements					
1	Repair, maintenance and renewal	86	86	86	86	
2	Customer-initiated and backlog	55	55	55	55	190
3	High Priority (over 5 years)				50	
4	Abandonments	17	17	17	17	17
5	**Annual Reduction - Utility Portion**	**158**	**158**	**158**	**208**	**207**
	Private Portion LSL Replacements					
6	Customer-initiated	38	38	38	38	
7	Eliminate Partials (utility funded)			86	86	230
8	High Priority (over 5 years) (utility funded				59	
9	Abandonments	17	17	17	17	17
10	**Annual Reduction - Private Portion**	**55**	**55**	**141**	**196**	**247**
	Years to remove High Priority LSLs					
11	Utility Portion	20	20	20	5	5
12	Private Portion	n/a	n/a	n/a	5	5
13	**High Priority LSLs in 2038 (Year 20)**	**1,205**	**210**	**71**	**0**	**0**
	Years to Remove All LSLs					
14	Utility Portion	20	20	20	18	15
15	Private Portion	n/a	n/a	n/a	n/a	15
16	**LSLs (all Private Portion) in 2038 (Year 20)**	**2,630**	**2,630**	**885**	**757**	**0**

109. Key assumptions in Table 6.1-1 include:

- Lines 1 and 2: Utility portion LSL replacements are based on LSL replacements between 2008 and 2017. On average, EWSI replaces 141 utility portion LSLs each year, including 49 LSLs replaced through existing repair and maintenance programs, 37 replaced through water main renewal programs and 55 replaced in response to customer- replacements of their own service line. Of these 55, 38 are replaced by the customer in a given year. The remaining 17 have been replaced in previous years and are part of backlog list that EWSI acts on.

- Lines 3 and 8. After the addition of orthophosphate, EWSI expects that 8% of LSLs (248 utility portion LSLs and 296 private portion LSLs) will still test greater than the proposed MAC of 5 ug/L at the tap (High Priority LSLs). Alternative D accelerates replacement of High Priority LSLs, so that they are replaced within five years. After that time, the reduction in LSLs will return to the same level as in Alternative C. The average annual replacement rates will, therefore, be 50 (248/5) and 59 (296/5), respectively, for utility portion and private portion.

- Lines 4 and 9: Besides replacements, an average of 17 LSLs are abandoned each year. Since the entire LSL is affected, abandonments reduce both the quantity of utility portion LSLs and the quantity of private portion LSLs.

- Line 6: Customers voluntarily replace 38 private portion LSLs each year, usually when a property is redeveloped or when a leaking service line requires replacement on private property. In Alternatives A through D, the costs of customer-initiated LSL replacements are borne by the customer. In alternative E, since EWSI replaces all private portion LSLs, the cost of these replacements are funded by EWSI and included in the regulated rate base.
- Line 7: Eliminating partial LSLs requires replacing the private portion LSL whenever EWSI replaces the utility portion LSLs through its repair and maintenance programs. The 86 private portion LSL replacements are equal to the 86 utility portion LSLs replaced through EWSI's repair and maintenance programs (49) and water main renewal programs (37).

110. In Alternative E, full replacement of LSLs replaces the existing and partial replacement programs, so that all utility portion and private portion LSLs are replaced over a 15 year period. The annual average replacement rates, after adjusting for 17 abandonments per year are 190 (3,100/15 – 17) for the utility owned portion and 230 (3,700/15 – 17) for the privately owned portion. As with Alternative D, High Priority LSLs will be replaced in the first five years of the program and the replacement of the remaining LSLs will follow.

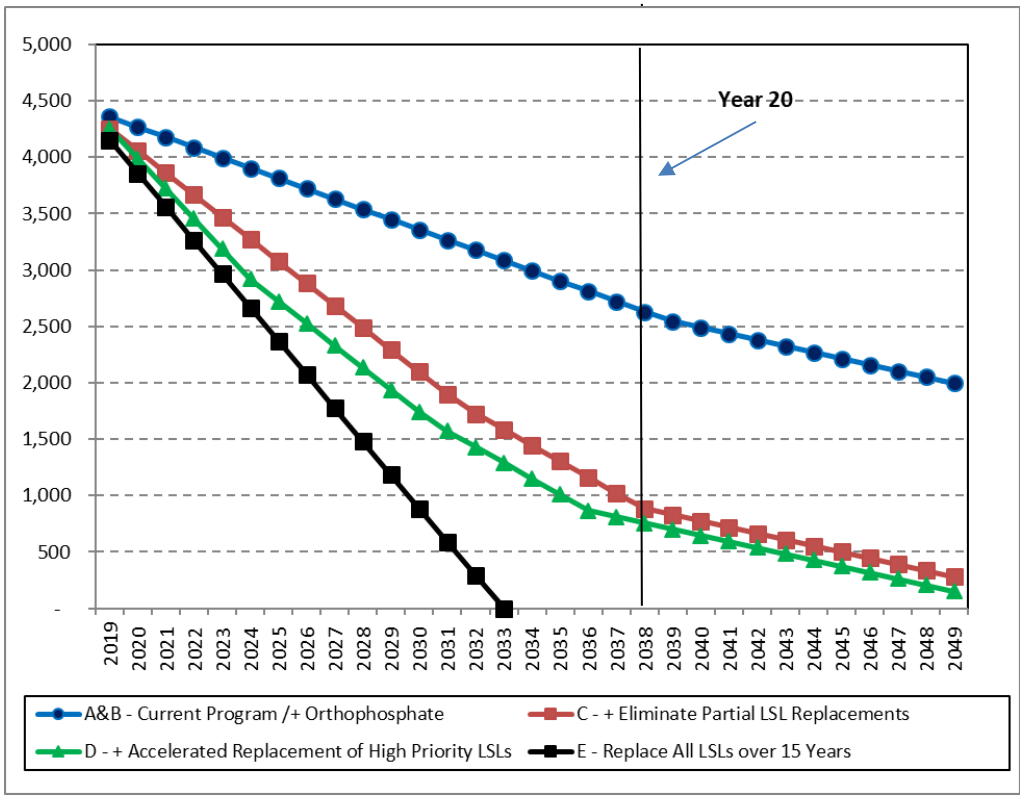
111. Lines 11 to 13 show reductions in High Priority LSLs under each alternative. Alternatives D and E accelerate replacements, so that High Priority LSLs are replaced within five years. Since Alternatives A, B and C do not focus on High Priority LSLs, these alternatives will leave LSLs with lead levels greater than the proposed Health Canada MAC in service indefinitely. Therefore, Alternatives A, B and C will not result in full compliance with expected regulations for homes with LSLs.

112. Lines 14 to 16 compare the total number of LSLs (all of which are private portion only) remaining in service in 2038, after all utility portion LSLs have been replaced. Although alternative E results in complete replacement of all LSLs (full, utility portion only and private portion only), this alternative requires a substantial increase in capital expenditures to accelerate replacement of private portion LSLs, most of which will have lead levels less than the proposed MAC. Alternative D, while leaving an estimated 757 private portion only LSLs in place, addresses all of the High Priority private portion LSLs, subject to the caveat that additional private portion LSLs may become High Priority as they age.

113. Figure 6.1-1 below shows the reduction in LSLs remaining in service under each alternative.

Figure 6.1-1

LSLs Remaining in Service



6.2 Financial Assumptions and Comparison of Alternatives

114. Table 6.2-1 below provides a summary of the net present value over a 30-year period (based on the economic life of the phosphoric acid injection facilities) of the cost impact to EWSI's In-City Water and Wastewater revenue requirements for the Current Program and the four alternatives for mitigating lead levels. An explanation of the assumptions supporting this table is included below the table.

Table 6.2-1
Financial Analysis of Alternatives
($million NPV)

	Revenue Requirements	A Current Program	B + Ortho-phosphate	C + Eliminate Partial LSL Replacements	D + Accelerated Replacement of High Priority LSLs	E Replace all LSLs over 15 years
1	In-City Water Revenue Requirement					
2	LSL Replacement Program					
3	Utility Portion	28.2	28.5	30.6	34.3	38.9
4	Private Portion			9.0	10.5	20.0
5	O&M		0.6	0.7	1.5	1.5
6	Sub-total	28.2	29.1	40.2	46.3	60.5
7	Orthophosphate Addition					
8	Phosphoric Acid Injection Facilities		9.0	9.0	9.0	9.0
9	Phosphoric Acid		14.9	14.9	14.9	14.9
10	O&M		6.1	6.1	6.1	6.1
11	Total Ortho-P		30.0	30.0	30.0	30.0
12	Less: Regional Share		(7.2)	(7.2)	(7.2)	(7.2)
13	Sub-total	-	22.8	22.8	22.8	22.8
14	**In-City Water Revenue Requirement**	**28.2**	**51.9**	**63.0**	**69.1**	**83.2**
15	Wastewater Revenue Requirement					
16	Orthophosphate Removal O&M	-	3.4	3.4	3.4	3.4
17	**Wastewater Revenue Requirement**		**3.4**	**3.4**	**3.4**	**3.4**

- **Replacement of the Private Portion of LSLs (line 4)** - Alternatives C, D and E include costs of replacing some private portions of LSLs. Alternative C includes replacement of the private portion of LSLs whenever EWSI replaces the utility portion of the LSL due to water main renewals and emergency repairs (to eliminate partial replacements). Besides eliminating partial replacements, Alternative D accelerates replacement of any LSLs with lead concentrations in excess of the proposed Health Canada MAC after the addition of orthophosphate. Alternative E includes systematic replacement of all full, private portion only and utility portion only LSLs over a 15 year term. EWSI has assumed that a cost of $7,500 in 2019 dollars for each private portion of LSL replacement. As with the utility portion of LSL replacements, this cost is based on responses to a Request for Information ("RFI" described in Appendix C) issued to local contractors, plus an additional $1,000 per private side LSL for hydrovac services needed to confirm the existence of the LSL prior to the start of construction.

- **Additional O&M Expenses (line 5)** - These costs include additional costs for operation of orthophosphate dosing systems, sampling and water testing needed to ensure compliance with the proposed Health Canada MAC, project management and coordination of LSL replacements, as well as on-going communication costs and annual notifications to homeowners with lead service lines. Alternatives D and E include additional costs for sampling and water testing sampling needed to target the High Priority LSLs. The enhanced sampling program will commence in 2020 and will conclude in 2025, after the last High Priority LSL is replaced.

- **High Priority LSLs (Alternative D, lines 4 and 5)** - Based on EWSI's assumption that orthophosphate dosing will reduce lead concentrations by 80%, 356 High Priority LSLs will be replaced over a five-year period beginning in 2020**.**

- **Addition of Orthophosphate (lines 7 - 11) -** Implementing an orthophosphate dosing program requires the construction of phosphoric acid injection facilities at the Rossdale and E.L. Smith Water Treatment Plants (the "WTPs"). EWSI expects that construction of these facilities will be completed by the end of 2020 at a cost of $9.8 million, with orthophosphate dosing to commence in 2021. This alternative also requires the purchase of 4.2 kg of phosphoric acid for every million litres of water treated at the WTPs, as well as the costs of personnel to operate and maintain the injection facilities.

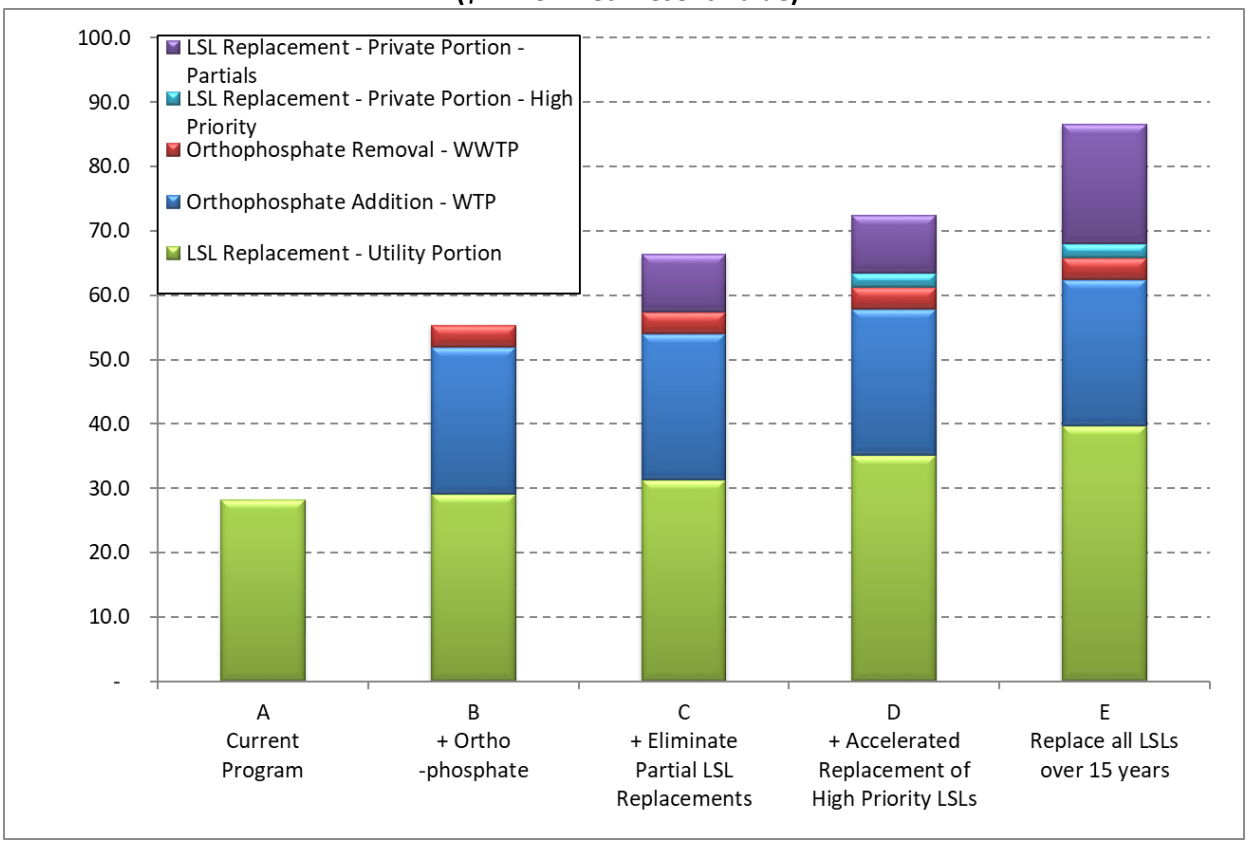
- **Regional share of costs (line 12**) - In accordance with the bulk water sales agreements with the members of the regional water customer group, regional customers share in the costs of water treatment in proportion to their demand on EWSI's water system. The regional customer share of demand is consistent with prior years' actual demand and long-term forecast demand.

- **Removal of Phosphorus (line 16) -** Adding orthophosphate to drinking water also increases phosphorus loading at EWSI's Gold Bar Wastewater Treatment Plant ("WWTP"). The additional costs at the Gold Bar WWTP are primarily the cost of alum to remove additional phosphorus.

- **Full Replacement of All LSLs (Column E)** - Besides specifically targeting High Priority LSLs, this alternative accelerates replacement of all LSLs, so that all full, utility-portion only and private-portion only LSLs are replaced within 15 years commencing in 2020. Relative to Alternative D, these alternatives require a substantial increase in capital expenditures to finance replacement of all private portion of LSL replacements and to advance the timing of utility portion of LSL replacements. This alternative assumes that the cost of all private portion of LSL replacements would be fully funded through EWSI's regulated rate base.

115. Figure 6.2-1 below provides a graphical depiction of the financial analysis as set out in Table 6.2-1 above. It also compares the net present value of the cost of the Current Program compared to the other four alternatives. Figure 6.2-1 breaks the investment between: (i) the cost of replacing the utility portion of LSLs (largely covered under approved investment in existing programs); (ii) the cost to add orthophosphate to drinking water beginning in 2021; (iii) the cost to remove orthophosphate from wastewater streams at the Gold Bar WWTP; (iv) the cost to replace private portion of LSLs replaced due water main renewals or emergency repairs; and (v) the cost to accelerate replacement of the private portion of High Priority LSLs.

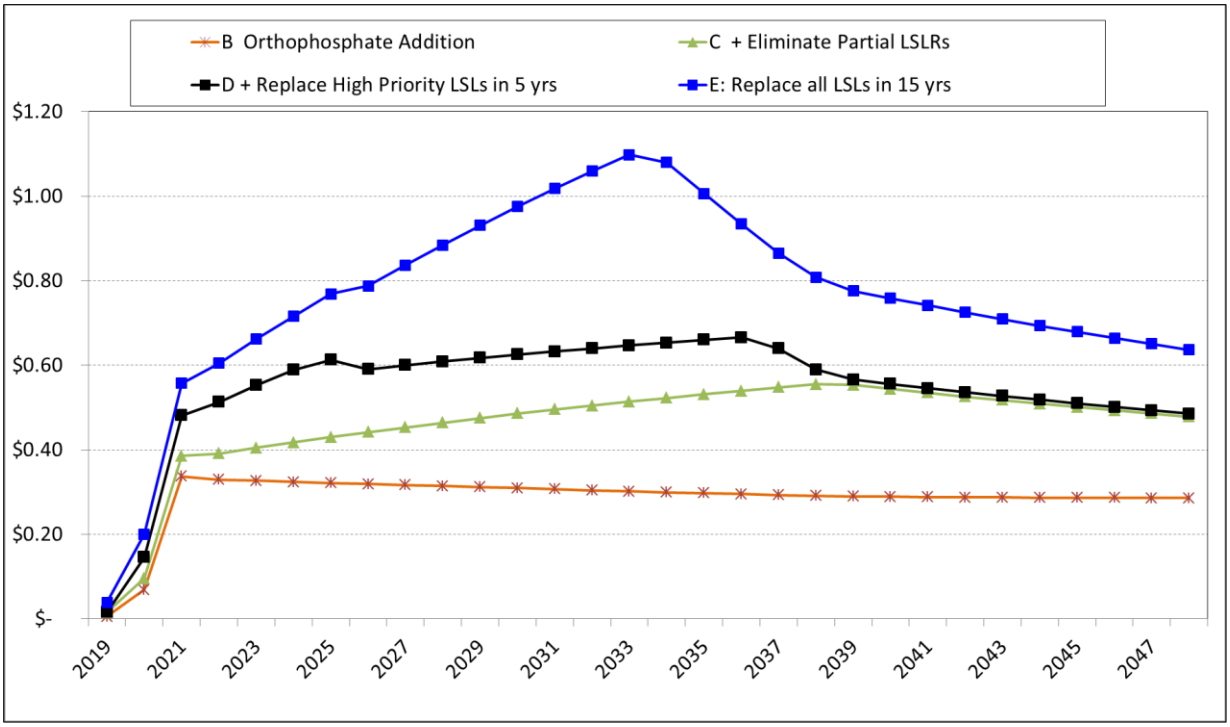
Figure 6.2-1
Financial Cost of Alternatives
($million Net Present Value)



116. The addition of orthophosphate at an NPV of $22.8 million (Alternative B) above the current program is forecast to reduce lead levels in homes with LSLs by 80% and to reduce the estimated number of homes with LSLs that exceed the proposed Health Canada lead MAC of 5 ug/L to 356. Adding elimination of partial LSL replacements requires and additional NPV of $11.1 million. These options, however, will not ensure full compliance with the new MAC for homes with LSLs. Alternative D is the least cost option for providing for full compliance for homes with LSLs by completely removing LSLs from the 356 homes that exceed the MAC by 2025 at an additional NPV of $6 million. Alternative E, the replacement of all LSLs alternative, will also result in full compliance with Health Canada MAC for home with LSLs, but at an additional NPV of $14.2 million relative to Alternative D.

117. The incremental impact on the average in-city residential water and wastewater bill for each of the proposed alternatives relative to the current program is show in Figure 6.2-2. Relative to the current program, which amounts to approximately $0.11 per month, the maximum annual rate impacts for the alternatives B, C, D and E are $0.34, $0.56, $0.66 and $1.09, respectively. For reference, average monthly water bill in 2018 including both the fixed monthly service charge and the variable consumption charge is $53 ($36 for water and $17 for wastewater). Alternative D, which includes orthophosphate addition, elimination of partial LSLs replacements and targeted replacement of High Priority LSLs, promises full compliance with the proposed Health Canada guideline in homes with LSLs and substantial reduction in lead in all homes in Edmonton and the region, with the lowest incremental impact on customer's monthly bills.

Figure 6.2-2
Incremental Impact of Lead Mitigation Alternatives
on Average Monthly Residential Water and Wastewater Bills
($ per customer per month - 2019-2048)



6.3 Non-Routine Adjustment Application

118. Prior to end of 2019, EWSI intends to file an application with the City Manager seeking a Non-Routine Adjustment ("NRA") to water rates beginning April 1, 2020 to recover the average annual increase in its water revenue requirement of approximately $1.1 million per year for the remaining three years of the current PBR term (2019-2021) necessary to implement its proposed Lead Mitigation Strategy. The revenue requirement for the proposed Alternative D to recover EWSI's costs for the period 2019 to 2021 as summarized in Table 6.3-2. The NRA increases the average monthly bill for the residential water customer by $0.40 per month beginning April 1, 2020.

119. The water related costs associated with this program exceeds the $500,000 annual revenue requirement threshold to be eligible for City approval as a NRA. EWSI is not proposing to apply for a NRA for increases to its wastewater revenue requirement as it is below the $500,000 threshold. With the upcoming changes to Health Canada's Guidelines for Drinking Water Quality and the eventual changes to Alberta regulations to enforce the new Health Canada MAC, the program will also meet the NRA criteria set out under the EPCOR Water Services and Wastewater Treatment Bylaw 17698:

> *5.1 Changes to Legislation, Regulation or Taxes*
> *In the event there is a change to:* ***legislation, regulation, bylaws, policy order or directive affecting EWSI's operations*** **[emphasis added]***, including allocation of costs*

between city of Edmonton and Regional customers and including the common law and the law of equity; rates of tax or other mandatory amounts payable by EWSI to any level of government; the status of EWSI under existing legislation or the application of existing legislation to EWSI; then costs arising from any such event will be considered as non-routine. [26]

Table 6.3-2

Alternative D Revenue Requirement for Water Related Costs and Impact in Current PBR Term (2019-2021) To be Recovered by NRA Beginning April 1, 2020 ($million)

Water Revenue Requirements	2019	2020	2021	Total Costs Recovered Through NRA
1 Orthophosphate	-	0.4	1.9	2.3
2 LSL Replacement Program	0.2	0.6	1.2	2.0
3 In-City Water Revenue Requirement	0.2	1.0	3.1	4.3
4 Less: Current Program (Alternative A)	0.1	0.3	0.5	0.8
5 Incremental In-City Revenue Requirement	0.1	0.7	2.6	3.4

[26] Section 5.1, Schedule 3 of City of Edmonton Bylaw 17698, EPCOR Water Services and Wastewater Treatment Bylaw.

Alberta Health Services
Healthy Albertans.
Healthy Communities.
Together.

February 19, 2019

Dr Steve Craik
Director, Quality Assurance & Environment
EPCOR Water Services Inc.
9469 Rossdale Road, N.W.
Edmonton, Alberta, T5K 0A5

Re: Letter of Support for EPCOR Water Services Inc. Lead Mitigation Strategy and Business Case

Dear Dr. Craik,

As Lead Medical Officer of Health of Edmonton Zone Alberta Health Services, I would like to express my support for the EPCOR Water Services Inc. (EWSI) New Lead Mitigation Strategy and Business Case.

Alberta Health Services (AHS) is aware of Health Canada's intention to update the drinking water guidelines for lead. This will reduce the Maximum Acceptable Concentration (MAC) from the current 10 µg/L to 5 µg/L, based on drinking water samples taken at the tap. While this may be challenging to achieve, this new Health Canada Guideline will ultimately reduce lead exposures to the population, and improve the overall health of Canadians.

It is understood that at the time drinking water leaves EPCOR's water treatment plants, there is no measureable level of lead. However, as the water flows through pipes that may contain lead, this heavy metal can dissolve or leach into the water. Health studies have indicated that low levels of lead exposure have long-term health effects, especially in children (i.e. neurological effects, lower IQ). In a 2013 study, Alberta Health Services estimated that drinking water accounts for 10-20% of total lead exposure in children and adults, and as much as 40-60% total exposure in infants. The proposed Lead Mitigation strategy is intended to reduce lead exposure from service lines and/or building plumbing fixtures.

AHS is pleased that EWSI is committed to maintaining a source-to-tap, multi-barrier approach to safe drinking water, and to making sure all known and potential hazards are identified and addressed. This ultimately results in safe drinking water being provided to our population. The EWSI's lead mitigation strategy aligns with this holistic approach and proposes to add orthophosphate at Edmonton's two water treatment plants. This will to reduce lead in drinking water from all sources within the distribution network (*e.g.* homes, schools, day cares). Addition of orthophosphate to drinking water will positively impact 940,000 consumers in Edmonton and 340,000 consumers from other communities served by EWSI. Orthophosphate is a corrosion inhibitor and is a safe and practical solution for controlling lead. It has been used successfully by numerous water utilities around the world. The Food and Drug Administration considers phosphates as generally safe food additives which are commonly added to beverages and food.

Adding orthophosphate to drinking water, along with prioritizing the replacement of lead service lines is in alignment with Health Canada's direction to make every effort to "*maintain lead levels in drinking water as low as reasonably achievable*". Moreover, I understand that EWSI's decision to begin adding orthophosphate has been a highly considered one, based on extensive reviews of scientific literature, detailed local pilot testing, financial modelling, conceptual engineering design work, and public consultation.

In conclusion, I believe EWSI's proposed Lead Mitigation Program will be an effective strategy for meeting the proposed Health Canada MAC of 5 µg/L at the tap and therefore protective of public health. The proposed plan will place EWSI, and its 1.3 million customers, in a strong position for ensuring on-going public health protection as well as for eventual regulation by Alberta Environment and Parks.

Sincerely,

Dr. Christopher Sikora MD MSc MPH CCFP FRCPC
Lead Medical Officer of Health – Edmonton Zone
Alberta Health Services

Shobhit Maruti

Dr. Shobhit Maruti MD MPH
Medical Officer of Health – Edmonton Zone
Alberta Health Services

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Alberta Environment and Parks

Dr. Steve Craik, Ph.D., P.Eng.
Director, Quality Assurance & Environment
EPCOR Water Services Inc.
9469 Rossdale Road, N.W.
Edmonton, Alberta
T5K 0A5

February 19, 2019

Re: Letter in Support of EPCOR's Lead Mitigation Strategy to Meet Changing Drinking Water Quality Requirements

I understand that on March 22, 2019, you will be representing EPCOR Water Services Inc. (EWSI) at the City of Edmonton's Utility Committee, where you will be presenting EWSI's Lead Mitigation Strategy and related business case. On March 2nd 2019, Health Canada will be publishing a new maximum acceptable concentration (MAC) for lead under the Guidelines for Canadian Drinking Water Quality. The Federal guideline MAC for lead will change from 0.010 mg/L (milligrams per litre) to 0.005 mg/L, based on drinking water sampled at the tap.

As you know, Alberta Environment and Parks (AEP) regulates municipal drinking water systems in Alberta including those owned and/or operated by EPCOR. AEP's regulatory role for drinking water is provided under the Environmental Protection and Enhancement Act (EPEA), its Potable Water Regulation, and AEP's Standards and Guidelines for Drinking Water. As the regulator, AEP does intend to fulfill its mandate under the Potable Water Regulation by requiring municipal drinking water systems to meet the lower MAC for lead of 0.005 mg/L.

We fully understand the challenges and complexities of meeting this lower value for lead at the tap. Consequently, AEP will be providing water utilities a 5-year timeline to work on developing and implementing their own utility lead mitigation strategies. Municipal water providers will have 5-years after receiving written notification from the EPEA signing Director to submit their plans to meet the lead MAC at the tap.

AEP, in conjunction with Alberta Health and Alberta Health Services will provide guidance on how consumers can reduce exposure to lead in water. To support municipal systems in their efforts going forward over the next 5 -years to develop their own mitigation plans for lead, AEP will be releasing a guidance document that provides information on lead sampling protocols, suggested action plans, and communication and reporting requirements.

We have been working closely with key stakeholders including yourself at EPCOR through the Municipal Systems - Lead Working Group, to develop the philosophy and principles that will be the basis of the AEP guidance document for lead management. AEP is very grateful to you and your team for having shared EPCOR's demonstrated expertise to date in managing lead in the distribution system and customer's drinking water tap.

I understand that you are planning to move forward proactively with an enhanced EPCOR lead mitigation strategy. AEP is supportive of this proactive approach by EPCOR. AEP understands that EPCOR will endeavour to develop and implement a multi-faceted program including orthophosphate addition to address the regulatory compliance expectations that come with this new lower MAC for lead. I support EPCOR's efforts to develop and implement an enhanced mitigation program for lead that will serve the drinking water needs of 1.3 million Albertans.

If you have any questions, please feel free to contact me.
Thank you.

Sincerely,

Lyndon Gyurek, Ph.D., P.Eng.
Director, Drinking Water and Wastewater/Stormwater
Provincial Programs | Operations Division
Alberta Environment and Parks
Lyndon.Gyurek@gov.ab.ca
Office: 780-427-4976
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APPENDIX B

CONTEXT ANALYSIS
Lead Regulations and Lead Mitigation Programs in Other Cities

1. The following context analysis provides information obtained from research into the regulations and programs other regulatory bodies and water utility providers have completed in order to mitigate lead in their drinking water.

1.0 LEAD REGULATIONS IN THE US AND UK

1.0 United States Lead Regulations

2. In the United States, lead in water levels are regulated by the US Environmental Protection Agency ("EPA") which has set maximum contaminant level goals ("MCLG"s) of zero for lead in water. The EPA further established an enforceable treatment technique[1] (1992 Lead and Copper Rule or "LCR")[2] for lead that requires water systems to control the composition of the water so as to prevent dissolution of lead into drinking water. The regulation also requires system owners to collect tap samples, after six hours of stagnation, from sites served by the system that are more likely to have plumbing or service line materials containing lead. If more than 10 % of these samples exceed the lead action level of 15 µg/L, then water utilities are required to take additional actions, such as the introduction of lead corrosion inhibitors or the removal of LSLs. States, such as Michigan discussed below, may set more stringent drinking water regulations than the EPA.

3. In 1986, the EPA issued an amendment to the federal Safe Drinking Water Act[3] which prohibits the "use of any pipe, any pipe or plumbing fitting or fixture, any solder, or any flux,

[1] A treatment technique is an enforceable procedure or level of technological performance which water systems must follow to ensure control of a contaminant
[2] US Code of Federal Regulations, 40 CFR Part 141 Subpart I
[3] Section 1417 of the Safe Drinking Water Act

after June 1986, in the installation or repair of (i) any public water system; or (ii) any plumbing in a residential or non-residential facility providing water for human consumption, that is not lead free." The Act also establishes the definition for "lead free" as a weighted average of 8% (lowered to 0.25% effective 2014) lead calculated across the wetted surfaces of a pipe, pipe fitting, plumbing fitting, and fixture and 0.2% lead for solder and flux. This legislation is enforced throughout the U.S. meaning, unlike in Canada, lead-containing plumbing fixtures are not currently available for purchase in the U.S.A.

4. In 2014, the source water for Flint Michigan was changed from the Detroit City water system, which abstracted water from Lake Huron and the Detroit River, to and older water treatment plant that abstracted water from the Flint River. A corrosion control inhibitor (orthophosphate) was added to the Detroit water, but there was no control inhibitor added to the Flint River water. Due to insufficient water treatment and lead inhibitor use, high levels of lead leached from lead pipes and plumbing fixtures into the drinking water, exposing over 100,000 residents and a federal state of emergency was declared in January 2016. This event has been termed the "Flint Michigan water crisis". Four government officials resigned over the mishandling of the crisis, one was fired and fifteen criminal cases have been filed against local and state officials.

5. Motivated by the Flint Michigan water crisis and based on 2015 recommendations from the National Drinking Water Advisory Council, the American Water Works Association, and the Flint Water Interagency Coordinating Committee, the LCR is in the process of being updated to:[4]

- establish a health-based "household action level" that triggers a report to the consumer and to the applicable health agency for follow up;
- increase the frequency of monitoring and modify the requirements to include customer requested tap samples;

[4] US EPA Lead and Copper Rule Revisions White Paper, October 2016

- require point of use filters be provided in instances where there has been disturbance of a LSL or where tap sampling indicates an exceedance of a health-based benchmark or action level;
- require proactive LSL replacement programs, which set replacement goals for both the utility-side and private-side portions of all LSLs by 2050, effectively engage customers in implementing those goals, and provide improved access to information about LSLs, in place of current requirements in which LSLs must be replaced only after a lead action level exceedance; and
- eliminate partial service line replacements.

6. Also in response to the Flint Michigan water crisis, on June 14, 2018, the State of Michigan passed a revised Lead and Copper Rule that imposed standards for the state above those in the EPA LCR. The new state standard:[5]

- reduces lead action levels from 15 µg/L to 12 µg/L at the tap after 6 hours stagnation without prior flushing;
- requires all public water systems to replace, and pay 100% of the costs associated with, all LSLs, including the private-side LSL, and galvanized service lines if the service line is or was connected to lead piping beginning in 2021 at a rate of 5% per year, not to exceed 20 years.
- bans partial LSL replacement, except during emergency water main repairs when the resident does not agree to allow full replacement; and
- does not permit coating and lining techniques of LSLs in lieu of replacement.

1.1 United Kingdom - Drinking Water Inspectorate

7. The Drinking Water Inspectorate ("Inspectorate") has set a maximum prescribed concentration for lead in England and Wales of 10 µg/L, at the tap without prior flushing.[6] In

[5] Michigan State Rules 325.10102 – 325.10710b

the event sampling does not meet the prescribed concentration, the utility is required to notify the Inspectorate and the customer, investigate the source of the lead and take actions to modify or replace any identified lead containing utility-side pipes and fittings. In the event customer-owned lines and fittings are identified as the source of lead, the utility is required to provide notice to the customer and encourage them to replace the sources.

2.0 LEAD CORROSION INHIBITOR USE IN OTHER CITIES

8. Phosphate-based lead inhibitors have been used by water utilities for more than 70 years to control the release of lead into water supplies and to prevent the dissolution of iron pipe and other metals into the distribution system.[7] With the advent of the EPA LCR in 1991, many utilities in the U.S. moved to orthophosphate use in order to meet the action limits for lead concentrations. In a 2001 survey of medium and large U.S. utilities, 56% reported using a phosphate-based lead inhibitor in their water treatment processes.[8] Canadian Cities that report using phosphate-based lead inhibitors include Winnipeg MB, Hamilton ON, Toronto ON, Halifax NS, and Saint John NB. A review of the results of lead corrosion inhibitor programs in three of these cities is included below.

Toronto, Ontario

9. In 2008, 52% of water samples taken at the tap in areas suspected to have LSLs in the City of Toronto exceeded the current Health Canada MAC of 10µg/L for lead. Based on these results, under the *Ontario Safe Drinking Water Act*, the City was required to take action to reduce these levels and a phosphate-based lead corrosion inhibitor program was implemented in 2014.[9]

- In 2017, only 2% of homes with LSLs exceeded the current Health Canada MAC of 10µg/L for lead.

[6] Guidance on the Implementation of the Water Supply (Water Quality) Regulations in 2010, Drinking Water Inspectorate

[7] Other common uses include the prevention of concrete corrosion, calcium scale, iron or manganese control, and to prevent red water.

[8] McNeill, L.S., and Edwards, M. 2002. Phosphate inhibitor use at US utilities. Journal American Water Works Association, 94(7): 57–63.

[9] Corrosion Control Significantly Lowers Lead Levels in Toronto Water, Water Canada, 2018

- The reported program costs for phosphate addition and excess removal from treated wastewater before it is released into Lake Ontario are approximately $3 million annually.

- Removal of utility-side LSLs is ongoing through scheduled capital projects and emergency work, with all 65,000 lines anticipated to be removed by 2029.

Winnipeg, Manitoba

10. In 2000, the City of Winnipeg began adding orthophosphate to their water supply to control lead in water levels at the tap. The program was approved by both Manitoba Health and Manitoba Conservation and follows the Manitoba Public Health Act.[10]

- Sampling conducted at homes with LSLs between 2000-2009 indicated average observed lead levels have decreased below the current Health Canada MAC of 10 µg/L. The average concentrations would not meet the proposed MAC of 5 µg/L during the summer months each year.

- The reported program costs for phosphate addition at a concentration of 2µg/L to the drinking water system are approximately $0.2 million annually.

- Excess phosphate is not removed from treated wastewater before it is released into Lake Winnipeg. Environmental sampling at the North End wastewater treatment plant has shown phosphorus levels have increased 17% in the water release to the environment and lead has decreased by 37% in biosolids.

- There are approximately 25,000 homes serviced by LSLs throughout the City of Winnipeg.[11]

Halifax, NS

11. Since 2009, the City of Halifax has used zinc orthophosphate as a lead corrosion inhibitor. Sampling has indicated that less than 10% of customers with LSLs exceed the Health Canada MAC of 10 µg/L and "the majority of Halifax Water customer with lead Service

[10] City of Winnipeg Website, https://winnipeg.ca/waterandwaste/water/leadOrthophosphate.stm, last updated 4/26/2018

[11] City to tweak lead battle, Water additive not eco-friendly, Winnipeg Free Press, 2011

Connection pipes are exposed to high levels of lead in their drinking water".[12] Based on these sampling results, Halifax has developed a program to remove all LSLs within the city, which is discussed below.

3.0 PRIVATE-SIDE LEAD SERVICE LINE REPLACEMENT PROGRAMS IN OTHER CITIES

12. EWSI has completed a contextual analysis of other communities across North America providing assistance to homeowners with private-side LSL replacement. EWSI was able to identify 19 (14 US and 5 Canadian) municipalities who provide such programs either on a mandatory or voluntary basis. Based on this analysis, EWSI has drawn the following conclusions:

- **Voluntary Programs -** In 9 of the 19 programs, homeowner participation is on a voluntary basis with customers required to fund all or a portion of the LSL replacement. Four of these programs have been in place for more than 10 years and indicated that voluntary programs tend to result in low customer participation rates (replacement of only 11% of private-side LSLs over the course of 11-14 years, which would suggest a timeframe of over 95 years to replace all LSLs in these communities);

- **Mandatory Programs -** in 10 of the 19 programs, homeowner participation is mandatory through the implementation of bylaws or ordinances for the removal of all LSLs with the majority (8 out of 10) requiring customers to fund a portion of the LSL replacement. These mandatory programs are expected to result in full replacement of all LSLs within 12 years, on average. Communities with more than 10% of homes being serviced by LSLs were more likely to mandate their removal.

- Municipalities funded between 25% and 100% of private-side LSL replacement costs from a variety of sources including government grants, revenue sources, capital and operating budgets, and rates with the remaining portion available as a loan or special assessment against property taxes and offered financing for any unfunded costs.

[12] Submission in Support of an Application by the Halifax Regional Water Commission for an Order Approving Amendments to the Halifax Regional Water Commission Regulations, February 23, 2017

- Replacement of private-side LSLs are being completed in conjunction with existing capital improvement programs which include the removal of utility-side LSLS, eliminating the practice of partial LSL replacements.

- City council and regulatory approval of these programs was deemed as being in the public interest and not considered to be a financial burden for customers.

- In the instances of private utilities (Indiana American Water Company and York Water Company) the utility funded 100% of private-side LSL replacement costs through rates. This is likely due to the administrative burden, costs, and risks associated with providing loans to customers for the replacement of private-side LSLs. In addition, private utility companies do not have the ability to implement special assessment against property taxes, meaning leans would have to be collected through customer's monthly bills.

- The reported average total cost to replace a private-side LSL is $4,300 in Canada.

13. In addition to identified municipal programs, EWSI has identified one state-level program. In 2017, the State of New York announced $20 million in grants to multiple municipalities throughout the state for the replacement of private LSLs..[13] Summaries of the identified voluntary and mandatory LSL replacement programs are included in Section 3.1 below.

3.0 Regulatory Precedence for Funding Private-Side LSL Replacement through Rates

14. In order to fund private-side LSL replacements through customer rates, multiple water utility service providers were required to have their proposed programs reviewed for regulatory approval prior to implementation. Some of the application approvals were supported by legislation approving the practice.

Wisconsin, USA

15. In 2000, Madison Wisconsin's application to the Wisconsin Public Service Commission to fund its' private-side LSL replacement program through rates was denied. The Wisconsin Public

[13] Section 1114 of the New York State Public Health Law, New York's Clean Water Infrastructure Act of 2017

Service Commission concluded that "*it would be unreasonable and unjustly discriminatory if public dollars generated through utility rates were used to subsidize a direct benefit to an exclusive group of private property owners.*"[14] In response to the Flint Michigan water crisis, on February 21, 2018, the State of Wisconsin passed legislation overturning this decision and granting a public water utility the ability to provide financial assistance through utility rates for the replacement of private-side LSLs. The Wisconsin Public Service Commission Chair later stated: [15]

> *"Safe drinking water is of the utmost importance to Wisconsinites, and* ***we must do all we can to grant our local governments and utilities the tools they need to provide adequate services to their customers****,"*

Pennsylvania, USA

16. In October 2017, the General Assembly of Pennsylvania passed House Bill 674, which included a provision giving municipalities the authority to replace or remediate private-side water and sewer laterals using public funds and municipal employees if they determine the work "will benefit the public health." [16] In its' Decision to approve York Water Company's application to fund 100% of the costs for private-side LSL replacements through rates, the Pennsylvania Public Utility Commission stated: [17]

> ***"Replacing a lead customer-owned service line at the same time as lead Company-owned service line is in the public interest****. The Company has access to determine the composition of the customer-owned line and will only realize an incremental cost to replace both lines.* ***Replacing both parts of the service line at the same time makes economic sense and greatly simplifies the replacement process. There is a reduction in coordination requirements between customer and Company as well as an elimination of a costly financial burden to the customer."***

Indiana, USA

17. In April 2017, the Indiana General Assembly passed House Bill 1519, allowing the Indiana Utility Regulatory Commission to approve an investor-owned utility's request to fold the actual costs of private-side LSL replacement into the rates paid by customers. In its' Order

[14] City of Madison v. Public Service Commission of Wisconsin, 253 Wis. 2d 846 (WI Ct. App., 2001)
[15] Lon Roberts, Chairman, Public Service Commission
[16] General Assembly of Pennsylvania House Bill 674, Page 43, Lines 8 and 17
[17] P-2016-2577404, Petition of York Water Company for an Expedited Order Authorizing Limited Waivers of Certain Tariff Provisions and Granting Accounting Approval to Record Cost of Certain Customer-Owned Service Line Replacements to the Company's Services Account, emphasis added

to approve East Chicago's application to fund 100% of the costs for private-side replacements through rates, the Indiana Utility Regulatory Commission stated:[18]

> *"..The Subsidization Program addresses a public health concern over heightened lead levels, both in the environment and in drinking water, for a number of residential customers …* ***we find that public interest requires the Subsidization Program should be included in the capital projects*** *that will be funded by the debt issue."*

Nova Scotia, Canada

18. On August 22, 2017, the Nova Scotia Utility and Review Board issued an Order approving amendments to its regulations for the City of Halifax to fund 25% of the costs of the repair and replacement of private-side LSLs in the provision of water service and 100% of the costs for emergency repairs. As part of its' approval, the Nova Scotia Utility and Review Board stated:

> *"The evidence presented indicates that a customer could experience increased levels of lead in their drinking water because of actions by Halifax Water to repair or replace its infrastructure.* ***It further explains that the replacement of the entire service line, as soon as possible, has been identified as the only reliable means to resolve the issue****. … [in emergencies] it may not be appropriate, or even possible, to attempt to negotiate payment arrangements with customers for the private portions****. Also, this could introduce a level of disparity among customers as some may simply refuse to pay anything, while others will offer to pay the entire cost.*[19]
>
> *…*
>
> *As research indicates that partial lead service connection replacement could result in elevated lead levels in the customer's drinking water, it is important to replace the entire connection pipe. However, as outlined in the Application, there are often barriers to prevent the replacement of the private section at the time of the replacement of the public portion of the lead service line. Halifax Water's proposed program, including the financial reimbursement, attempts to reduce these barriers.* ***The proposed replacement program, and estimated cost, are not considered by the Board to pose a significant financial burden on Halifax Water's customer base, in terms of rate implications****."* [20]

[18] Cause No. 44826, Petition of the City of East Chicago, Indiana for Authority to Issue Bonds, Notes, or Other Obligations for Authority to increase its Rates and Charges for Water Service, and for Approval of New Schedules of Water Rates and Charges, emphasis added

[19] Document 256968, Par. 39-41, Nova Scotia Utility and Review Board, emphasis added

[20] Document 256968, Par. 39-41, Nova Scotia Utility and Review Board, emphasis added

3.1 Program Summaries

19. Summaries of the identified voluntary and mandatory LSL replacement programs are included in Tables A – 3.1 and A – 3.2, respectively.

Table A-3.1
Voluntary Municipal Lead Service Line Replacement Programs

Municipality	Year	Number of Private-Side LSLs (% of total customers)	LSLs Removed to Date[21]	Funding Type	Additional Program Details
Boston, MA[22,23,24]	2004	5,000 (2%)	20%	$2,000 Grant / Remaining as Loan Grant from the City's Capital Budget.	As regularly scheduled utility-side LSL replacement is completed by the city, homeowners are notified and given the option to have their portion of the LSL also replaced. In emergency situations, the line is replaced at the homeowner's expense.
Guelf, ON[25]	2007	3,700 (7%)	5%	$2,000 Grant from the City's Capital Budget.	Once work is completed, the grant is provided to the customer and the utility-side of the lines is replaced. A limited number of grants are available each year.
Hamilton, ON[26,27]	2007	20,000 (9%)	10%	$2,500 loan	Once work is completed, the utility-side of the line is replaced.
Welland, ON[28,29]	2011	730 (3%)	10%	$1,500 Grant from City budget; increased to $2,000 for quotes above $3,000.	Owner obtains two bids and submits them with an application to the City prior to performing work. Reimbursed is issued to the homeowner once confirmation of replacement is received.
Halifax, NS[30,31]	2017	10,000-15,000 (8%)	Not Available	25% up to $2,500 / Remaining as loan Funded through rates.	Replacement of LSLs is completed in conjunction with scheduled utility-side LSL replacements. Emergency replacements are completed by the City with no cost to the homeowner.

[21] Participation rate to date for the life of the program
[22] Boston Water and Sewer Commission, The Lead Replacement Incentive Program brochure, 2016
[23] City of Boston Policy on leaks up to Owner and Replacement of Lead Water Service Pipes
[24] Boston launches new program to address lead water contamination dangers - The Boston Globe, April 07, 2016
[25] City of Guelf website, https://guelph.ca/living/environment/water/drinking-water/drinking-water-and-lead/replacement-program/
[26] City of Hamilton Information Report, Lead Water Service Pipes (BOH07049(a) / PW08036) (City Wide), March 17, 2008
[27] "Get price quotes for lead pipe replacement, councilor advises", CBC News, April 14, 2009
[28] Welland Lead service line Replacement Program Website, https://www.welland.ca/Building/LASSR.asp
[29] TRAN Committee Meeting, House of Commons of Canada – Evidence transcript (42-1) – 85, November 30, 2017

Municipality	Year	Number of Private-Side LSLs (% of total customers)	LSLs Removed to Date[21]	Funding Type	Additional Program Details
York Water Company,[32] (Private Company)	2017	1,660 (10%)	Not Available	100% Funded through rates.	Replacement of a maximum of 400 LSLs per year for 4 years in conjunction with utility-side LSL replacements. Replacements at homes with only LSLs on the private-side portion will be completed once utility-side LSL replacements are complete.
Indiana American Water[33] (Private Company)	2018	50,700 (4%)	Not Available	100%, up to $7,000. Funded through rates	1,000-5,000 private-side LSLs will be replaced each year for the next 5 years and increasing replacements to 6,000 lines each year through 2041 until all lines have been replaced. Customers who do not participate must sign a waiver acknowledging risks and will not be eligible for funding if replacement occurs at a later date.
Pittsburgh Water and Sewer Authority[34] [35]	2018	19,200 (13%)	Not Available	100% Funded through a grant and diversion of regulatory fines to replacement program.	Replacement of LSL is completed in conjunction with scheduled utility-side LSL replacements. As part of a settlement with the Department of Environmental Quality due to lead violations, the utility has agreed to provide $4.2 million in funding in lieu of fines for the replacement program.

[30] Document 256968, Nova Scotia Utility and Review Board.
[31] "Halifax Water readies list of contractors for lead pipe replacements", The Chronicle Herald, January 25, 2018
[32] P-2016-2577404, Petition of York Water Company for an Expedited Order Authorizing Limited Waivers of Certain Tariff Provisions and Granting Accounting Approval to Record Cost of Certain Customer-Owned Service Line Replacements to the Company's Services Account
[33] Indiana Utility Regulatory Commission Cause No, 45043, Indiana-American Water Company, Inc., Petitioner's Exhibit No. 1
[34] Commonwealth of Pennsylvania Department of environmental Protection Consent Order and Agreement, Pittsburg Water and Sewer Authority Violations of the Pennsylvania Safe Drinking Water Act and the Rules and Regulations Promulgated Pursuant Thereto Regarding the Lead and Copper Rule, November 17, 2017
[35] Time running out for some So. Side property owners to get lead lines replaced by PWSA, South Pittsburg Reporter, October 16, 2018

Municipality	Year	Number of Private-Side LSLs (% of total customers)	LSLs Removed to Date[21]	Funding Type	Additional Program Details
Washington DC[36]	2019	12,000 (4%)	Not Available	100% Funded through capital improvement program.	Replacement of LSL is completed in conjunction with scheduled utility-side LSL replacements starting in October 2019. Low income homes where the utility-side LSL have previously been replaced are eligible for funding up to 100%.

[36] Bill 22-507, Lead Water Service Line Replacement and Disclosure Amendment Act of 2018, Washington DC

Table A-3.2
Mandatory Municipal Lead Service Line Replacement Programs

Municipality	Year	Estimated Number of Private-Side LSLs (% of total customers)	Funding Type	Additional Program Details
Madison WI[37,38]	2000	8,000 (8%)	50% up to $1,500/ Remaining as loan Funded by City.	In 2000, the utility passed an ordinance requiring homeowners to replace all private-side LSL by 2006. Prior to program implementation, testing at the tap 90th percentile results were 16ug/L. The utility now boasts a 90th percentile result of 3ug/L.
Saskatoon, SK[39,40,41]	2003	5,300 (8%)	60% / Remaining as loan Funded through grants.	Mandate requires the replacement of any private-side LSL during utility-side LSL replacement or if the LSL is found to be damaged. Prior to receiving the current grant, the program was funded via rates.
East Chicago, IN[42,43]	2017	6,500 (65%)	100% Funded through rates.	Replacement of full LSLs will target homes in a Superfund site (500) and the city will apply for additional funds and grants to remediate remaining lines (6,000) in the future. The state agreed to lower interest rate debt funding for the utility's entire LSL replacement program ($18M) to offset costs associated with the customer's portion ($3M).

[37] Madison Water Utility website, https://www.cityofmadison.com/water/water-quality/lead-service-replacement-program/information-for-utilities-on-lead-service
[38] Record of Conversation with Robin Piper, Chief Administrative Officer, Madison Water Utility
[39] City of Saskatoon website, https://www.saskatoon.ca/services-residents/power-water/water-wastewater/drinking-water/2017-water-mainlead-water-pipe-replacement-project
[40] Saskatoon accelerates lead pipe removal program, CBC News, March 24, 2017
[41] Stephen Wood, City of Saskatoon Water and Sewer Preservation Manager, Stephen.Wood@Saskatoon.ca
[42] Cause No. 44826, Petition of the City of East Chicago, Indiana for Authority to Issue Bonds, Notes, or Other Obligations for Authority to increase its Rates and Charges for Water Service, and for Approval of New Schedules of Water Rates and Charges.
[43] "East Chicago official says more community buy-in key to expansion of lead water line replacement program", NWI Times, May 14, 2018

Municipality	Year	Estimated Number of Private-Side LSLs (% of total customers)	Funding Type	Additional Program Details
Grand Rapids, MI[44]	2017	20,000 (30%)	100% 20% funded through O&M budget and 80% funded through grant.	Replacement of private-side LSLs is completed in conjunction with scheduled utility-side LSL replacements and on an emergency basis.
Milwaukee, WI	2017	74,125 (44%)	33% up to $1,600/ Remaining as loan Funded through grant.	Bylaw mandates replacement of any private-side LSL during utility-side lead replacement or if the LSL is found to be damaged. Prior to the program becoming mandatory, only 14% of LSLs were replaced over 10 years.
Cincinnati, OH[45,46,47]	2017	27,000 (11%)	$1,500 / Remaining as loan Funded through capital budget.	Mandate requires the replacement of private-side LSLs in coordination with utility-side lead replacement or if the LSL is found to be damaged. Private donations established a fund for low income home owners.
Kenosha, WI	2018	2,150-7,800 (25%)	50% / Remaining as loan Funded through rates,	Ordinance requires the removal of all private-side LSLs prior to scheduled utility-side LSL replacement. Citations and 10-day disconnection notices are issued for non-compliance.
Wetaskiwin, AB[48,49]	2018	140 (3%)	60% / Remaining as loan Funded through rates.	Mandate requires the replacement of private-side LSL in conjunction with the city's water main and road replacement program over the next 10 years. Previously the program was voluntary.

[44] "Grand Rapids is paying to replace every lead water pipe in the city", MLive - Grand Rapids News, December 4, 2017
[45] Greater Cincinnati Water Works, H2) Connection Newsletter, Fall 2017 Edition, October 27, 2017
[46] City of Cincinnati Ordinance No, 185
[47] "Cincinnati adopts an innovative plan to eliminate lead service lines that is a model for other cities", Environmental Defense Fund, October 12, 2017
[48] City of Wetaskiwin Bylaw No. 1895-18; Sections 3.2.9, 3.2.10, and 3.2.11
[49] "Lead pipe replacement policy gets approval Wetaskiwin Times, August 30, 2017

APPENDIX C

Operational Plan for EWSI's Proposed Lead Mitigation Program

1. The following operational implementation plan provides information on EWSI's planned activities for implementing the proposed Lead Mitigation Program. This includes operational plans for: (i) the lead corrosion inhibitor program (section 1.0); (ii) the lead service line ("LSL") replacement program (section 2.0).

1.0 LEAD CORROSION INHIBITOR PROGRAM

2. EWSI is proposing dosing to a concentration of 0.9 mg/L of phosphate (as P) at each of the two Edmonton WTPs (E.L. Smith and Rossdale) using concentrated (75%) phosphoric acid. When phosphoric acid (H_3PO_4) is added to water it is immediately converted into the orthophosphate form (PO_4^{2-}). The concentration of orthosphate is then measured as the concentration of phosphorous or P. Phosphate dosing systems will be designed and constructed at each facility to inject the phosphoric acid to the treated water in the water leaving the storage reservoirs at the plant. The dosing systems will consist of phosphoric acid storage tanks, dosing pumps, associated piping, controls and buildings to house the equipment. The water leaving the water treatment will be monitored for orthosphate downstream of the dosing point as it leaves the plant to ensure accurate dosing.

3. Orthophosphate doses of 1.0 mg/L and 2.0 mg/L were tested on new lead service lines in the EWSI pilot facility between Sept 2017 and February 2019. The results of the pilot testing has indicated the dose of 1.0 mg/ was sufficient to reduce lead concentrations levels by 90%.

4. Another factor to be considered when selecting the target orthophosphate dose is that the current EPCOR Drainage Bylaw (18100) limits the concentration of total phosphorous in the discharges to the storm sewer system to 1.0 mg/L a P. Therefore, EWSI has selected an initial target dose of 0.9 mg/L orthophosphate as P to ensure that discharges from the water system due to routine distribution system flushing activities remain do not result in bylaw exceedances

5. It is fully expected that further optimization of phosphate dosing will be required in the 1-3 year period following commencement of phosphate addition. The system, therefore, will be designed to be able to dose up from 0.5 mg/L to 2.0 mg/L to allow for optimization of the dose as needed with an anticipated long term dose of 0.7 mg/L. Optimization will be based on continued monitoring of the system for both lead and phosphate at the tap in homes with and without LSLs and continued experimentation in the pilot facility.

6. Although orthophosphate dose requirements generally depend on utility-specific factors including source water quality and treatment practices, doses reported by other Canadian utilities are in a similar range as indicated by EWSI's pilot studies. Toronto's WTPs have been dosing orthophosphate at 0.65 mg/L during winter and 0.82 mg/L during summer.[1] Winnipeg started dosing at 1 mg/L in 2000, but after one year adjusted the dose downward to 0.65 mg/L.[2] After conducting a pilot study, Hamilton planned to start dosing orthophosphate at 1 mg/L in Nov. 2018, with a provision to reduce the dose within two years depending on results of a monitoring program.[3]

7. Detailed design and construction of the orthophosphate systems is expect to take approximately two years and start-up is expected in early 2021. EWSI contracted Stantec to complete a Conceptual Design Report for the addition of phosphoric acid for lead control at the Rossdale and E.L. Smith Water Treatment Plants including key design criteria (target dose, applied flow rates, estimated chemical usage); chemical injection (location, approach, control); and equipment sizing (storage tanks, chemical dosing and transfer pumps, piping). Stantec utilized average and maximum flow rates based on the forecasted demand in the year 2030 and the current plant capacities to design the dosing systems. Considerations for accurate dosing, preventing phosphate loading to water bodies, minimizing injection points, accessibility for routine maintenance and monitoring, and regulatory requirements were included in the general design of the system. The estimated capital cost of this project based on a conceptual design report prepared by Stantec is $9.8 million. Operating costs are approximately $1.4 million per year and include purchases of 4.2 kg of phosphoric acid for every million litres of water treated at the WTPs, as well as the costs of two personnel to operate and maintain the injection facilities and a third employee to conduct the additional water testing needed to determine the efficacy of orthophosphate in reducing lead levels.

1.1 Wastewater Treatment Operations

8. Addition of orthophosphate to the drinking water will result in an increase in phosphorous loading to wastewater streams going to EWSI's Gold Bar Wastewater Treatment Plant ("WWTP"). Gold Bar must meet total phosphorous limits for discharge of treated

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[1] Tadwalkar, Abhay; Manager, Process, Innovation and Energy, Water Treatment & Supply, Toronto Water. Personal communication, telephone conversation, Oct. 24, 2018.

[2] Grosselle, Renee; Manager of Environmental Standards, City of Winnipeg. Personal communication, email exchange, Aug. 29, 2018.

[3] https://www.hamilton.ca/home-property-and-development/water-sewer/corrosion-control

wastewater to the North Saskatchewan River. Addition of orthophosphate to the drinking water at the proposed dose of 1 mg/L would result in an increase in phosphorous loading in the WWTP influent of about 15%. Currently, the wastewater treatment processes at Gold Bar are targeted towards the removal of phosphorus from wastewater by using alum. EWSI conducted its own analysis to understand the impacts of orthophosphate dosing on the Gold Bar WWTP. Engineering analyses determined the Gold Bar WWTP has the available capacity to chemically remove additional amounts of phosphorous. Using existing treatment processes, EWSI can effectively mitigate the potential environmental impacts of higher phosphate loading in Edmonton's wastewater effluent through minimal changes to its wastewater treatment processes. The additional costs at Gold Bar will be limited to additional alum costs, with no need for any other capital expenditures or operations and maintenance costs.

9. A fraction of the orthophosphate added to the drinking water will not be removed in the WWTPs but will be released to the North Saskatchewan River through the storm water system or through overland or groundwater flow. This includes orthophosphate in drinking water that is released to the river at the water treatment plants (i.e. for filter backwashing), through drinking water distribution flushing activities and other system losses, due to outdoor water use, combined sewer overflows and WWTP wet weather bypasses. An estimate of the increase in total loading from these sources was completed based on historical data.

10. The estimated total phosphorous loading to the river from all sources in the City of Edmonton is 97,000 kg annually and the largest contributor is the WWTP effluent. Addition of orthophosphate to the drinking water would result in a 19,000 kg (20%) increase in phosphorous loading to the river. The largest fraction of this (7,000 kg) is the release from the WTPs through return of filter backwash water to the river. This can be eliminated by ensuring that the orthophosphate is added to the treated drinking water downstream of the reservoirs at the WTPs. The phosphate injection points at the WTP, therefore, have been designed downstream of water treatment plant filter backwash water supply systems to avoid phosphate loading to the North Saskatchewan River via existing waste streams.

11. The second largest fraction (6,500 kg) is due to losses from the drinking water distribution system due to flushing activities, watermain breaks and leaks. It was assumed that most of the phosphate in the water lost from the drinking water distribution system, and the phosphate in it, would be captured in the storm water system and would end up in river, The third largest fraction (3,100 kg) is due to outdoor water use (i.e. lawn watering, etc.). There is no reliable data on what fraction of the orthophosphate in this water would be discharged to

the river as some fraction is likely to be decomposed in the soil or taken up by plants. After considering these factors, the net increase of phosphate loading to the river would then range from 9,000 to 12,000 kg or a between and 9% and 13% increase on an annual loading basis

12. After addition of orthophosphate begin, environmental monitoring will be conducted to more accurately assess the increase in total loading of phosphorous to the river. Any substantial increase could be potentially be offset by technological upgrades to the wastewater treatment plants to improve phosphorous removal.

13. Orthophosphate added to the drinking water at the two WTPs in Edmonton will also be in the wholesale drinking water supplied by EPCOR to the regional water service commissions and their customers. These customers will be able to benefit from the lead corrosion inhibition properties of the orthophosphate and will be allocated a portion of these costs (approximately $7 million per year). Most of the communities served by the regional system discharge their wastewater to either the Alberta Capital Region Wastewater Commission (ACRWC) or to local wastewater treatment lagoons. Lagoons in Alberta do not have total phosphorous limits. EWSI has informed ACRWC about the intent to dose orthophosphate and, similar to the Gold Bar WWTP, the Alberta Capital Region WWTP will also need to use additional alum to remove increased phosphorous loading. A similar engineering assessment to the one that was done on the Gold Bar WWTP was carried out at the Alberta Capital Region Wastewater Treatment Plant. The ACRWWTP will add alum to remove the additional phosphorous loading entering the plant.

1.2 Ongoing Sampling and Monitoring

14. Sampling protocols differ depending on whether the desired objective is to identify sources of lead, control corrosion, assess regulatory compliance or estimate exposure. An ideal lead sampling strategy is one that can estimate peak lead levels accurately with reasonable logistical requirements[4]. Typical exposure in residential dwellings can be determined by two sampling protocols as recommended by Health Canada to identify priority areas for reducing lead concentrations and for assessing compliance: Random daytime ("RDT") and 30-minute stagnation ("30MS"). To be statistically robust, RDT sampling requires 2-5 times more samples than 30MS, but it is relatively inexpensive and generally more acceptable to consumers. 30MS is more useful for determining causes of exceedances and identifying appropriate mitigation

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[4] Cornwell and Brown, 2015.

measures. For either protocol, it is recommended that samples be collected throughout the year from cold water taps.

15. Currently, EWSI uses both sampling methods in its current lead management program, and expects to continue to do so into the future. EWSI will adjust compliance sampling efforts at the tap once regulatory direction is provided from Alberta Environment and Parks. In addition to monitoring lead at the customer's tap, EWSI will also develop a formalized program to include monitoring phosphate within the distribution system to confirm the efficacy of orthophosphate dosing from the water treatment plants. Monitoring phosphate at established points within the distribution system such as reservoirs and fire stations will help to confirm the status of corrosion control efforts. EWSI will also conform to any regulatory requirement related to phosphate monitoring established by Alberta Environment and Parks.

2.0 LEAD SERVICE LINE REPLACEMENT PROGRAM

16. The following operational implementation plan provides information on EWSI's planned activities for LSL replacements. EWSI relied on a 2018 LSL replacement pilot and Request for Information from ten contractors as described below. EWSI describes its plans to replace LSLs for the following cases:

2.1 Ongoing Sampling and Monitoring

17. EWSI completed a pilot in 2018 to gain a better understanding of the scope of work for a coordinated full LSL replacement. The pilot involved LSL replacements at eight homes in Edmonton. Four of these were managed by EWSI and four were managed by one independent contractor. The pilot demonstrated that the majority of the work could not be completed using EWSI in-house resources and required contracting out specific scopes of work. The scope required EWSI to contract out all hydrovac, horizontal directional drilling ("HDD"), asphalt and concrete restorations. The full LSL replacement work also requires a high level of homeowner and resident coordination and communications. EWSI's experience with this pilot highlighted the unique risks associated with working on privately-owed LSLs. These risks include potential damages to the home's foundation, interference with other utility infrastructure on private property and the home's sanitary services. Key risk and mitigation strategies are discussed further in Appendix D.

2.2 Request for Information on LSL Replacement

18. In November 2018, after completion of the pilot, EWSI publically issued a Request for Information ("RFI") for LSL replacements in order to gain an understanding of which other contractors may be interested in participating in a larger LSL renewal project. The objectives of the RFI included:

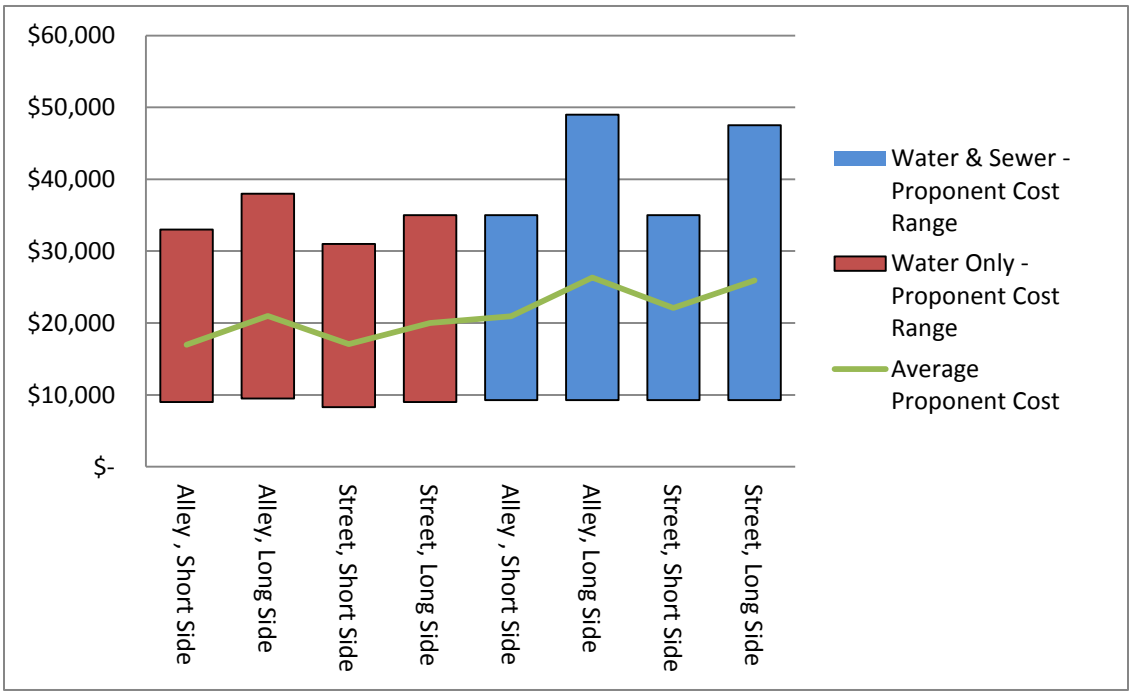
- determine the proponent's interest in participating in the Project;
- understand the proponent's services and product offerings, level of experience, industry partnerships;
- gather information and input from proponents that may be used to inform EWSI of possible further steps that could shape the direction of the Project; and
- assist EWSI in determining its requirements, scope of work and approach in preparation of next stage procurement requests.

19. Ten proponents responded to EWSI's RFI. From their responses, it was garnered that the majority would use various methods depending on site specific circumstances. The least destructive and least expensive method is extraction, which would be used if feasible based on site conditions. A secondary method of HDD, most likely method to be used due to site conditions, would abandon the old lead service in place and install a new service parallel to the old one. A third method of pipe bursting the sanitary service and pulling through both a new water service and a sanitary service can be viable on some sites. This method is particularly useful when the sanitary service is in need of replacement as by replacing both the sanitary and water service at the same time, cost savings can be realized. All of the above methods would require an excavation pit at three points: at the water main stop, at the curb cock, and inside the basement of the house. A final method for LSL replacement would be to replace the water service through open cut method if the above trenchless methods are not viable options. This method is the most disruptive option and likely the most expensive due to the extent of surface restoration. The service line materials suggested by the proponents were generally reserved to copper or Municipex (plastic) which are both suitable for HDD or extraction methods.

20. The proponents were asked to provide their estimated average costs replacing the LSL for the following four situations: (i) water services in alley, short side (approximately 25m length); (ii) water services in alley, long side (approximately 35m length); (iii) water services on street or avenue, short side (approximately 15m length); and (iv) water services on street or avenue, long side (approximately 25m length). The proponents were also asked to estimate the additional cost to replace the sanitary service at the same time. The proponent's pricing varied considerably from one another. One of the proponents pricing was substantially lower

than the others and would warrant additional follow-up. It is likely that this proponent priced the cost to replace the private portion of the LSL only. Due to this one Proponent being an outlier, they have been excluded from EWSI's cost estimates and from the figure below. EWSI used all of this information to estimate the costs for LSL replacements in its Lead Mitigation Program. EWSI is estimating $6,500 plus $1,000 for hydrovac services for replacing the private portion LSL replacement and $14,500 for replacing the utility portion.

Figure 2.2-1
Proponents Cost Estimates for LSL Replacements
($)



21. The majority of proponents suggested that they would have capacity to complete 100 to 200 LSL replacements per construction season and could mobilize multiple crews to meet a demand between 200 and 400 LSL replacements per season. The majority of proponents suggested that geographic bundling of LSL replacement locations would be preferred in order to reduce mobilization costs and coordination costs. In addition, the ability to schedule multiple locations at once and to coordinate the lead service line replacement with the water main renewal was expressed as advantageous. Proponents were only able to decrease their pricing per service by an average of 3.4% per additional hundred services added to the scope which indicated low economies of scale.

22. The full construction timeline from initial contact with the homeowner to the final restorations varied greatly between Proponents from two to eight weeks in duration. The average construction timeline appears to be four weeks for from initial contact to final restoration. The turnaround time for construction varied greatly between proponents, ranging from 1.6 LSL replacements being completed per day per crew to a three day turn around per LSL replacement per crew. The contractors noted several concerns with customer communications, coordination, and liability that have been included in Appendix D – Key Risks and Mitigation Strategy.

2.3 LSL Replacement Plan

23. Since 2008, EWSI has replaced an average of 141 utility portion LSLs per year and abandoned an additional 17 LSLs each year. About one third of utility portion LSL replacements are completed under the Water Service Replacement and Refurbishment program or where the customer has replaced the privately portion of an LSL and requests replacement of the utility portion. The remaining two-thirds of utility portion replacements are completed by EWSI as part of water main renewal programs or on an emergency basis when a leaking service requires replacement. At current replacement and abandonment rates, it will take EWSI approximately 20 years to eliminate the remaining 3,100 full and utility portion only lead service lines. Currently, replacement of the private LSLs is voluntary with approximately 38 replacements occurring each year.

24. EWSI anticipates that its LSL replacement plan will follow a similar trend as historically however both the private portion will be completed at the same time as the utility portion. The yearly estimate of LSL replacements is subject to how many LSLs are present in the Water Main Renewal area, which can vary from year to year. In the first five years of the LSL replacement program, it is anticipated that an increased number of LSL replacements will be completed per year due to the prioritization of High Priority LSLs. The LSL locations will be chosen based on lead concentrations at the tap exceeding the Health Canada MAC (5ug/L) after orthophosphate addition.[5] In addition to its current average level of LSL replacements, EWSI anticipates completing an additional approximately 50 more replacements per year during the first five years to replace the High Priority LSLs. These estimates are subject to the actual number of locations where the lead concentration at the tap exceeds the Health Canada MAC guidelines.

1.

[5] Actual sampling results after orthophosphate addition and calculated results based on previous sampling prior to orthophosphate addition.

After the first five years, the number of total LSL replacements will begin to decrease as the High Priority homes will have been renewed in the initial five years of the program.

25. In order to plan for full LSL replacement, an exploratory hydrovac program will be started to gain confirmation of the accuracy of the LSL records through an exploration phase. The exploratory program will involve daylighting anticipated LSL locations prior to any excavation activities to confirm locations and whether or not LSL are found on private and/or utility sides. This information will also help EWSI determine the extent of LSL on private side and the accuracy of existing information.

26. EWSI will commence the selection of one or two contractors through an RFP process. These contractors will be selected to trial approximately 200 LSL replacements. The precise quantity awarded will be dependent on the number of LSL Replacements in the Water Main Renewal areas and the effect of the orthophosphate addition on Health Canada MAC levels. A quantity awarded to each contractor will be chosen to allow the contractor to dedicate personnel to the project, likely more than 100 LSL replacements.

27. EWSI plans to hire three full time employees to support the LSL Replacement program: a Project Manager, a Coordinator, and an Inspector. The main function of the Project Manager will be to oversee the program, set up process, coordinate between departments, and sets up the customer communications. The Project Manager will also be present at Town Halls or Information sessions. The Coordinator and Inspector will be primarily out in the field supervising construction and assisting in the coordination with the homeowners/residents. The inspector will also assist with taking samples. This model is comparable to the structure employed by Halifax Water and Greater Cincinnati Water Works on similar LSL Replacement Programs. The LSL Replacement program will continue in subsequent years. The quantities, schedules and contractors will be adjusted to maximize the effectiveness of the LSL replacement program.

28. Under its proposed Lead Mitigation Program, EWSI has categorized its LSLs replacements into the following four categories: (i) High Priority LSLs (those testing above the Health Canada MAC); (ii) Repairs (done on an emergency basis to repair leaks); (iii) Water Main Renewals (those LSL replacements that are replaced as part of EWSI's planned water main renewal programs); and (iv) Customer Initiated (EWSI replacements of utility portion of LSLs when a customer elects to replace its private portion). The replacement plan for each of these is as follows:

High Priority LSLs

29. While adding orthophosphate will result in a significant reduction in the number of customers with lead concentrations above the Health Canada MAC, EWSI anticipates there will still be approximately 360 homes with LSLs that will exceed the MAC. Under this proposed Lead Mitigation Program, EWSI will prioritize over a five-year period replacement of both the private portion and utility portion of these 360 High Priority homes. EWSI intends to prioritize the replacement of these 360 High Priority homes based on completing the worst cases first. The homes are scattered across many different neighbourhoods so they will generally be completed one at a time. However, all efforts will be made to coordinate the replacement of High Priority LSLs with other construction work, including water main renewals and City of Edmonton neighborhood renewals. EWSI will also continue water sampling of known homes with LSLs to identify any that exceed the MAC in the future. Rather than wait until 2021 and implementation of orthophosphate addition to begin identifying and replacing LSLs at the High Priority homes, EWSI will begin to identify High Priority homes using the existing extensive database of lead testing in homes with LSLs. Full replacement of High Priority LSLs may being as early as 2019 but for purposes of the financial assumptions in this business case, EWSI has assumed a 2020 start. Utility portion only LSL replacements will be completed by EWSI's internal crews and full LSL or private portion only LSL replacements will be completed by contractors.

Repairs

30. EWSI replaces LSLs on an emergency basis because they have failed. The annual amount of leaks on lead services varies from year to year, but on average 49 LSLs fail annually. As these types of replacements are on an emergency basis and need to be completed in a timely manner to restore water to the residents, EWSI crews will replace the utility portion to expedite the repair. Once the utility portion of the LSL repair is complete, an external contractor will follow EWSI as soon as possible and complete the replacement of the private portion of the LSL to eliminate any future partial LSL replacements. These replacements can begin as early as 2019.

Water Main Renewals

31. For the homes with LSLs that coincide with EWSI's Water Main Renewal programs, replacement of both full LSLs and utility portion only LSLs will be completed by EWSI along with the water main replacement. This will eliminate any future partial replacements during Water

Main Renewal projects. Typically, the water main will be renewed and then the LSL will follow prior to final restoration of the site. The quantity of LSL replacements completed as part of EWSI's Water Main Renewal program can vary from year to year depending on the locations of the renewals and how many LSLs are present. Historically LSL replacements as part of EWSI's water main renewals have averaged 37 per year. These LSL replacements may begin as early as 2019.

32. If EWSI's Water Main Renewal contractor is awarded the lead services contract, they would be able to complete the LSL replacements and the Water Main Renewal together. If the same contractor is not awarded both contracts, there will have to be a separation of work zones and the LSL replacement contractor would follow behind the water main renewal contractor. The quantity of LSL replacements completed as part of EWSI's Water Main Renewal program can vary from year to year depending on the locations of the renewals and how many LSLs are present. Should a customer with a full LSL choose to replace their private portion LSL ahead of EWSI's scheduled Water Main Renewal program, EWSI will continue to prioritize the replacement of the utility portion of the LSL. Customers choosing the replace their private portion LSL ahead of the scheduled Water Main Renewal program will not be reimbursed for the costs associated with the private portion LSL replacement.

Customer Initiated

33. EWSI will continue to replace the utility portion of approximately 55 LSLs per year in cases where: (i) the customer has decided to replace and fund their private portion either as part of a new infill development (28 per year on average); the customer has decided to replace their private portion of the LSL (10 per year on average); or where EWSI annually replaces some of 750 pre-existing utility portion only LSLs in the system (17 per year on average).

34. EWSI's proposed Lead Mitigation Program will not including a plan to replace homes with private portion only LSLs unless they are determined to be High Priority homes. If they are not High Priority, EWSI will continue to notify the homeowner annually to encourage them to replace their privately-side only LSL.

35. Any homes with LSLs will be prioritized for replacement, ahead of the scheduled Water Main Renewal program, when lead concentration at the tap exceeds the Health Canada MAC (5ug/L) after orthophosphate addition.

APPENDIX D

KEY RISKS AND MITIGATION STRATEGY

1. The following tables summarize key Project risks EWSI has identified along with comments on each of these risks and planned mitigation strategies. Risks have been categorized between those associated with lead corrosion inhibitor plans and with LSL replacement plans and identified as financial, regulatory environmental and stakeholder/customer risks.

Table 1
Orthophosphate Addition
Key Risks and EWSI Risk Mitigation Strategies

A **Project Risk**	B **EWSI Mitigation Strategy**
Financial Risks	
O&M Costs – Phosphate Costs – Risk of changes in the costs or availability of phosphate and the U.S. exchange rate may affect the calculated costs associated with the lead corrosion inhibitor program.	Historical average prices for phosphoric acid and U.S. exchange rates have been used to calculate the lead corrosion inhibitor program costs. The average historical costs account for some cyclical price volatility. Substantial cost fluctuations beyond these levels are not anticipated.
O&M Costs – Phosphate Removal - Risk that orthophosphate addition increases the amount of phosphorous that presents at the Gold Bar and Capital Region wastewater treatment plants, exceeding the phosphorus discharge limits, requiring changes to wastewater treatment processes.	Engineering assessments completed for both Gold Bar and Capital Region wastewater treatment plants indicate that additional phosphate can be removed by adding alum at the wastewater treatment plants. Both plants are equipped for this process and any additional costs associated with the alum addition have been included in project costs.

O&M Costs –Phosphate Addition Risk – more phosphate is required than anticipated as the effectiveness of orthophosphate for lead reduction is based largely on pilot testing.	Although pilot testing has indicated a target dose of 0.9 mg/L, it is fully expected that further optimization of phosphate dosing will be required in the 1-3 year period following commencement of phosphate addition. The system, therefore, will be designed to be able to dose up from 0.5 mg/L to 2.0 mg/L to allow for optimization of the dose as needed with an anticipated long term dose of 0.7 mg/L. Optimization will be based on continued monitoring of the system for both lead and phosphate at the tap in homes with and without LSLs. A communications plan will be implemented to encourage customers to replace their lead containing plumbing fixtures and to educate customers at the point of sale to reduce exposure to lead from plumbing fixtures.
Capital Costs Risk – Project capital costs increase beyond the forecast	The capital cost estimate for the Project is based on conceptual design drawings in the Stantec report and include a 25% contingency to account for cost and scope variability. EWSI will initiate a request for proposal process to competitively bid the design and construction of the Project. This process will allow EWSI to obtain the best value offer for completing the Project design and construction. Cost estimates will be evaluated at several stages through design to mitigate potential cost increases.

Regulatory Risks	
Risk of phosphorous release to the Environment – risk that orthophosphate addition results in increased phosphorous loading to the North Saskatchewan River from both the wastewater treatment plants and stormwater management systems, exceeding limits set by Alberta Environment and Parks.	The Gold Bar WWTP currently uses biological nutrient removal (BN) to remove phosphorus to meet total limits for discharge of treated wastewater to the North Saskatchewan River. The plant has the capability to add alum to precipitate and remove any excess phosphorous the BNR process cannot remove. The additional costs at Gold Bar will be limited to alum, with no need for any additional capital expenditures or operations and maintenance costs and have been included in the Project costs. In addition, phosphate injection point have been designed downstream of water treatment plant filter backwash water supply systems to avoid phosphate loading to the North Saskatchewan River via existing waste streams. EWSI completed a cumulative effects assessment to assess the amount of phosphorus loading to the North Saskatchewan River due to the introduction of orthophosphate as a lead corrosion inhibitor. The report concluded that under the worst case scenario, the increase phosphorous loading the North Saskatchewan River would be between 6 %and 22% during the warm water period (May through September) mainly through unavoidable real losses in the water distribution system. Discussions with AEP on this issue have been started. EWSI is engaged with AEP through Capital Region Industrial Heartland Water Management Framework. The CRIH-WMF is developing a cumulative effects management framework for the section of the river that passes through the City and the IH (Devon to Pakan). This will include phosphorous as a managed parameter. An application will be submitted to Alberta Environment and Parks for approval of phosphate addition to EWSI's water treatment processes prior to implementation of the program. Increased instream monitoring of phosphorous and algae is recommended to better determine

Development Permit – Risk a Phase I Environmental Site Assessment ("ESA") will be required to support the development permit application, triggering possible Phase II and remediation activities at the site prior to construction.	EWSI will request an exclusion to the Phase I ESA requirement based on the proposed construction activities being commercial in nature, at an existing site, not requiring excavations, and under 10% in size as compared to existing infrastructure on site. If an exclusion is denied, a Phase I ESA will be required and completed once the site location is confirmed. Should the Phase I ESA recommend a Phase II ESA, soil and/or groundwater sampling will be completed and submitted with the development permit application as a supporting document.
North Saskatchewan River Valley Area Redevelopment Plan ("NSRV ARP")– The NSRV ARP may require field work, a Municipal Environmental Impact Assessment prior to construction.	EWSI will consult with the City of Edmonton on construction requirements for the orthophosphate facilities under the NSRV ARP. Based on the location of the proposed infrastructure within the previously disturbed areas of the existing plants, no field work is anticipated and a desktop study should suffice.
Historical Resource Act – The province may require Historical Resource Act archaeological consultations prior to construction.	The proposed building locations are on previously disturbed land and do not require excavations. Should Historical Resource Act clearance require fieldwork, historical resources are not anticipated to be encountered.
Stakeholder/Customer Risks	
Water Quality Concern Risk –customers express concerns with the safety and long term effects associated with the addition of orthophosphate to their water.	A communications plan will be implemented to educated customers on the safety and effectiveness of orthophosphate addition to drinking water. Details of this plan included in Appendix D.

Table 2
Lead Service Line Replacements
Risks and Risk Mitigation

A **Project Risk**	B **Mitigation Strategy**
Financial Risks	
Capital Costs Risk – Project capital costs increase beyond the forecast due to a lower effectiveness of orthophosphate that anticipated, leading to an increase in the number of High Priority LSL replacements required.	EWSI calculated High Priority LSLs assuming 80% orthophosphate efficacy. Based on experience in other jurisdictions, EWSI considers the likelihood of reductions in lead levels of less than 70% to be unlikely. The 80% effectiveness assumption will be revisited after the introduction of orthophosphate by monitoring and sampling at High Priority homes and the scope of the program will be adjusted as necessary.
Capital Costs Risk – Project capital costs increase beyond the forecast due to higher than expected costs for replacement of privately-owned portion and/or utility-owned portion of LSLs.	EWSI has relied on its experience from the pilot program and Request for Proposal to determine average LSL replacement costs.
Capital Costs Risk – Project capital costs increase beyond the forecast due to an increase in the number of LSLs requiring removal due to incomplete or inaccurate records for LSLs.	EWSI has relied on its records, field reconnaissance notes and industry data to estimate the number of LSLs with lead on the privately-owned portions, but notes that due to incomplete records these estimates are subject to variability. EWSI records private-side service materials when lead is observed at the water meter during a meter installation or at the curb cock during maintenance. Moving forward, EWSI will initiate a hydrovac program to confirm records prior to LSL replacement and as part of the EWSI communication plan, will encourage customers to confirm the construction of their service lines.

Damage to Third Party Utilities Risk – Damage to other utilities occurs during use of Horizontal Directional Drill method due to incomplete or non-existent utility services information on private properties resulting in additional project costs for repairs.	EWSI will utilize One-call locates prior to any work occurring to identify known utilities. In addition, EWSI will coordinate with Drainage Services to identify available records of drainage services on private properties. To prevent damages, hydrovac services will be performed for visual confirmation of any identified utility services located within 1.0 m of the proposed new water service alignment.
Damage to Customer's Premises Risk - Project capital costs increase beyond the forecast due to the structural integrity of the homes, conditions within finished basements, and other damages that will require repair.	Work completed within a customer's home will be completed by a third party contractor with a goal to limit vibratory compaction and use a sand/fillcrete backfill to prevent damage. Any damages identified by customers will be covered by the contractor scope of work. In addition, EWSI will be using preconstruction photos in an attempt to identify any weak points/cracking in the walls and foundation, maintain a record of existing conditions and identify possible issues prior to start of work. In instances where the structural integrity of the home is a concern, EWSI may hire a geotechnical consultant to perform vibration monitoring and assessment prior to the start of work. Such measurements would show that the vibrations due to our work were in an order of magnitude below what is required to cause structural damage prior to the start of work.
Regulatory Risks	
Regulation changes – Risk of future changes to regulatory requirements mandating the removal of all lead service lines, including private-side LSL.	The proposed LSL replacement program includes full LSL replacements and the removal of High Priority private-side only LSLs. Any changes to regulations requiring the removal of remaining private-only LSLs, not exceeding the Health Canada MAC, will be addressed at that time.

Customer/Stakeholder Risks	
Customer Participation Risk –customers and property owners are resistant to replace the private section of the LSLs during full LSL replacements, are not aware of the program, or are not available for access into the home. This includes vacant and rental properties.	A communications plan will be implemented to educated customers on the LSL replacement program, health concerns associated with lead, and the benefits of LSL replacement. Communication and education of customers will occur through direct conversations, open houses, and advance notifications in order to provide ample notice to residents and clearly communicate the proposed construction schedule. In order to meet with customers who work during the day, notifications and construction may have to be performed during evening or weekends.
Reputational Damage – Risk of Potential for reputational damage to EPCOR if customers are unhappy with the portion of work undertaken on their property.	Work completed within a customer's home will be completed by a third party contractor with a goal to limit vibratory compaction and use a sand/fillcrete backfill to prevent damage. Any damages identified by customers will be covered by the contractor scope of work. In addition, EWSI will be using preconstruction photos in an attempt to identify any weak points/cracking in the walls and foundation, maintain a record of existing conditions and identify possible issues prior to start of work. As part of EWSI's Communication Plan, post-construction follow-up contact with customers will occur to identify issues and address concerns.

APPENDIX E

EWSI's Lead Mitigation Program - Communication Plan

1. The following abbreviated communications plan provides information on EWSI's planned communications strategy, communication goals and key messages, strategies and tactics for implementation and evaluation process. The scope of this communication plan covers initiatives up to the introduction of the new Health Canada guideline as well as EWSI's enhanced efforts around lead management in Edmonton.

1.0 Communication Plan Overview

2. The proposed communications plan will target all Edmontonians, customers with LSLs, large customers, EWSI employees, the media, and the Regional Water Customers Group. EWSI is a proactive leader in protecting public health and the environment and this plan reflects this position. The primary goals of this communication plan include: (i) ensuring its customers are informed about lead in drinking water and the efforts EWSI is taking to enhance its' Lead Mitigation Program; (ii) provide its customers with information on what they can do to prevent lead in drinking water; (iii) help Edmontonians understand the importance of and feel positive about EWSI's Lead Mitigation Program; and (iv) ensure customers with LSLs are cooperative and willing to take steps to prevent lead in drinking water.

1. EWSI conducted consultation with customers to understand how Edmontonians would likely respond to the proposed Lead Mitigation Program. The information gathered informs EWSI's communication plan and messaging to customers.

In fall 2018, EWSI worked with market research firm Stone Olafson to probe on customer views on lead in drinking water in Edmonton. EWSI carried out face-to-face interviews and an online survey of approximately 400 customers with both customers with and without LSLs. The feedback from this research has provided the following insights into EWSI's customer's views:

- Water Quality Concerns - The large majority of customers (89% of respondents) believe their water is safe and (79%) drink the tap water today. Lead is not a top-of-mind issue for customers and when asked about potential water issues, only 5% of respondents mentioned lead. When provided information about the new Health Canada guidelines for lead and the potential sources of lead in the water system (LSLs, plumbing and fixtures), 53% still consider their water to be safe; 32% plan to conduct research to learn

more; 18% plan to start filtering their water; and 10% plan to contact EPCOR to get their water tested.

- Lead Corrosion Inhibitor (Orthophosphate) - The survey determined that 27% of respondents would support the addition of a lead inhibitor while 44% would support with more information, 19% would oppose it until they received more information and only 4% said they would oppose it regardless of any further information. The remaining 6% had no opinion. Generally, respondents would support the addition with further information about the safety of the additive, long-term effects and more specific information about the additive and how long other cities have been using it.

- Funding for a Lead Mitigation Program - When customers were told that the homeowner is currently responsible for the cost of replacing their portion of the LSL, 23% of respondents said it should be the home owner's responsibility; 38% said it should be EPCOR's responsibility and 33% said it should be a shared responsibility.

- Based on the outcome of this public consultation process, EWSI recognizes that introduction of the new drinking water additive combined with a new program to replace private portion of LSLs (for High Risk, water main renewals and repairs) will require a well-coordinated and sustained stakeholder engagement and communication strategy. The customer communication strategy will include a plan to encourage replacement of private portion of LSLs, to address concerns with orthophosphate dosing and to encourage customers to identify and replace lead-based plumbing and fixtures.

3. Key messages for customers from the communication plan will include:

    - When drinking water leaves EPCOR's water treatment plants and flows through the municipal distribution piping it contains no measureable level of lead.

    - Lead service lines are a common source of lead. Another source can be a customer's private in-house plumbing, including old solder, brass plumbing fixtures and/or lead deposits in plumbing systems.

    - Water at the tap in these homes has the potential to exceed the maximum acceptable concentration for lead in drinking water set by Health Canada.

- Nothing has changed overnight in Edmonton's drinking water. There is no immediate health risk, but the lead issue must be addressed over time.
- With the new guideline, Health Canada has set more challenging targets for lead in drinking water in order to improve the overall health of Canadians
- Customers should be aware of the issue, especially in LSL homes, and can take immediate measures to reduce risk such as flushing their taps after the water has been stagnant or use of a filter.
- This new guideline, once announced, will enhance public health protection, and as Edmonton's water provider, EPCOR supports the change as it aligns with its efforts to reduce lead exposure from drinking water as much as possible.

2.0 Communication Program Strategies and Tactics

4. There are three phases of communication associated with EPCOR's enhanced lead management program milestones.

Phase 1: A new Health Canada MAC is announced (March 2, 2019 and until 2021):

5. During this phase EWSI will:

- provide the public with insight on EWSI's work done to date in lead management in Edmonton;
- continue to work with City Council and Utility Committee , EWSI's regulator, to confirm the proposed long-term funding approach and plans for a lead corrosion inhibitor;
- provide the public, including regional water customers, with tools and information on how they can check for lead in their household and limit their exposure to lead in their drinking water with good water quality habits and NSF filters available at their home improvement store;
- provide City of Edmonton Councilors with information on the new Health Canada guidelines and reiterate EWSI's Lead Mitigation Plan in response to these changes;
- reach out to customers with LSLs and give them more detailed information about the change in Health Canada MAC and what they can do given the new standard;
- Inform LSL customers that EWSI will continue to provide them with annual free water testing services, tap mount filtration units and lead management information; and
- reach out to local retailers to explore opportunities for customer education on lead.

Phase 2: New enhanced LSL replacement program goes live (2019):

6. Leading up to and during this phase, EWSI will:

- reach out to LSL customers who have full LSLs to give them an update on when they are slated for replacement and explain how to proceed if they choose to replace the private-side of the LSL ahead of the scheduled replacement;
- prioritize the High Priority LSL replacements;
- reach out to LSL customers who are identified as High Priority and give them an update on when they are slated for replacement; and
- launch an LSL customer education program outlining what they can expect in the LSL replacement process and how to ensure their replacement is seamless.

Phase 3: Orthophosphate program goes live (2021):

7. Leading up to this phase, EWSI will:

- educate and remind the public on the need to limit exposure to lead as much as possible;
- communicate the effectiveness of orthophosphate in helping to limit lead at the tap, while also having no negative health effects;
- work with Alberta Health Services and/or Alberta Health to provide further health information associated with the additive to validate and support the program; and
- reach out to businesses who might need to modify their process water use practices given orthophosphate addition to treated water and work with them to help them prepare for the change.

3.0 Evaluation

8. EWSI will use various measurement tools to assess the effectiveness of the communication plan and its implementation including monitoring the following sources of feedback:

- Media coverage – amount, tone, key messages, quotes
- Social media comments – amount, tone
- Visits to epcor.com/lead and views of online videos and content
- Calls to Lead Program Representatives, Water Dispatch and Call Centre – tone and content of calls
- Follow up with customers who take part in our enhanced LSL replacement programs