Public Utilities Commission of the City of Sault Ste. Marie

Drinking Water System Asset Management Plan

Technical Memo – Lifecycle Strategy and Financial Planning

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Date: July 2023
Project #: 60596267

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Project #

60596267

Dear Orlan:

Subject: **Drinking Water System Asset Management Plan**
Technical Memo – Lifecycle Strategy and Financial Planning

Please, accept the FINAL report for TM#5 - Lifecycle Strategy and Financial Planning.

We trust the enclosed meets your approval. Should you have any questions or require further information about our submission, please do not hesitate to contact us.

Sincerely,

AECOM Canada Ltd.

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AECOM: 2015-04-13

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Table of Contents

page

List of Figures

List of Tables

Appendices

1. Introduction

1.1 Background

PUC Services Inc. ("PUC") is a utility services company operating as a wholly owned private company of the Corporation of the City of Sault Ste. Marie. PUC operates a drinking water system and an electrical distribution system under service contracts between PUC and its clients. The City of Sault Ste. Marie (herein referred to as "the City") has a population of 73,368 and is projected to experience an increase in population of 9,900 by 2036 (as reported to Council in 2019). To service this population, PUC maintains a drinking water system dating back to 1916. Today, PUC supplies drinking water from both surface water and groundwater using a combination of surface water intakes and pumps, a surface water treatment plant, 6 wells, two reservoirs, and 445 kilometres of watermains (**Figure 1**).

PUC is charged with maintaining and renewing a diverse portfolio of mixed vintage infrastructure within the bounds of available funding levels. At the same time, PUC strives to enable development in a municipality that has experienced minimal growth in recent years. PUC desires to align its future investments in drinking water sources, treatment facilities, storage, and conveyance with growth projections while ensuring that a high quality of drinking water is provided. As well, PUC recognizes the challenges in drinking water distribution. Unlike wastewater and/or stormwater collection systems, pressurized watermains are often operationally and cost prohibitive to inspect, resulting in many municipalities possessing limited condition information, and in many cases managing them in a reactive fashion.

With the inception of Ontario Regulation 588/17, PUC faces an upcoming series of regulatory requirements for asset management systems that align with ongoing PUC and City initiatives to update the Financial Plan, develop a Drinking Water Master Plan, and update the City's Official Plan. Recognizing the alignment of these goals with asset management, PUC has engaged AECOM to develop a Drinking Water System Asset Management Plan (AMP). The key tasks for establishing an AMP include:

1. A review of asset data and data management practices to evaluate requirements for the proposed asset management system.
2. The creation of an Asset Management Policy (**Appendix A**) to serve as the top-down guidance document that defines the components of the asset management system.
3. An analysis of the State of the Infrastructure using a combination of desktop and field assessments to develop risk profiles and identify further condition assessment activities for large assets.
4. Development of PUC's current and proposed Levels of Service.
5. The consolidation of plans and projects required to achieve the objectives of the asset management system into a Lifecycle Strategy.
6. The development of a Financial Strategy to evaluate the requirements for sustainably funding the asset management system, to propose funding models for meeting the needs of the system, and to support the update of PUC's Financial Plan.

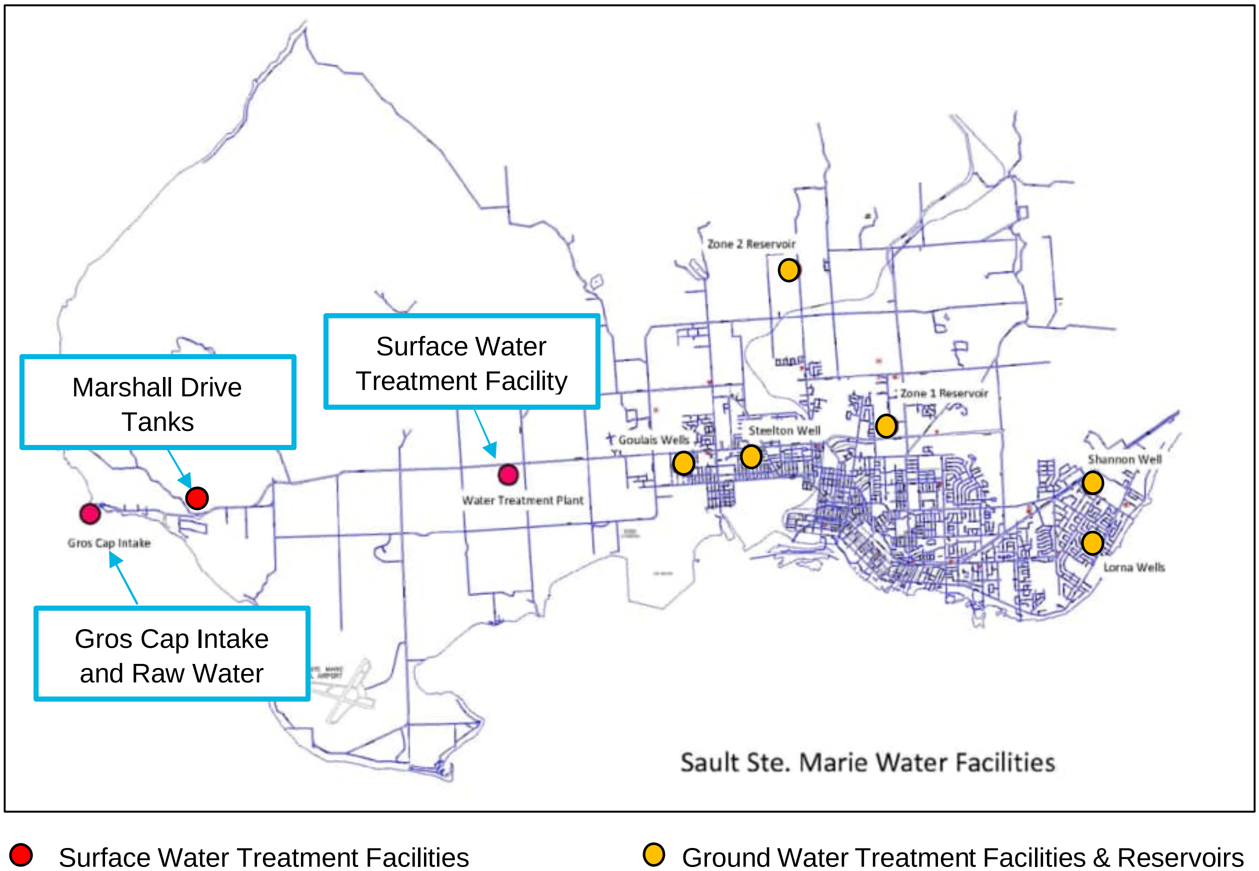


Figure 1: Map of Sault Ste Marie's Drinking Water System

Note: the Lorna Wells have been removed from active duty but remain in the system as a contingency to meet high system demands and/or to supplement production when other production facilities are offline.

1.2 Key Steps Supporting Asset Management Plan

The actual steps used to develop this AMP are presented in **Figure 2**, and have been selected to ensure that reliable and robust useful information is provided from which PUC can have confidence to make fact-based and defensible business decisions. The basic building blocks of the step-by-step methodology outlined in **Figure 2** are founded upon the Water Environment Research Foundation (WERF) SIMPLE (Sustainable Infrastructure Management Program Learning Environment) process.

The objective of SIMPLE is "*to drive a broad range of benefits to the industry by providing a systematic rationalization for determining where the most cost-effective investment (acquisition, maintenance, renewal) in the asset portfolio is, over the life cycle of the asset portfolio (that is, directing limited dollars toward the optimal application in any given budget cycle)*". At the heart of the SIMPLE process (and what was the primary focus of this AMP) was to explore the following topics:

- Current State of Assets;
- Levels of Service;
- Asset Life Cycle Strategies;
- Funding Strategies; and

- Implementation Plan.

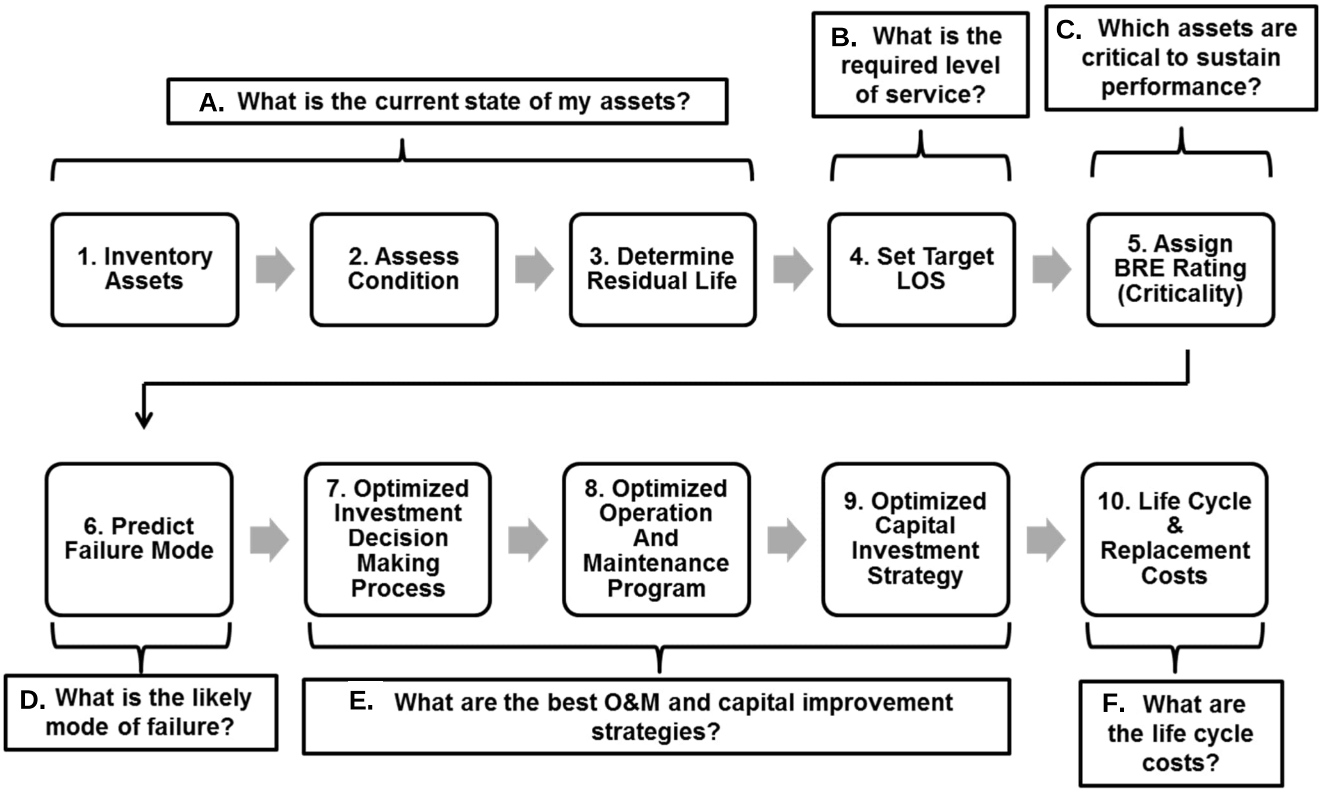


Figure 2: Key Building Blocks in Developing this AMP

The following sections summarize the exploration and findings of the AM Planning process for PUC.

1.3 Asset Lifecycle Strategies

Any responsible owner of assets such as PUC has a desire to preserve the condition of their existing assets for as long as possible, by maintaining or even extending their design lives through routine activities such as maintenance and active interventions. PUC is continually constructing or acquiring assets that require increased funding for operating and maintenance (O&M). PUC is also responsible for the replacement of deteriorated assets for as long as their service is required. While individual assets may have a useful life that can be predicted in years or decades, the service that the asset provides could be required for a substantially longer duration.

Decisions that are made at the design stage can significantly influence the maintenance activities required and vice versa (**Figure 3**). Monitoring and measurements during the acquisition phase, and the quality of assembly / construction can significantly affect the durable nature of an asset and the expected serviceable life or operating costs.

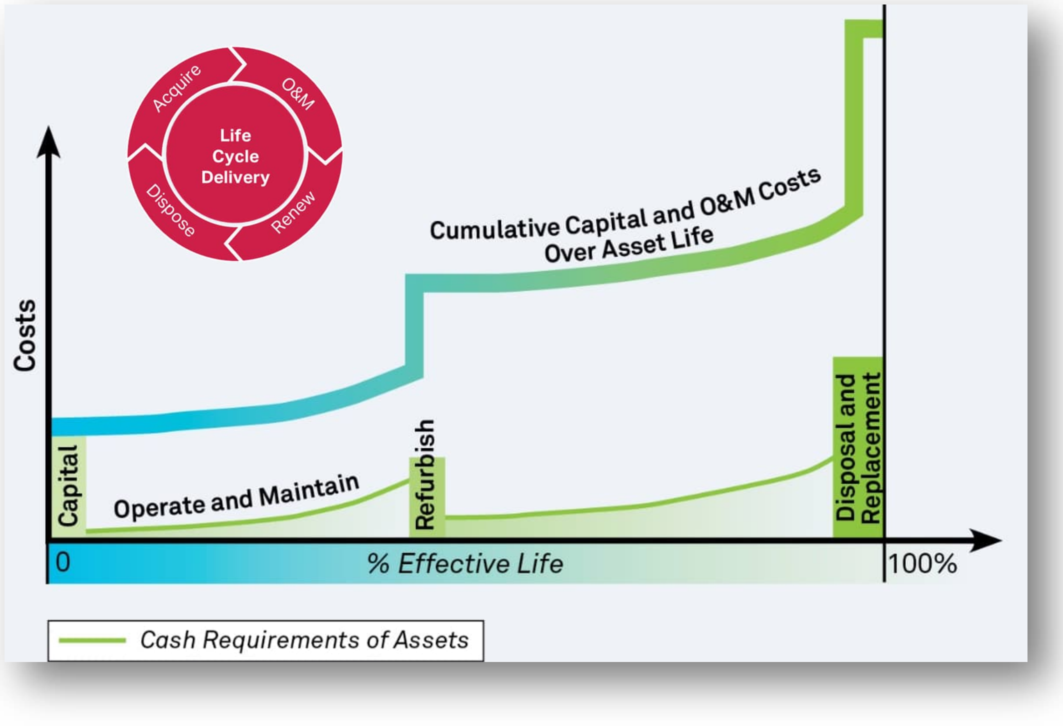
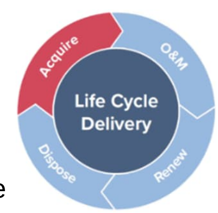


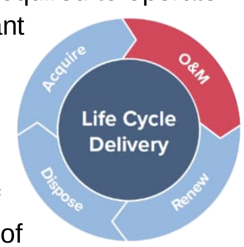
Figure 3: Through Understanding the Full Life Cycle Costs of its Assets, PUC Will Make Better, More Informed and Financially Sustainable Asset Decisions

The following describes the asset lifecycle in general.

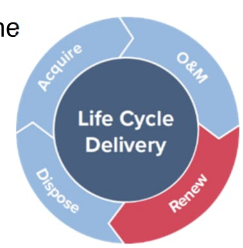


Asset Acquisition / Procurement / Construction: PUC has made significant investments in the design, construction and acquisition of its water infrastructure assets. PUC's infrastructure inventory was developed over many decades through infrastructure paid for by the PUC. Looking towards the future, when constructing or acquiring new assets, PUC should evaluate credible alternative design solutions that consider how the asset is to be managed at each of its life cycle stages.

Asset Operations and Maintenance (O&M): As new infrastructure is commissioned, PUC accepts the responsibility of operating and maintaining the infrastructure according to O&M standards to ensure that the infrastructure is safe and reliable. Operations staff provide the day-to-day support required to operate infrastructure. In some cases, O&M costs are minor, but in other case there are significant costs. Maintenance expenses include periodic preventive maintenance to ensure that the infrastructure can provide reliable service throughout the life of the asset and corrective maintenance that is required to repair defective assets as and when needed. Inadequate funding for O&M will have an adverse impact on the lifespan of assets. The amount of O&M resources required in any period is a function of the current inventory of infrastructure and total O&M needs required for each asset. As the inventory of infrastructure grows, total O&M requirements will also grow.

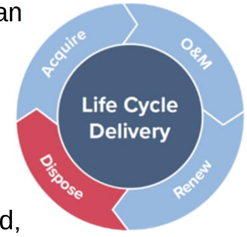


Renewal and Replacement: The third portion of full life cycle costing relates to the renewal and replacement of infrastructure that has deteriorated to the point where it no longer provides the required service. Renewal cost is sometimes incurred during the life of an asset where an investment is made to improve the condition and / or functionality of the asset e.g., re-lining of a pipe. Disposal and replacement costs are



incurred at the end of an asset's life when it is disposed of and replaced by a fully new asset.

Decommissioning and Disposal: There will inevitably come a point in time when an asset must be removed from service and, depending on the type of asset, there may be significant costs associated with its decommissioning and disposal. Factors that may influence the decision to remove an asset from service include: changes to legislation that cause the asset to be in non-compliance, the inability of the asset to cope with increased service levels, technology advances that render the asset obsolete, the cost of retaining the asset is greater than the benefit gained, or the current risk associated with the asset's failure is not tolerable. Normally, major costs that may be incurred during disposal and decommissioning derive from the environmental impact of the disposal and, if required, the rehabilitation and decontamination of land. In some cases, there will be residual liabilities and risks to consider if a decision is made to partially abandon the asset as opposed to fully disposing of its components (e.g., leaving a non-functioning pipe in the ground, or an inactive building standing). However, some cost savings may be achieved through the residual value of the asset or by exploring alternative uses for the asset. In all cases, it is important to consider disposal and decommissioning as the strategy employed has the potential to attract significant stakeholder attention. For that reason, the costs and risks associated with disposal and decommissioning should be equally considered in PUC's capital investment decision-making process.



2. Overall Methodology for Asset Categorization, Condition Assessment, Lifecycle Costing and Financial Plan

2.1 Overview

In developing a lifecycle costing, timing and type of maintenance, maintenance, repair, rehabilitation and replacement activities should be considered in order to increase the confidence level of estimating the annual needed budgets for annual interventions, where needed.

In this report, the methodology for the lifecycle costing and financial planning focuses on the:

- Water Vertical Assets; and
- Water Linear Assets.

All data used in this report and associated reports were based on 2018-2020 data.

As per **Figure 4**, the outcomes of the completed tasks in this project along with other information and studies completed during the course of the project played a major role in completing the lifecycle costing and financial planning.

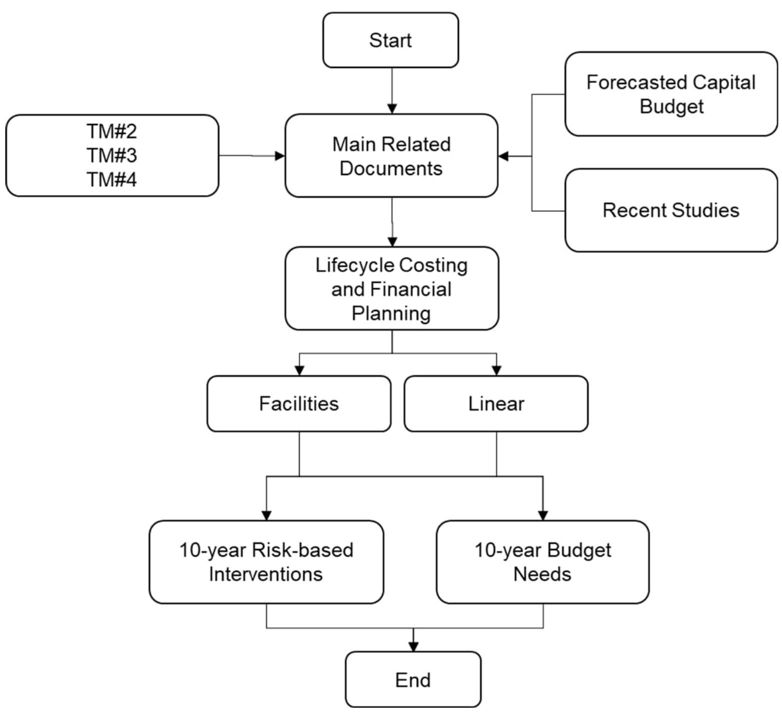


Figure 4: Approach for PUC's Lifecycle Costing and Financial Plan

The asset management plan is a living document and the PUC has a significant number of vertical and linear assets. PUC prioritised detailed assessments on vertical assets with highest consequence of failure and will continue to prioritize the assessment on assets with greater risk exposures.

In some cases the vertical assets were categorized and vetted at a very high level (i.e., hierarchy limited to two levels and asset condition was broadly assessed based on current age versus typical service life) while in other cases assets were categorized to five levels in the hierarchy and visually inspected. The higher level of assessment was completed for those assets that are considered more critical to the overall system and service delivery to customers. In the future, the PUC will enhance the categorization and condition assessment of those vertical assets that have only been assessed at a high level in this document.

Specifically, some of the electrical, mechanical and structural assets at the Surface Water Treatment Plant have been considered in greater detail within the context of this study (refer to **Appendix B**). Similarly, some of the electrical and mechanical assets at the Gros Cap Pump Station were considered in greater detail in a separate companion study which was also completed by AECOM. The results of the Gros Cap study have been incorporated into the AMP. The visual inspection of the individual assets at both facilities support the condition assessment and likelihood of failure (LoF) analysis (refer to **Appendix C**).

As noted previously, watermains are operationally and cost prohibitive to inspect. A “tabletop” approach to assessing watermain condition and LoF was implemented within the context of this study and focused on pipe type, pipe age, soil, cathodic protection and watermain break rates. These factors were used to calculate the LoF for the liner assets.

Other important parameters that impact system financial planning is the forecasted capital funding that PUC has planned to allocate in the next ten years as well as the O&M expenses incurred in the past and forecasted for the future.

The following section summarizes the forecasted capital funding which will constrain future annual capital interventions. For O&M costs, the 2018 O&M expenses reported by PUC have been incorporated as the base costs for the modeling (refer to **Appendix D – Table 10**). This amount was approximately $13.3 M ($7.1 M for linear and $6.2 M for facilities)[1].

2.2 Forecasted Capital Funding

According to PUC’s 2019 Financial Plan[2], the available budget for 2020 is $7.6 M and it increases to $12.5 M in 2026. Since this study period is from 2020 to 2029, the average annual capital funding increase between 2019 to 2026 was used to estimate the amounts in 2027, 2028, and 2029. The resulting numbers brought from PUC’s 2019 Financial Plan[1] and shown in **Table 1** were used to constrain the budget requirements for future capital work. The split between linear and facilities was 60% (linear) and 40% (vertical), in accordance with previous budget spending. However, this split or allocation is for modeling purposes only and may vary from year to year depending on the capital needs to restore the infrastructure.

Table 1: Forecasted Capital Funding

Year	Available Budget
2020	$7,600,000
2021	$8,300,000
2022	$8,900,000

[1] *Billing, collection, general and admin costs ($4.8 M) were distributed based on relative weights of the total costs of facilities and linear assets.*

[2] *https://ssmpuc.com/documents/assets/uploads/files/en/puc_water_financial_plan_report_2019_final.pdf, accessed on December 15, 2020.*

Year	Available Budget
2023	$10,000,000
2024	$11,200,000
2025	$12,300,000
2026	$12,500,000
2027	$13,600,000
2028	$14,900,000
2029	$16,200,000

3. Water Vertical Infrastructure Lifecycle Costing and Financial Planning

3.1 Vertical Infrastructure Asset Overview

3.1.1 Asset Hierarchy

Implementing a well thought out and well-constructed hierarchy of asset classifications (or "asset hierarchy") is one of the most important steps in building an effective asset management program. The asset hierarchy structure is already being used by PUC to organize assets. Typically, a hierarchy will accomplish the following:

- An asset hierarchy provides both context and organization to the information recorded in the asset registry. The asset hierarchy is the fundamental building block for asset life-cycle management;
- The asset registry records every asset with a unique identification tag ("number") along with certain asset attributes and other-asset related information. The asset registry serves as the main repository of information about assets as they are constructed or acquired, used, inspected, maintained, replaced and retired. The way in which assets are classified will assist users in assessing groups of related assets in addition to individual assets; and
- In the context of drinking water facilities, a hierarchy is necessary to distinguish assets by their facility type, drinking water process, and asset category.

In this study, a detailed hierarchy was not completed on all vertical assets but only on prioritized critical assets in the Surface Water Treatment Plant and Gros Cap Raw Water Pumping Station. These 410 assets were categorized and visually assessed during a site visit (more information is included in the subsequent subsections). For all vertical assets, PUC's 2019 Financial Plan[3] hierarchy was used for a high-level assessment and illustration (refer to **Table 2**).

Table 2: PUC Vertical Assets

Vertical Asset Category (Production or Reservoirs and Booster Stations)	Asset Description
Production - Water Treatment Plant	Gros Cap Intake
Production - Water Treatment Plant	Gros Cap Pump Station
Production - Water Treatment Plant	Direct Filtration Plant
Production - Water Treatment Plant	High Lift Pump Station
Production - Water Treatment Plant	Low Lift Pumping Station
Production - Water Treatment Plant	Marshall Drive Tank
Reservoirs and Booster Stations	WTP Reservoir
Production - Goulais Well Site	Goulais Well #1
Production - Goulais Well Site	Goulais Well #2
Reservoirs and Booster Stations	Zone 1 Reservoir
Reservoirs and Booster Stations	Zone 2 Booster

[3] *https://ssmpuc.com/documents/assets/uploads/files/en/puc_water_financial_plan_report_2019_final.pdf, accessed on December 15, 2020.*

Vertical Asset Category (Production or Reservoirs and Booster Stations)	Asset Description
Production Steelton Well Site	Steelton Well
Reservoirs and Booster Stations	Zone 2 Reservoir
Production - Shannon Well Site	Shannon Well
Reservoirs and Booster Stations	Coronation Drive Booster Pump Station
Production - Lorna Well Site	Lorna Well #1
Production - Lorna Well Site	Lorna Well #2
Reservoirs and Booster Stations	Crimson Ridge Booster Pump Station
Reservoirs and Booster Stations	Peoples Road Booster Pump Station

For the 410 assets that were visually inspected, the inventory includes assets down to a fifth level of detail, as presented by example in **Figure 5**. Generally, assets below this level would include consumable items that are typically replaced through a preventive maintenance program and are often funded out of the operations and maintenance budget and are therefore excluded from the analysis. The complete asset hierarchy of the 410 assets, including all five levels, can be found in the supporting documents for this AMP included in the **Appendix C**.

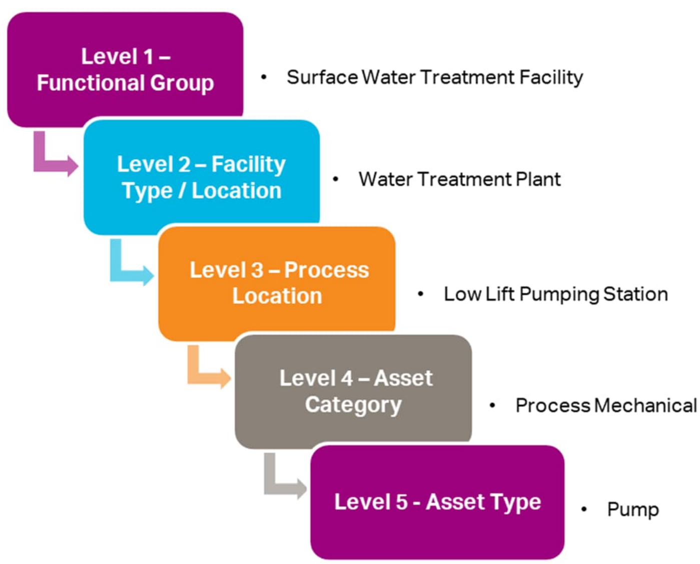


Figure 5: Example Asset Hierarchy Levels

3.1.2 Asset Inventory

Since PUC did not have an updated asset inventory list, an asset inventory and condition assessment (ICA) exercise was performed to develop an asset register, mainly at the Gros Cap Raw Water Pumping Station and Surface Water Treatment Plant. A total of 410 assets were recorded during the asset ICA exercise. This exercise was limited to process mechanical and process electrical at both facilities and included process structural assets at the Surface Water Treatment Plant. For each asset, the scope of the inspection included:

- Inventory and visual, non-destructive, physical condition assessment;

- Categorize the asset within an asset hierarchy;
- Determine the current condition grade using a rating scale; and
- Confirm installation year (using field verification or discussion with PUC staff).

3.1.3 Asset Installation Profile

Considering the list in **Table 2** and the year of installation in **Figure 6**, most of the vertical assets were constructed in the 1980s. The oldest installed vertical asset is a groundwater production facility (Steelton Well) which was constructed in 1934.
These years are a general representation of the overall assets and may not be the same for assets within the facility itself (Level 3 and beyond due to upgrades after the facilities' reported year of installation). This has been observed during the ICA performed on the 410 assets in the Gros Cap Raw Water Pumping Station and Surface Water Treatment Plant as some assets within these facilities have been replaced over time (**Figure 7**).

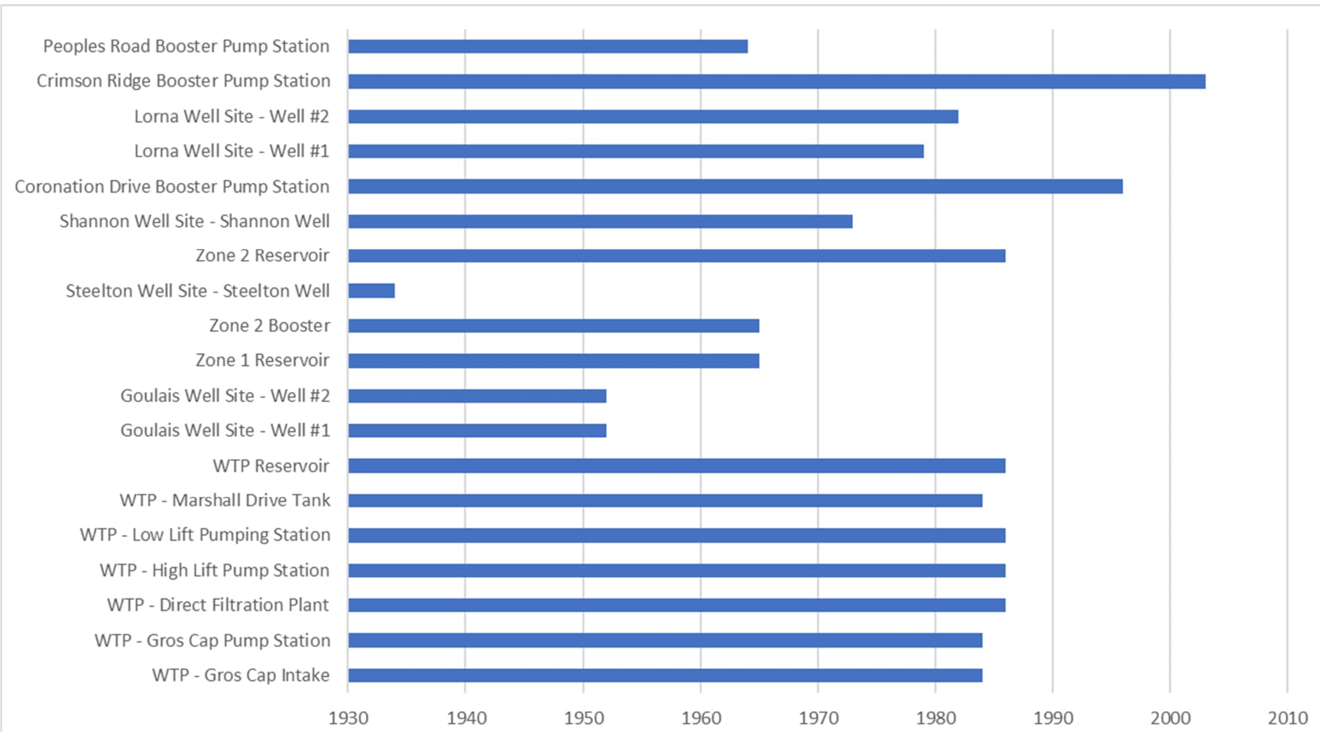


Figure 6: Breakdown of Assets based on Install Year

Figure 7 provides a breakdown of the 410 assets based on installation year. As demonstrated in the figure, most of the assets were installed in 1986 at the Surface Water Treatment Plant (80%) and 1983 at Gros Cap Raw Water Pumping Station (98%) which mimics the timeline of when both facilities were commissioned.

Few assets were recorded with an installation year later than 1983 at Gros Cap. At the surface water treatment plant, 20% of assets recorded were installed after 1986. Of these, most assets were installed in 2015 (27) followed by 10 assets installed in 2018.

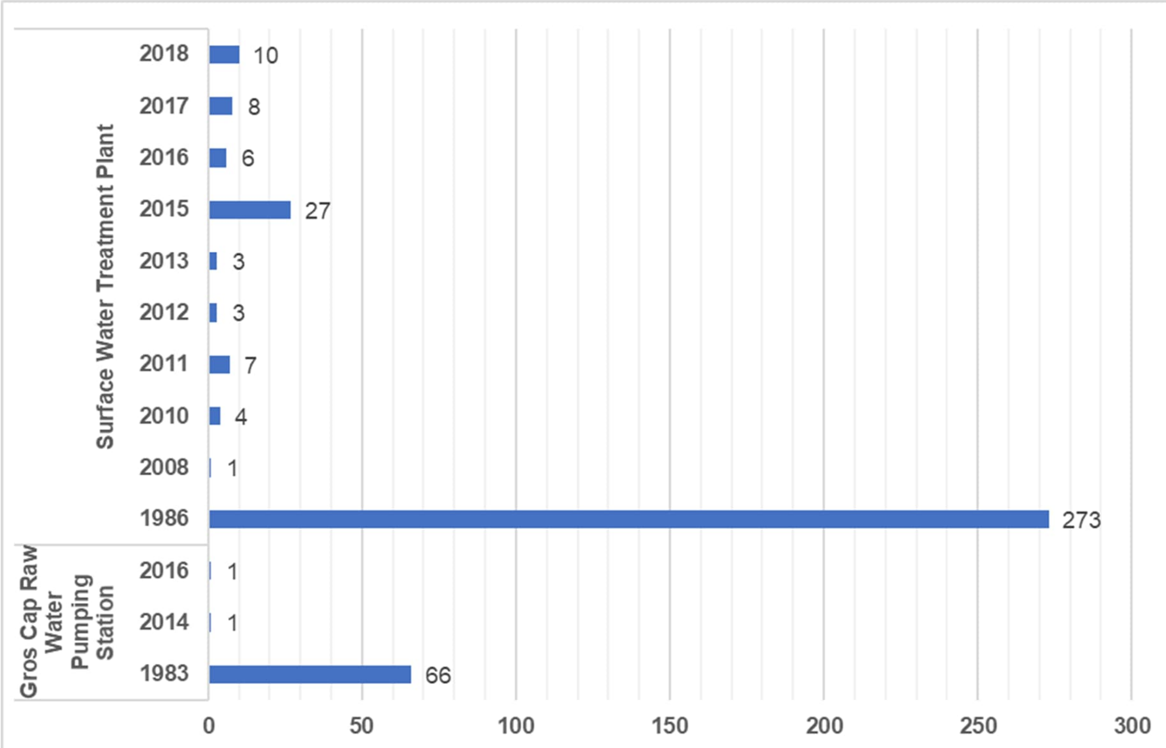


Figure 7: Breakdown of Assets based on Install Year

3.1.4 Asset Condition

As noted previously, it was not possible to categorize and visually assess all vertical assets within the scope of this study. Therefore a high-level strategy was developed to categorize and assess the overall condition of the vertical assets. The approach taken consisted of the following:

- The year of construction/installation of the overall vertical asset (i.e. age) was considered as the main input for the condition rating;
- Recognizing that each vertical asset consists of individual assets with different service lives, consideration was given to proportioning the overall asset into the following asset types:
  - Building structure – estimated service life = 75 years;
  - Process mechanical – estimated service life = 25 years;
  - Process electrical – estimated service life = 25 years; and
  - Site works – estimated service life = 50 years.
- The estimated service life for the Gros Cap Intake, Marshall Drive Tanks and all reservoirs was established at 75 years based on the limited process mechanical, process electrical and siteworks at these facilities.
- A lower estimated service life of 55 years was established for production facilities and pump stations. The 55 years was calculated considering a weighted average approach of the replacement costs of the components assembling the overall assets as follows:
  - Building structure: 75 years with a replacement cost sharing of 60%;
  - Process mechanical: 25 years with a replacement cost sharing of 27%;

  - Process electrical: 25 years with a replacement cost sharing of 12%; and
  - Site works: 50 years with a replacement cost sharing of 1%.
- The Weibull distribution was used to determine the condition of the asset from 1 to 100% which was then translated to a condition grading from 1 to 5. The condition grading definitions were assumed to be similar to the definitions of the ICA; and
- In cases where PUC recently scheduled or is scheduling replacements in the future for some assets, the replacement cost sharing of these assets was used and multiplied by 5 (the worst condition grade). The remaining replacement cost sharing was multiplied by the condition grading calculated from the Weibull distribution.

Based on the aforementioned high-level methodology, the majority of the vertical assets have grades 1 and 2 but there are some assets that have exceeded their estimated service lives including Peoples Road Booster Pump Station, Steelton Well, and Zone 2 Booster (**Figure 8**).

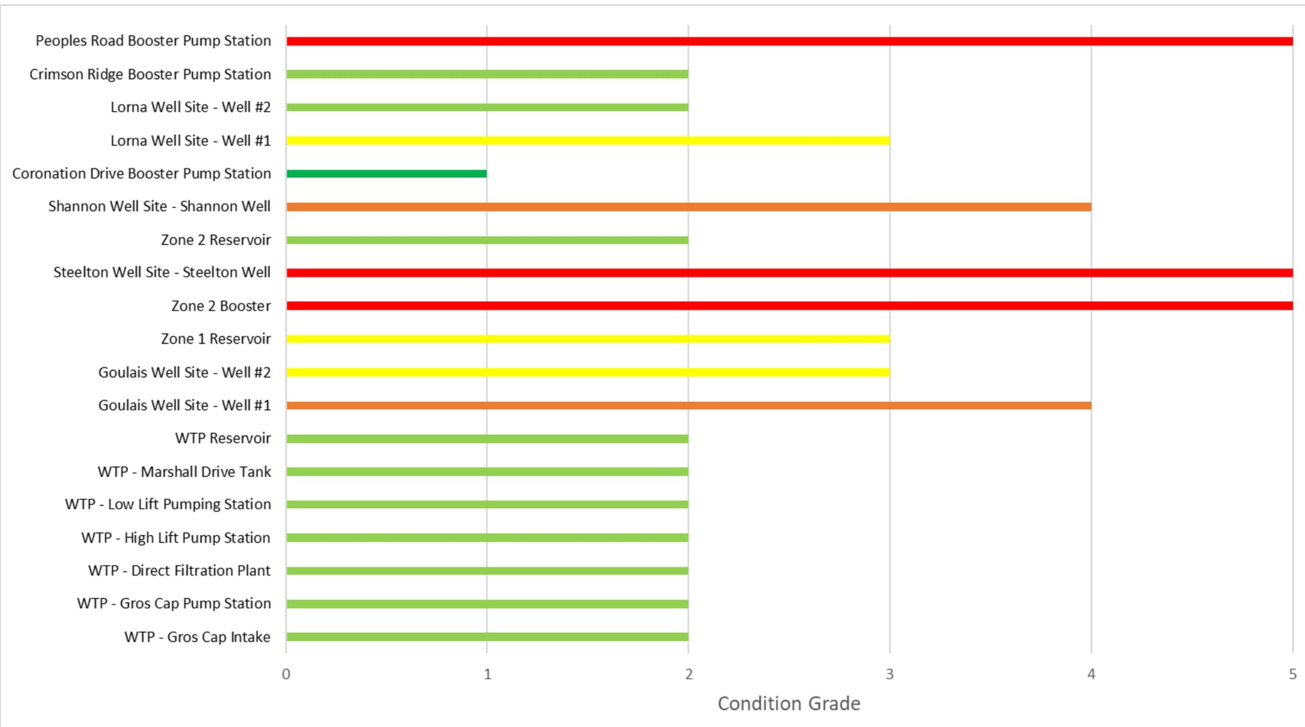


Figure 8: Breakdown of High-Level Condition Grading

As discussed in **Section 2.1**, the recently assessed structural, electrical and mechanical assets at Gros Cap and the Surface Water Treatment Plant were incorporated in the lifecycle costing and financial planning to supplement the grades assigned and presented in **Figure 8**. The visual condition assessment grades' definition was tailored to focus on electrical and mechanical assets to assist in identifying the magnitude of risk from a reliability standpoint. Therefore, some variations between the outputs were observed, given the different definitions of the condition gradings. As most of the modified grades are generally severer, incorporating them in this study is prudent to maximize the benefits of this lifecycle costing and financial planning. Accordingly, the following paragraphs summarize statistics from the visual condition assessment.

Of the 410 assets recorded at both facilities during the ICA exercise, 69% of the assets were observed to be in *2-Good* condition followed by 17% which were observed to be in *3-Fair* condition. The number of assets with condition grades of *4-Poor* were 46 (i.e. 11%) and only one asset was in *5-Very Poor* condition.

Figure 9 provides a breakdown of the number of assets by condition score and facility. It can be observed that the majority of assets at Gros Cap Raw Water Pumping Station had a score of *2-Good* with some assets scoring *3-Fair* and *4-Poor* conditions. None of the assets at Gros Cap were observed to be in *5-Very Poor* condition. Similarly, the majority of the assets at the Surface Water Treatment Plant had a score of *2-Good* with some assets having a score of 1-*VeryGood, 3-Fair or 4-Poor.* The only asset with a score of *5-Very Poor* was observed at the Surface Water Treatment Plant.

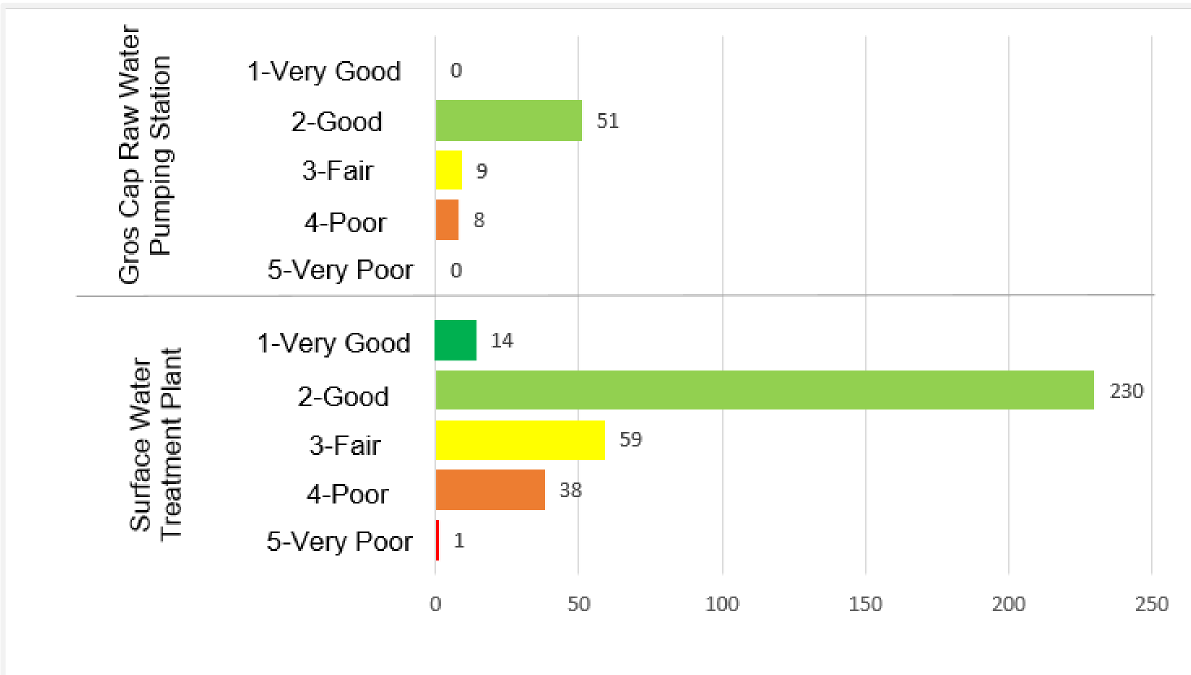


Figure 9: Breakdown of Visual Condition Assessment Score

3.1.5 Asset Value

Figure 10 shows the replacement costs of all vertical infrastructure assets. As per the figure, the total replacement costs of the vertical infrastructure assets, in 2020 dollars, is approximately $154M. Roughly, $108M of the replacement cost is for production facilities and the remaining $46M is for reservoirs and booster pump stations.

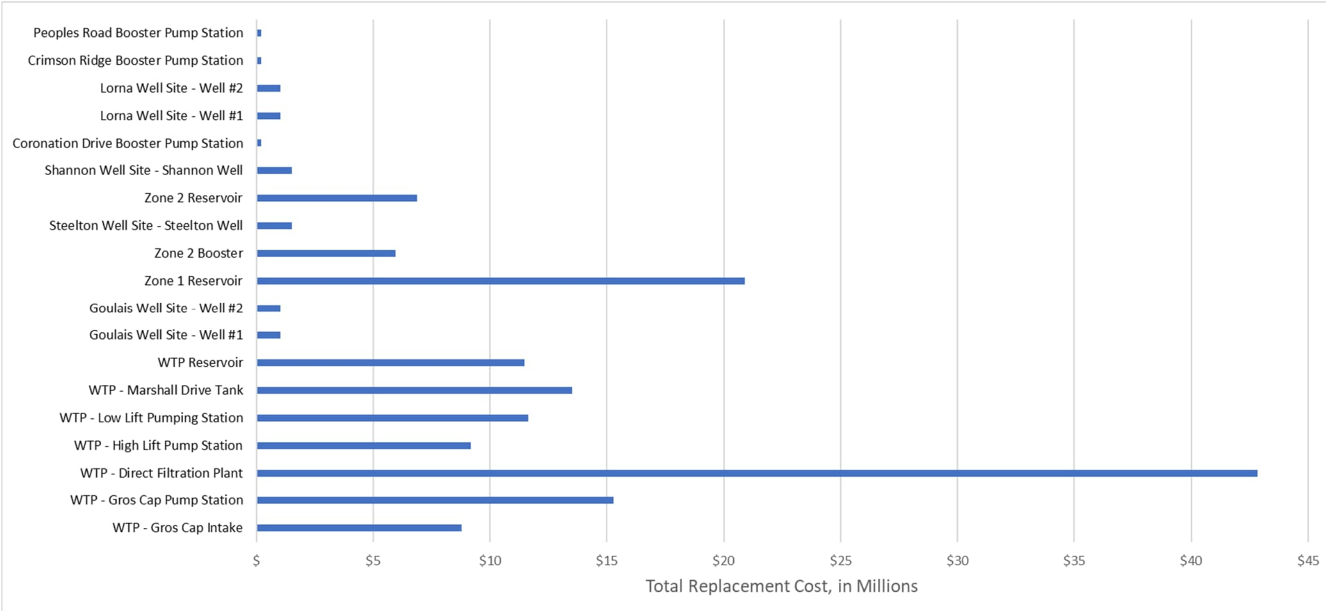


Figure 10: Vertical Asset Replacement Cost by Facility

Figure 11 and **Figure 12** provide a breakdown of replacement costs estimated for assets captured during the ICA exercise. Assets inventoried during the condition assessment exercise at Gros Cap Raw Water Pumping Station and the Surface Water Treatment Plant were estimated at approximately $7.75M.

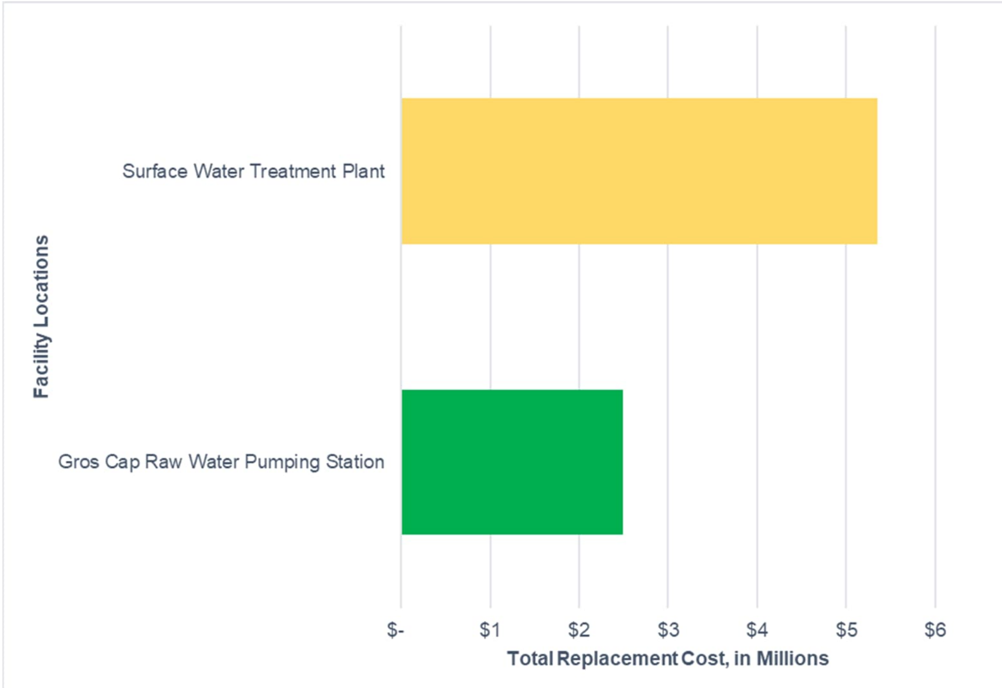


Figure 11: ICA Asset Replacement Value by Facility Location (Hierarchy Level 2)

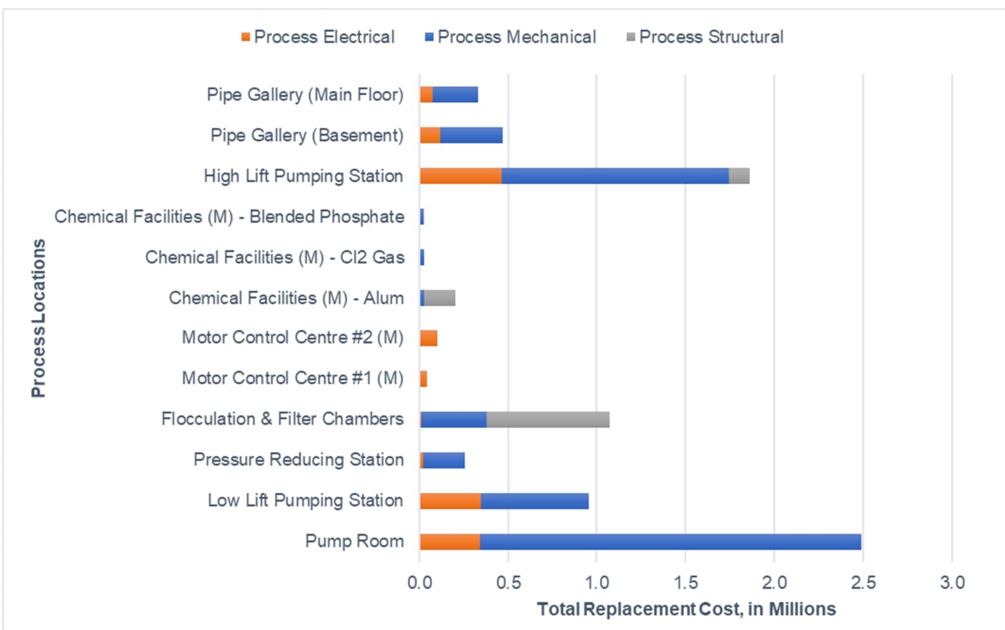


Figure 12: ICA Asset Replacement Value by Process Location (Hierarchy Level 3 & 4)

3.1.6 Criticality Assessment

An overall Consequence of Failure (CoF) was classified to each vertical asset as per **Figure 13** but detailed CoF ratings were assigned for each asset captured during the ICA. The CoF score was classified into five different ratings ranging from insignificant (1) to catastrophic (5) (**Appendix B**). The criticality rating scale considered the failure impacts on the environment, public safety, worker safety, equipment, operations, and process aspects.

On a high-level classification of CoF, the total replacement costs of assets classified as catastrophic failure is $87.7M; major is $61.8M; and moderate is $4.7M.

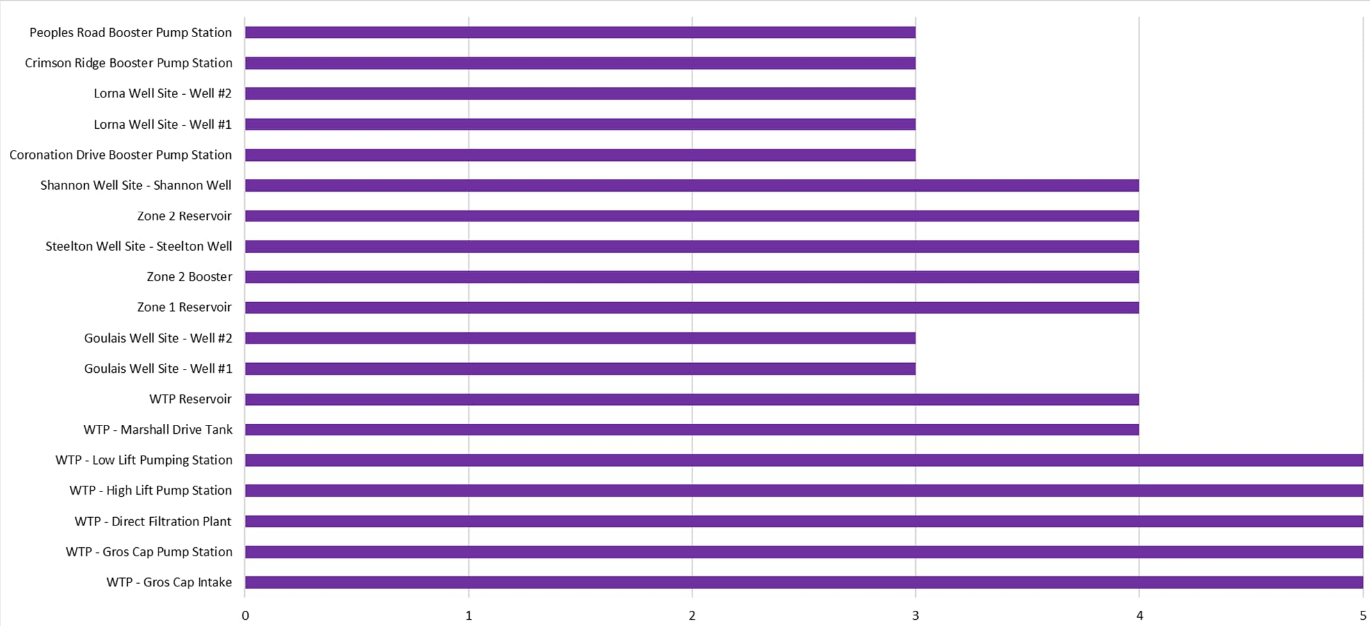


Figure 13: CoF Score Breakdown Based on Replacement Value

Figure 14 represents the CoF score as a function of the replacement cost of assets inventoried during the ICA exercise. Approximately 43% of the asset replacement costs were determined to be major or catastrophic and 42% were determined to be moderate CoF. Generally, PUC should focus on replacement of all assets determined to be high CoF prior to end of asset service life or failure to prevent adverse impacts.

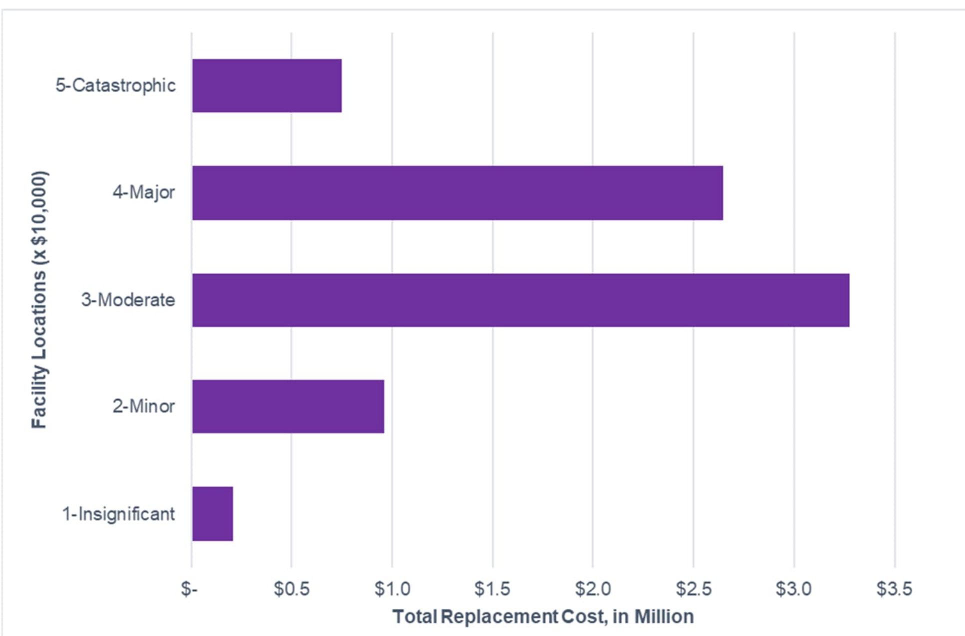


Figure 14: CoF Score Breakdown for ICA Assets Based on Replacement Value

3.1.7 Risk Score

The risk score is the product of the LoF and the CoF (Risk = LoF x CoF) for each asset. Since both parameters have scores from 1 to 5, the resulting risk score ranged between 1 to 25. Risk scores that range between 1 and 10 would be rated as low priority for intervention; assets that are in excess of 10 and less than 15 are identified to be at a higher priority for intervention (**Appendix B**) and a detailed condition assessment or replacement should be considered at a risk score of greater than or equal to 16 (**Section 3.2**).

A high-level approach for risk scores was initially performed for the vertical assets (as listed in **Table 2**) after considering the assigned CoF and LoF. The results of the risk scores are shown in **Figure 15**. Approximately, $90M of the assets are rated at a risk score of 9.

While there are assets in excess of 10, detailed assessment of the condition and criticality is warranted to confirm intervention needs.

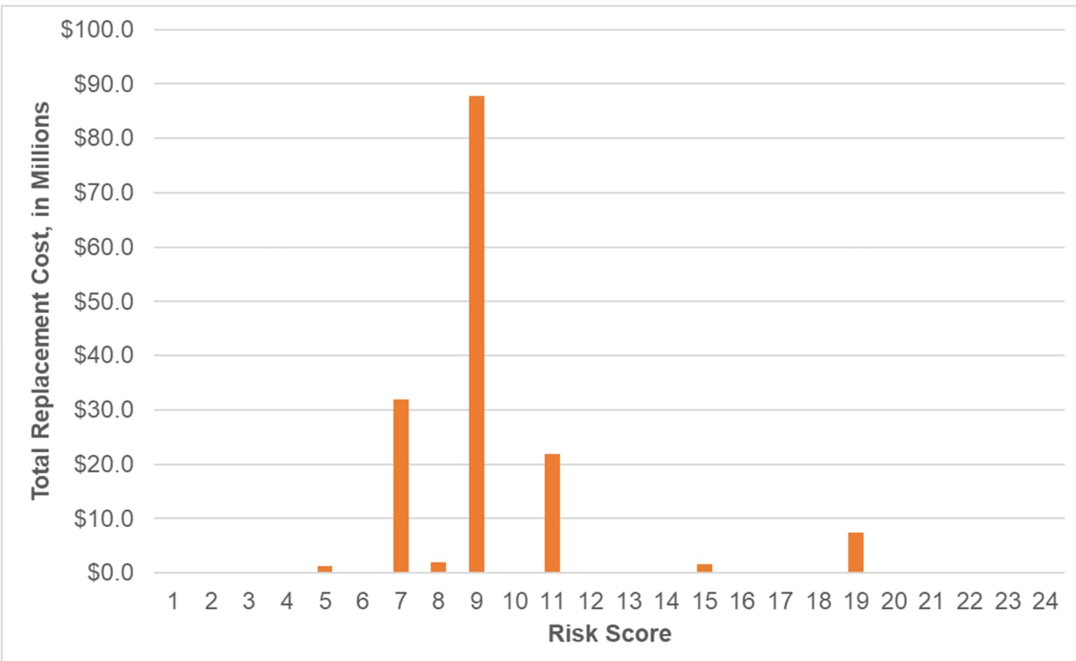


Figure 15: Total Replacement Cost Versus Risk Rating by Asset Type

Of the total $7.75M replacement value of the inventoried assets during the ICA, 97% of the replacement cost was for assets with a risk score of 10 and lower (**Figure 16**).

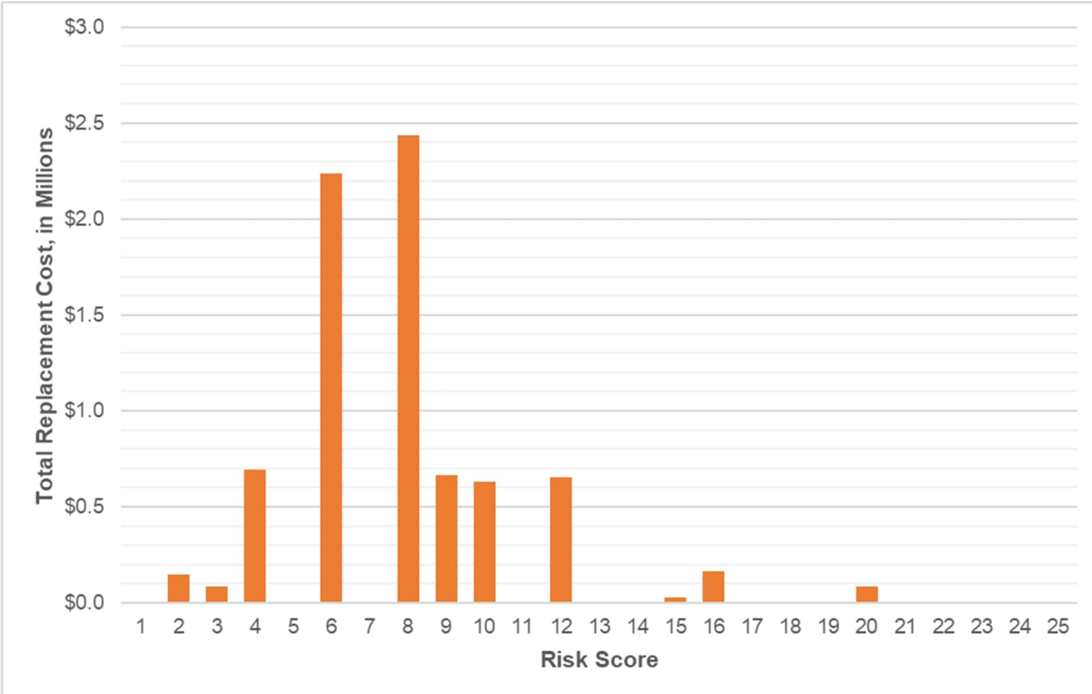


Figure 16: Total ICA Asset Replacement Cost Versus Risk Rating by Asset Type

3.2 Lifecycle Management and Funding Methodology

There are several methods used to anticipate when assets will need to be replaced in the future. Depending on the type of asset and the complexity of analysis, different methods may be selected. For the assets inventoried in the ICA and to address the variation in expected versus actual condition, the remaining life of each asset was adjusted based on an "apparent age" to reflect the current condition of the assets according to the following methodology:

- If the observed condition was worse than the expected condition at the time of assessment, then the apparent age was linearly scaled upwards according to the observed condition.
- If the observed condition was better than the expected condition at the time of assessment, then the apparent age was non-linearly scaled downwards according to the difference between the observed and expected conditions.
- If the observed condition was the same as the expected condition at the time of the assessment, then the apparent age was set equal to the actual age of the asset.
- Assets that were not inventoried in the ICA exercise require detailed analysis to suggest a specific assessment or replacement need.

The effect of apparent age is illustrated in **Figure 17**, which shows its relationship versus the actual age of an asset for all possible condition ratings. The linear scaling applied (represented by the vertical lines in **Figure 17**) is generally more drastic than the nonlinear scaling applied (represented by the curved lines in **Figure 17**). As a result, the age of the asset is scaled upwards by a greater factor than it is scaled downwards. Different scaling parameters were chosen to make the results more conservative in cases where the observed condition was better than expected.

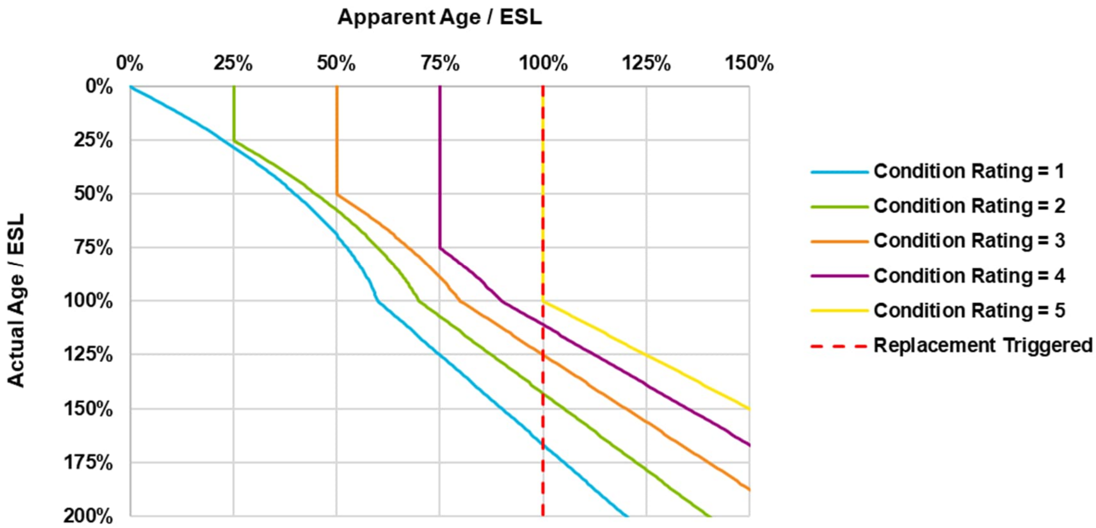


Figure 17: Apparent Age versus Actual Age for Different Condition Ratings

To demonstrate the apparent age methodology, consider a pump that is 15 years old and has an ESL of 20 years (Actual Age / ESL = 75%). The expected condition rating of the pump would be equal to 4. However, if it is instead given a condition rating of 5 (the worst possible rating), according to **Figure 17**, the age of the pump would be scaled up to 20 years (Apparent Age / ESL = 100%) and, consequently, its lifespan would be shortened by 5 years. Conversely, if the pump had been given a condition rating of 1, the age of the pump would have been scaled down to 11 years (Apparent Age / ESL = 52.5%) and its lifespan would have been extended by 4 years. The entire methodology described above is presented in more detail in **Figure 18**.

After obtaining the apparent age, the replacement year for an asset was calculated based on the difference between its ESL and apparent age. Alternatively, for high risk assets, the replacement year was set equal to the starting year of the analysis period (i.e., 2020).

Other triggers for asset replacement that are beyond the scope of this assessment include the following:

- Capacity: Infrastructure requirements to address growth.
- Upgrades: Regulatory changes, new technologies, changes in raw water properties and operational improvements can all trigger asset replacement.

Projects related to capacity and upgrades should always be undertaken after a thorough review of the asset inventory and renewal plan to identify any assets in the area that are due to be replaced as it may be more efficient to replace the asset as part of a combined project (upgrade / renewal). Some of the recent work identified and related to capacity and service level requirement is the expansion of the water treatment plant to 44,000 or 45,000 m^3/day. This expansion may require an upgrade of a transmission main at Second Line. The same project may result in decommissioning of east wells that would require transmission main from the Shannon Well to the Shannon Right of Way.

Formulas:

- *Risk Score = Condition Rating x Criticality Rating*
- *Age at Time of Condition Assessment = Age – (Start Year – Condition Assessment Year)*
- *Expected Condition* = 1 + Age at Time of Condition Assessment / ESL x 4*
- *Apparent Age***
    - o *Formula 1: Apparent Age = [(Condition Rating – 1) / 4] x ESL*
    - o *Formula 2: Apparent Age = [1 – (Expected Condition – Condition Rating) / 10] x Age at Time of Condition Assessment*

** The expected condition was limited to a value of 5 (i.e., the maximum condition rating).*

***An amount equal to the (Start Year – Condition Assessment Year) was added to each asset's apparent age to account for the amount of time that has elapsed since the assessment took place.*

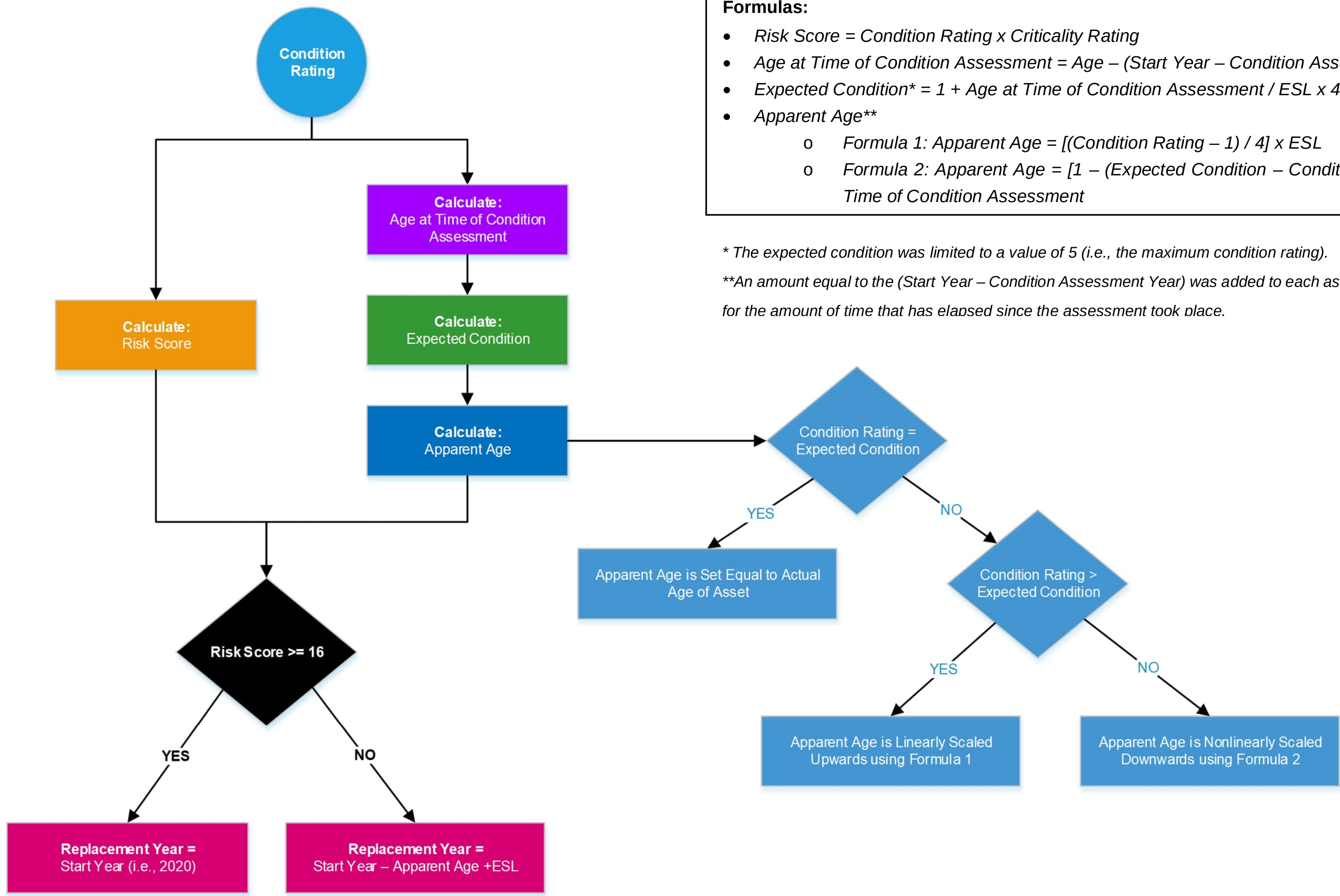


Figure 18: Renewal Timing Methodology for Assets Inventoried in ICA

3.3 Funding Strategies Results

3.3.1 Funding Needs for Vertical Infrastructure

While it is difficult to predict the exact timing for long-term infrastructure renewal projects, it is reasonable to use theoretical expected service life estimates to generate a reinvestment profile to estimate the order of magnitude of funding requirements over time. The asset renewal forecasts prepared for this assessment are estimates of what it will cost over the next 10 years to replace assets as they age and move past their ESLs and / or exceed PUC's risk tolerance. The project costs include the construction, installation and commissioning of the replacement assets plus an additional allowance of 45% of asset's replacement cost to account for engineering, administration, removal and demolition costs.

It is worth recalling the famous quotation that "*Prediction is very difficult, especially if it's about the future*". It is worth remembering that an analysis of this nature is based on literally thousands of data inputs and many assumptions, and is therefore, at best, a high-level estimate of future funding needs based on the best available information now.

Throughout the process of completing the asset renewal assessment, a list of assets that are past their expected service life were identified and the replacement cost of these assets make up the infrastructure renewal additional financial resources. This was prepared on a high-level approach for assets that were not part of the ICA exercise. Generally, the following logic applies to determine the recommended action:

- **Assess:** Assets that have an age or apparent age past their expected service life, are moderately to highly critical, but have a lower risk score (less than 16). A more detailed assessment may reveal issues that are not yet apparent or may be required to determine if asset replacement is warranted based on newer technology with improved efficiency or performance. In a few cases assets that are no longer in service have been assigned as "Assess", as further evaluation is required to determine if there is value in the asset for another purpose in the future or whether decommissioning should be planned.
- **Replace on Failure:** Assets that are of low CoF (criticality rating less than 3) and where replacement equipment is available either on site or within a short time frame and the replacement can generally be performed by maintenance staff.
- **Replace and/or Assess:** High risk assets where their age or apparent age is beyond their expected service life or are deteriorating in condition, reducing reliability of performance (Risk Score greater than or equal to 16).
- **Detailed Analysis:** Assets that were not inventoried in the ICA exercise would require detailed analysis to identify a specific assessment or replacement need.

Table 3 summarizes the results of the recommended actions.

Table 3: Infrastructure Intervention Summary Table

Intervention	No. of Assets	Replacement Value
Assess	82	$2,924,100
Replace on Failure*	26	$715,900
Replace or Assess	15	$255,200
Detailed Analysis	Varies	$150,332,268
TOTAL	**123**	**$152,279,868**

** Note: "Replace on Failure" does not necessarily mean a catastrophic failure of the equipment but could be triggered by any deterioration in condition or function that would require a repair. Therefore, expenditures for these assets may be deferred until required. However, the renewal cost of these assets is shown as a 2020 expenditure as it is recommended that funds associated with assets past their expected service lives be available in the reserve fund.*

Section 3.3.1 presents the predicted funding needs for the surface water treatment production facilities for the 10-year period. Note that the following assumptions were made when developing the figures:

- The allocated available capital budget per year is as per **Table 4**.

Table 4: Vertical Infrastructure Forecasted Capital Funding

Year	Available Budget	Vertical Infrastructure Percentage	Vertical Asset Budget
2020	$7,600,000	40%	$3,040,000
2021	$8,300,000	40%	$3,320,000
2022	$8,900,000	40%	$3,560,000
2023	$10,000,000	40%	$4,000,000
2024	$11,200,000	40%	$4,480,000
2025	$12,300,000	40%	$4,920,000
2026	$12,500,000	40%	$5,000,000
2027	$13,625,000	40%	$5,440,000
2028	$14,851,000	40%	$5,960,000
2029	$16,188,000	40%	$6,480,000
Total	$107,864,000	40%	$46,200,000

- Budget needs for assets not inventoried in the ICA exercise were not specifically identified per asset due to limited condition rating and detailed criticality analysis. However, the residual annual budget remaining after deducting the intervention needs identified for 410 assets was assumed to be assigned for assets not inventoried in the ICA exercise.
- Assets identified as “Assess and / or Replace” are included in 2020.
- Assets identified as “Assess” are included as potential expenditures in 2020, the scope of work and their cost estimates should be confirmed.
- Assets identified as “Replace on Failure” are included as an expenditure in 2020, but these expenditures may consist of contributions to the reserve fund with the actual expenditures deferred until required.
- Replacement timing has been adjusted based on Condition and Risk.
- Costs associated with the acquisition of new assets and decommissioning of existing assets are not considered at this time and have, therefore, been excluded.

3.3.1 Age-based Capital Additional Financial Resources

Since a significant proportion of vertical infrastructure were not inventoried during the ICA exercise, the additional financial resources were determined by only comparing the age and estimated service life (discussed in **Section 3.1.4**), where each facility was classified into four divisions. Each division had an assumed cost sharing along with an assigned estimated service life. For example, as per the cost sharing, the replacement cost per division for Peoples Road Booster Pump Station (total replacement = $204K) is as follows:

- Building Structure = $122K
- Process Mechanical = $55K

- Process Electrical = $25K
- Siteworks = $2K

Each assigned estimated service life per division was compared with the overall age assigned to each infrastructure asset. This comparison was completed for the analysis period (2020-2029). As an example, People Road Booster Pump Station was constructed in 1964. Considering the assigned estimated service life for each division, the first replacement for the building structure will be in 2039; thereby, the replacement value was excluded from the calculation. The process mechanical and electrical replacement need was observed in 1989, 2014, and 2033; thereby, their replacement costs in 1989 and 2014 were considered only, excluding the replacement needed at 2033 as it is beyond 2029. All replacement costs were inflated at the observed year of analysis. The available capital budget was assigned to each vertical asset based on its proportion to the total replacement values of the vertical infrastructure to approximately determine the assumed additional financial resources per vertical asset.

Based on a high-level age-based analysis, the overall total replacement needs captured was approximately $62M. Given an available capital budget of $46M for vertical infrastructure, the overall additional financial resources would approximately be $17M. **Figure 19** shows the distributed additional financial resources per asset. On a 10-year average, the additional financial resources would roughly be $1.7M.

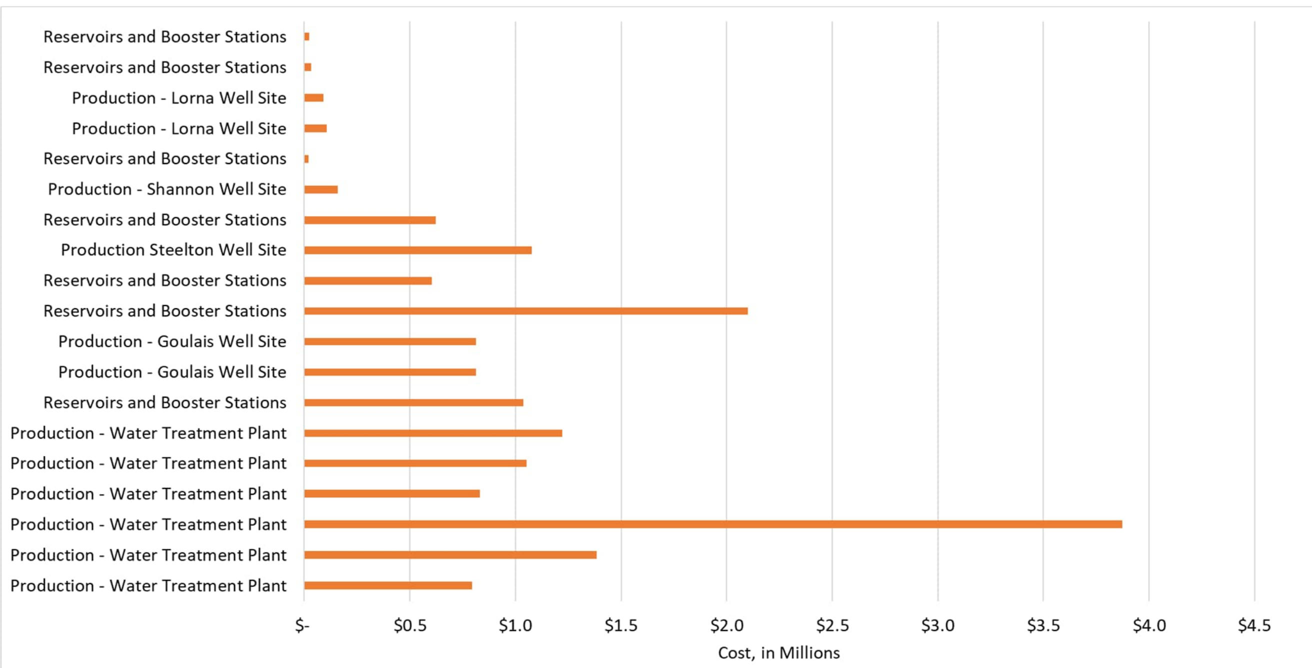


Figure 19: Vertical Assets Additional Financial Resources

3.3.2 Funding Needs Analysis

Figure 20 classifies the costs into the "Inventoried Asset Needs" and "All Other Assets". The latter represents those assets that were not inventoried in the ICA and are basically the remaining amount of capital budget after reducing intervention requirements based on ICA exercise. From the ICA exercise, the total replacement costs of assets requiring intervention is $5M.

A red line is also plotted to show the maximum assumed available capital for vertical infrastructure; cost exceeding the red plotted line are considered as additional financial resources. From the inventoried assets during the ICA assignment, $800K (additional financial resources) was observed (when considering the available budget at year

2020 to the observed need). However, it was not shown in the figure as they observed assets will most likely have been captured in the already calculated additional financial resources using the age-based scenario, limiting any potential duplication.

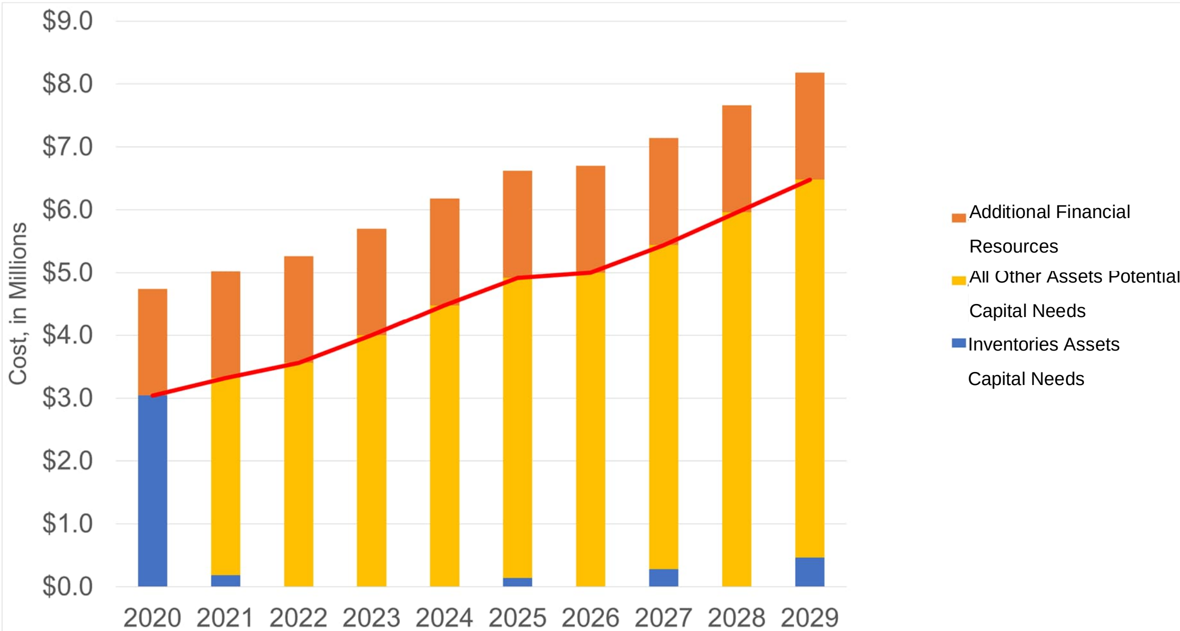


Figure 20: 10-year Funding Needs

Figure 21 and **Figure 22** focus on assets inventoried in ICA by displaying the 10-year reinvestment funding results excluding, the O&M costs as per **Section 2.1.** In addition to the additional financial resources captured from ICA exercise, there is also a further $2.0 M of reinvestment required over the next 10 years, which brings the 10-year average to $500K.

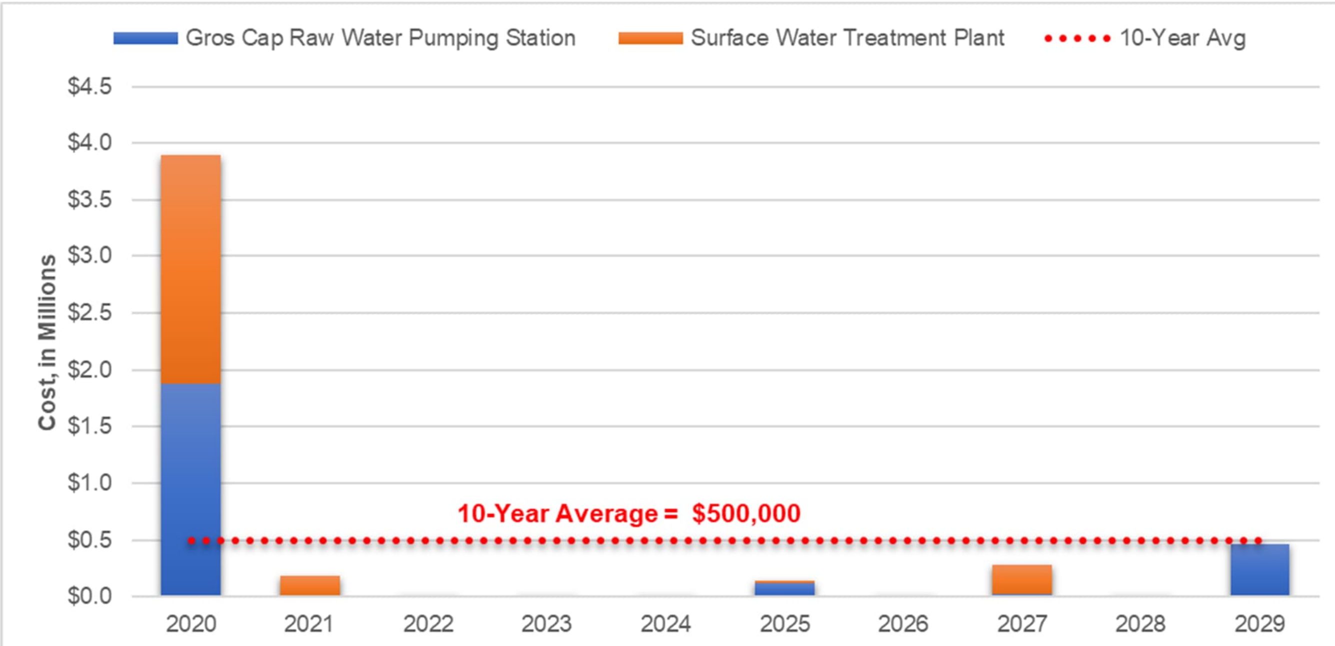


Figure 21: 10-year Funding Needs vs. Year by Asset Type

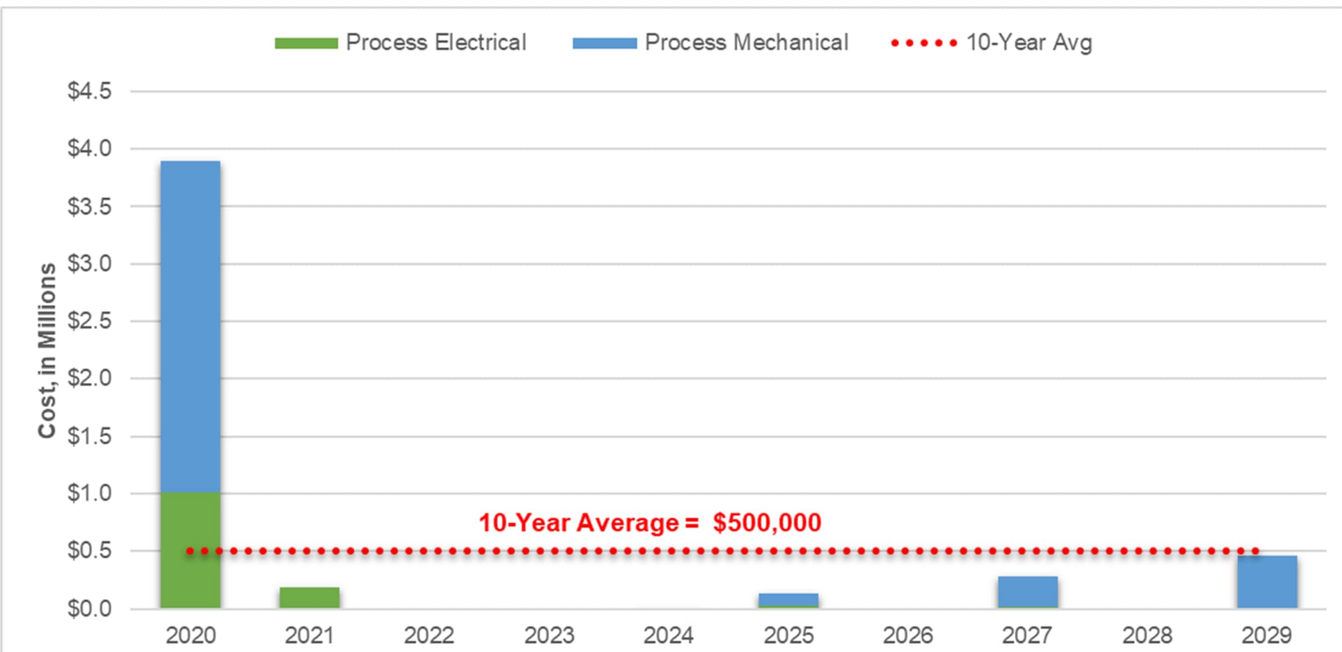


Figure 22: 10-year Funding Needs vs. Year by Process Category

Figure 23 shows the 2020 to 2029 capital reinvestment needs and the calculated additional financial resources, considering the constrained budget, for the inventoried assets as well as the residual budget available for all other assets not inventoried as part of the ICA. The figure also includes 2018 O&M costs which were adjusted using an inflation rate of 2%.

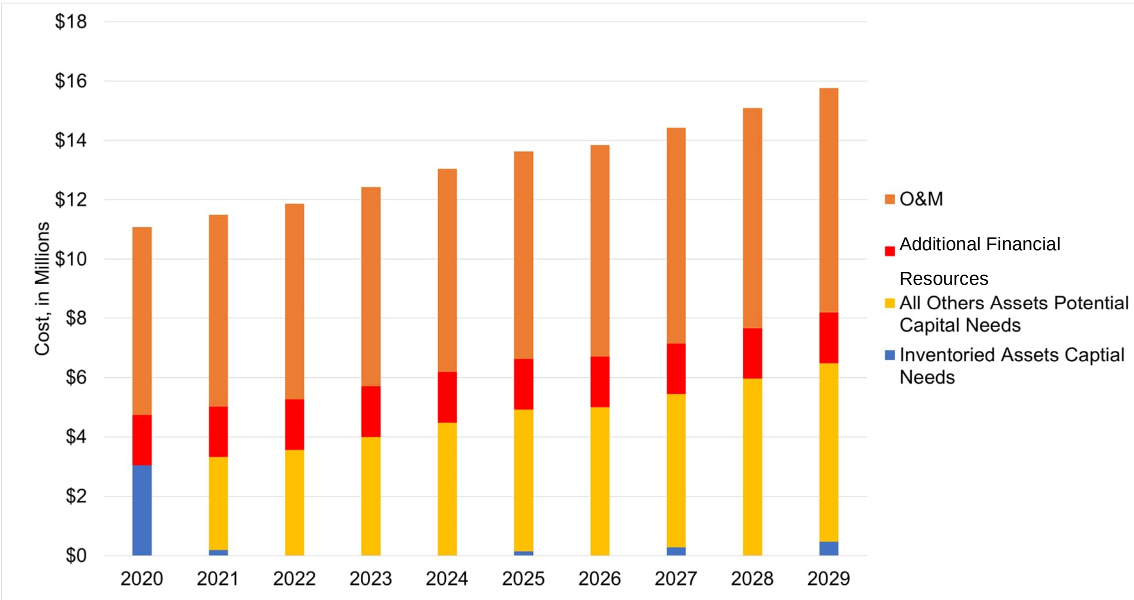


Figure 23: Vertical Assets Lifecycle Costing

Appendix E shows the list of the inventoried assets along with their recommended interventions. The list incorporates the updated condition grades for the recently inspected mechanical and electrical assets, where applicable.

4. Water Linear Lifecycle Costing and Financial Planning

4.1 Water Linear Asset Overview

4.1.1 Asset Installation Profile and Material Type

Within PUC's distribution network, ferrous material types are the primary material used for watermains (**Table 5**). More than half of the total length of watermains consists of ferrous materials (69%, 307 km). Approximately, 20% (90 km) of the watermains consists of Polyvinyl Chloride (PVC) material, and roughly 8% (38 km), 2% (7 km) and 0.13% (0.6 km) consists of Concrete Cylinder (CCYL), Asbestos Cement (AC), and Concrete Pressure Pipe (CPP), respectively.

Figure 24 demonstrates the period in which a group of watermains are constructed along with their material type and total length for each decade. According to the figure, the majority of pipelines installed from 1900 to 1970 were constructed of CI. Installation of DI started in the 1970s and continued until the 1990s. Thermoplastic pipelines started to emerge in the period of 1980-1990 and have become the material of choice since that time. It should be noted that some materials were observed in periods when the same material type was not available in the market (e.g. PVC pipelines observed in 1900-1920 period but in small quantities). This information was gathered from PUC's Geographic Information System (GIS) data.

Table 5: Watermain Material Types by Length (km)

Material	Material Definition	Length (km)
AC	Asbestos Cement	7.1
CCYL	Concrete Cylinder	37.8
CI	Cast Iron	200.0
CPP	Prestressed Concrete Cylinder Pipeline	0.6
DI	Ductile Iron	106.5
PE	Polyethylene	0.9
PVC	Polyvinyl Chloride	88.9
	Missing	0.6

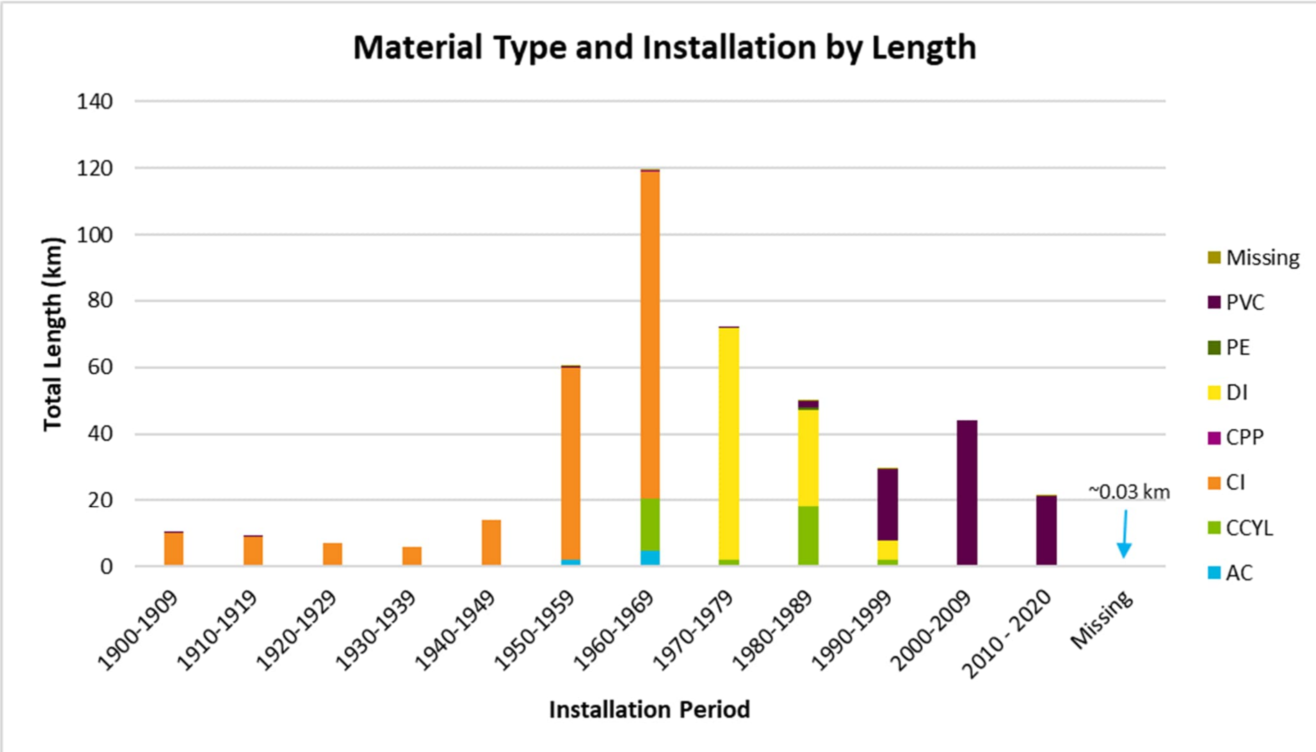


Figure 24: Length of Watermain by Installation and Material Type

More details can be found in **Appendix B**.

4.1.2 Asset Condition

Age and break rates were used to estimate the likelihood of failure (LoF) along with additional information related to soil and cathodic protection. The amalgamation of these factors was used as a proxy to determine the condition of the mains. The calculated condition, ranging from 1 to 100, was classified into a five-point scale as shown in **Table 6**.

Table 6: Asset Condition Breakpoints

Definition	Lower Limit	Upper Limit
Very Good	1	3
Good	3	19
Fair	19	73
Poor	73	90
Very Poor	90	100

Using the breakpoints, **Figure 25** shows that 39 km of the mains were rated as Very Poor, while the total length of the Very Good category was roughly 215 km. The Very Poor category was mainly observed in diameter sizes of 200 mm and smaller with a total length of approximately 34 km. The majority of the Very Poor and Poor categories were observed in the CI and DI with a total length of roughly 77 km.

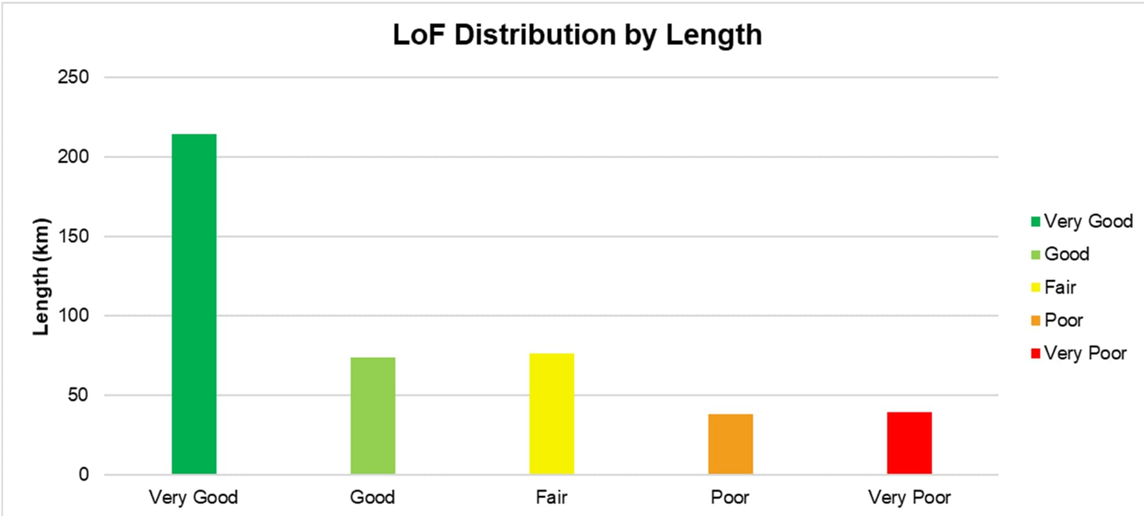


Figure 25: Watermain LoF by Length

Detailed calculations and results are available in **Appendix B**.

4.1.3 Asset Value

The total estimated value of linear assets is $788M (**Figure 26**). The total costs are based on 2020 dollars with the unit rates provided by PUC. The unit costs include the construction of all system components including watermains, services, valves, hydrant assemblies, water meters, etc. and also include an allowance for soft costs (i.e. engineering). The same unit costs are used in the lifecycle analysis.

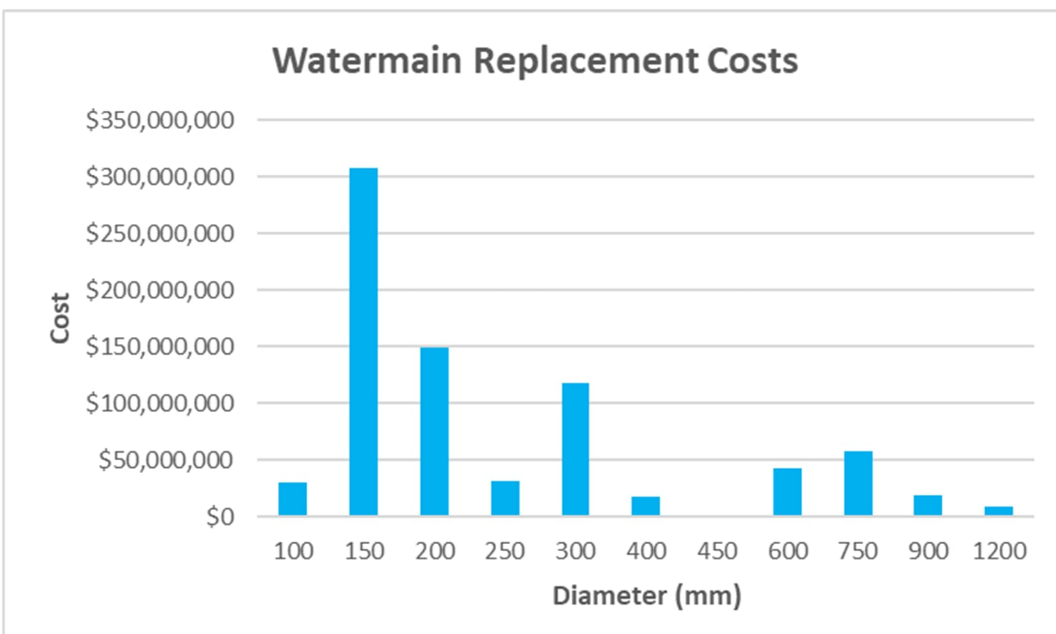


Figure 26: Watermain Replacement Costs by Diameter

More details of replacement costs can be found in **Appendix B**.

4.1.3.1 Criticality Assessment

The criticality assessment or the consequence of failure (CoF) was determined by considering the impact of failure on the society, environment, economy, and operations. Each parameter was defined in a scoring system ranging from 1 to 100, where the scores of the four parameters were aggregated through relative importance weights to conclude the main's CoF. The estimated CoF scores were classified into three different categories (refer to **Table 7**).

Table 7: CoF Breakpoints

Definition	Lower Limit	Upper Limit
Minor	1	42
Moderate	42	61
Major	61	100

Using the breakpoints, **Figure 27** shows that 319 km (72%) of the total length is in the minor category; 74 km (17%) of the total length is in the moderate category; and approximately 49 km (11%) of the length is in the major category.

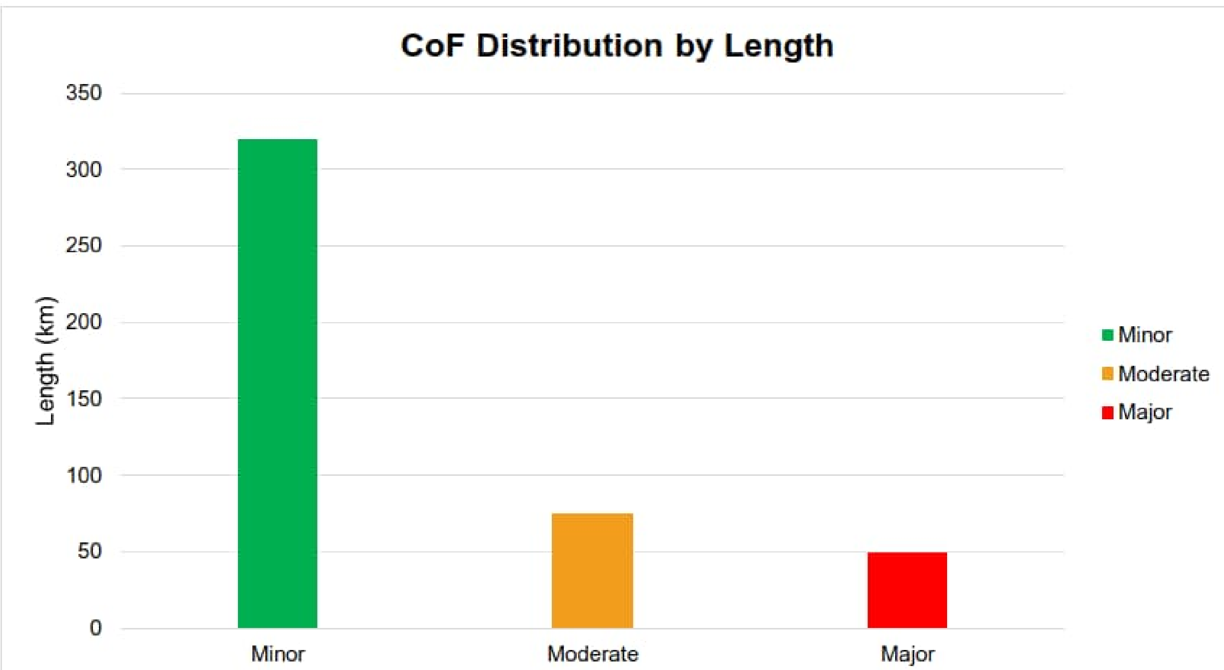


Figure 27: CoF Distribution by Length

Detailed calculations and results are included in **Appendix B**.

4.1.3.2 Risk Score

The risk is the product of the LoF and CoF, where the multiplication takes into consideration the condition of the asset as well as its impact if failed. The resulting value, in this assignment, was normalized to a score ranging from 1 to 100, where a risk score closer to 100 corresponded to a major risk. Detailed classification of the categories is shown in **Table 8.**

Table 8: Risk Breakpoints

Definition	Lower Limit	Upper Limit
Minor	1	42
Moderate	42	61
Major	61	100

According to **Figure 28,** 337 km (76%) of the total length is in the minor category; 61 km (14%) of the total length in the moderate category; and approximately, 44 km (10%) of the length is in the major category.

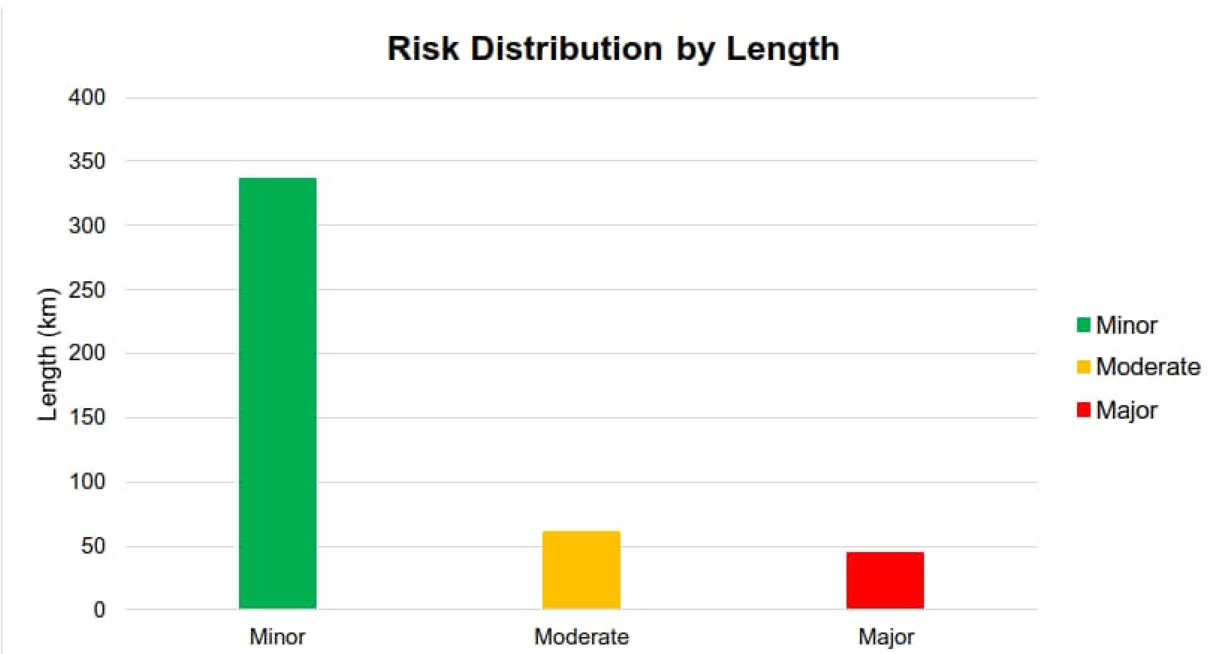


Figure 28: Risk Score by Length

Details of the calculations and results are available in **Appendix B**.

4.2 Lifecycle Management and Funding Methodology

4.2.1 Overview

Linear asset's lifecycle strategy is based on pipe condition assessment and the needs of intervention actions. The condition assessment provides an understating of the state of the infrastructure, whether through a desktop model or advanced condition assessment tools. Intervention actions could vary depending on different factors including pipe material, pipe size, hydraulics, etc. and may consist of "do nothing", minor intervention (e.g., corrosion protection), major intervention (structural or non-structural lining), or replacement. Interventions may not only be for deterioration-related reasons as some replacements of pipes may be required to enhance water quality or the hydraulics of the system (e.g., increase capacity requirements).

Figure 29 summarizes the methodology implemented to identify future capital reinvestment needs (2020-2029). This approach focussed on two principle elements as follows:

1. Service Criteria Model – This model takes into consideration the minimum available fire flow requirements versus existing as well the number of lead/galvanized connections along watermains; and
2. Risk-based Model – This model reflects the risk scores calculated using the CoF and LoF of each watermain.

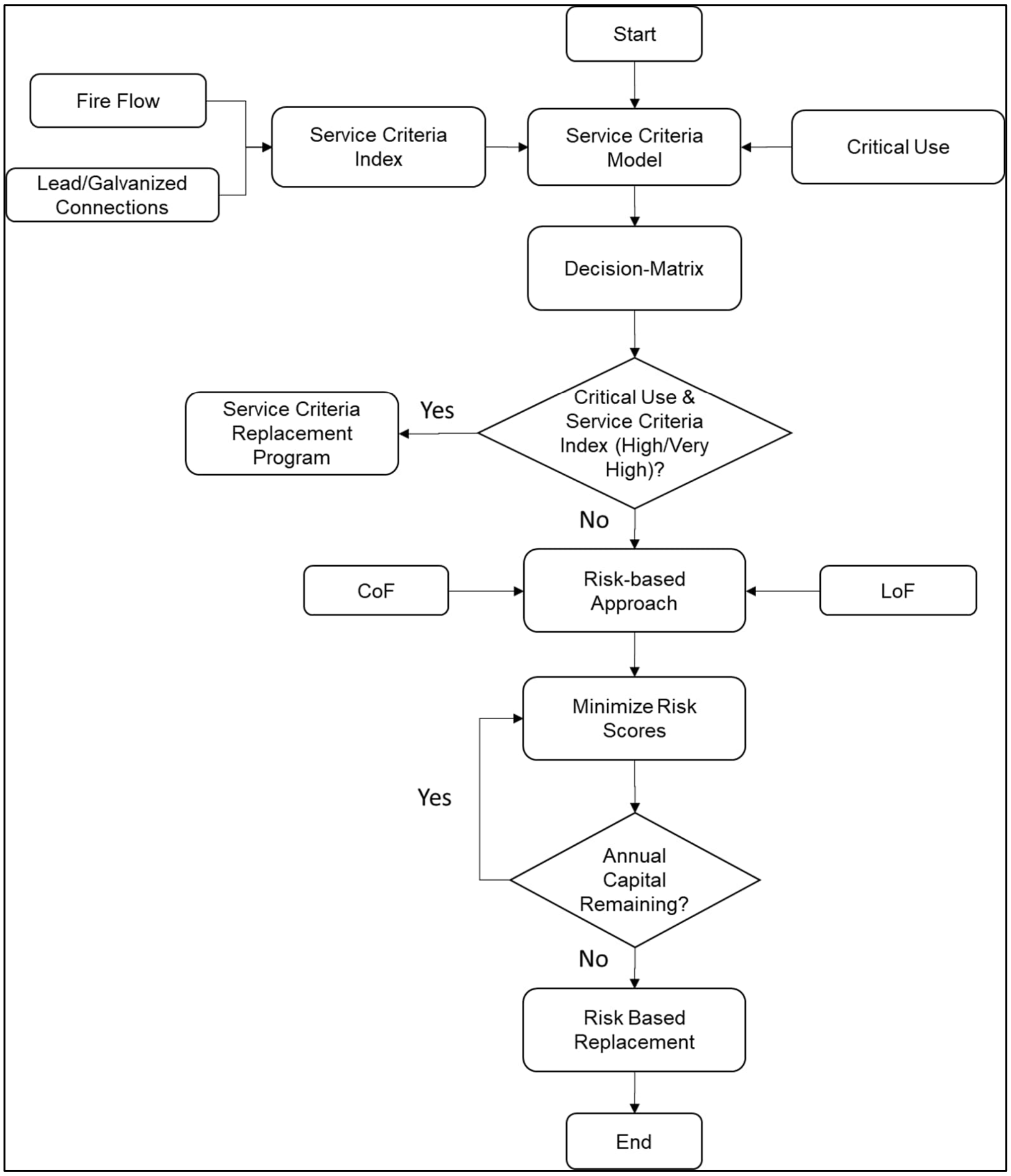


Figure 29: PUC Asset Management Strategy Methodology

4.2.2 Linear Assets Capital Budget

As water linear assets are a resource-intensive infrastructure, constraining the available budget would aid in identifying near optimum reinvestment projects**. Section 2.2** showed the estimated available capital funding from year 2020 to 2029 for both linear and facilities. Therefore, **Table 9** is prepared to show the linear budget assumed for this analysis by considering 60% of the total capital budget (this was derived from the LoS workshop discussion and average capital cost distribution during past years). Despite considering 60% for linear assets, the assigned percentage is subject to a change in the future depending on specific vertical and linear capital needs.

Linear asset additional financial resources have been identified by considering the ESL assigned for each material type relative to watermain age. Assets that exceed the estimated service life will be considered for replacement within the given year. Backlog is identified in cases where assets exceeded their estimated service life but are not replaced due to financial resources.

The linear capital needs are prepared by considering a conservative unit cost related to open-cut replacement (**Table 10)**. This unit cost is generally higher than other trenchless methodologies such as lining. While lining is most likely a cost-effective solution (site by site related), detailed studies are needed to determine if lining would be the optimum method when compared to replacement. In principle, lining reduces the cross section of the pipe which may impact the hydraulics lining may no be suitable in areas with a high density of appurtenances (e.g., valves, hydrants, bends, tees, etc.) and services.

Table 9: Linear Infrastructure Forecasted Capital Funding

Year	Available Budget	Distribution System Percentage	Distribution System Budget
2020	$7,600,000	60%	$4,560,000
2021	$8,300,000	60%	$ 4,980,000
2022	$8,900,000	60%	$ 5,340,000
2023	$10,000,000	60%	$ 6,000,000
2024	$11,200,000	60%	$ 6,720,000
2025	$12,300,000	60%	$ 7,380,000
2026	$12,500,000	60%	$ 7,500,000
2027	$13,625,000	60%	$ 8,175,000
2028	$14,851,000	60%	$ 8,911,000
2029	$16,188,000	60%	$ 9,713,000
Total	$107,864,000	60%	$ 69,278,000

4.2.3 Replacement and O&M Costs

The unit costs of linear assets are summarized in **Table 10**. Assets that are 300 mm and smaller and are in residential areas have unit costs of $1,600/m while in the downtown area, the unit cost will increase to $2,700/m. These costs are all-in costs for watermains that are installed along with the City road reconstruction activities. All unit rates are adjusted to reflect 2020 dollars.

Table 10: Water Pipe Unit Cost ($/m)

Diameter (mm)	All Inclusive Unit Rates
<= 300	$1,600/m in residential $2,700/m in downtown area
400	$1,600
450	$1,770
600	$2,750
750	$3,080
900	$4,350
1200	$9,640

PUC performs a number of O&M activities to deliver high quality water and preserve linear assets. These activities include the following:

- Unidirectional flushing: the three-year average cost (2017 to 2019) is $18,214.
- Dead-End Flushing/Flushing Unit Maintenance: the three-year average cost (2018-2020) is $24,714.
- Leak Detection: the three-year average cost (2018-2020) is $25,011.
- Watermain Breaks and Associated Costs (excluding restorations): the three-year average cost (2018-2020) is $146,303.

The summation of the three-year average cost of these four activities is approximately $214K. To consider all O&M expenses reported by PUC and not only those four O&M activities, the 2018 amount of $7.1 M was used while considering an inflation of 2% during the 10-year period (more details in **Section 6.2)**. It is assumed that the costs of listed O&M activities are included in such amount. In addition to the forgoing, an additional $250,000 was considered to account for field condition assessment for water pipes that PUC could implement based on the recommended staged-approach methodology (more details in **Section 6.2.1** and **Appendix F**).

The following sections expand on **Figure 29** by providing detailed methodologies for the Service Criteria and Risk-based intervention models.

4.2.4 Service Criteria Model

The consequence of failure model was established to understand the impacts of a pipe failure on the environment, operations, society, and economy. However, there are other parameters related to Level of Service (LoS) that are not assessed within the risk based model that should be factored into the linear assets intervention model

The Service Criteria considered in the linear assets intervention modeling consists of the following:

1. *Service Criteria Index* – This parameter establishes a grade based on fire flow deficiencies and the proportion of lead/galvanized connections to watermains; and
2. *Critical Use* – This parameter measures the criticality of the segment from an LoS perspective using two criticality factors which are the Land Use and Critical Customers.

It is important to note that the model output combines the contribution of both the Critical Use and Service Criteria. While some pipes may be unsatisfactory under one of the criteria, they may not be selected as it satisfied the other criteria.

4.2.4.1 Service Criteria Index

The Service Criteria Index calculation is introduced to identify watermains for a potential service criteria replacement program. Generally, the benefit/cost ratio of performing advanced field assessment on pipelines operating at a lower flow than required would be low.

Equation [1] and **Figure 30** show the inputs and outputs needed to compute the Service Criteria Index.

$$Service\ Criteria\ Index\ =\ W_s S_s + W_f S_f \quad [1]$$

Where:

W_s is the weighting assigned to the lead/galvanized connections factor. In this assignment, it is taken as 40%.
W_f is the weighting assigned to the available fire flow factor. In this assignment, it is taken as 60%.
S is the assigned score from 1 to 100.

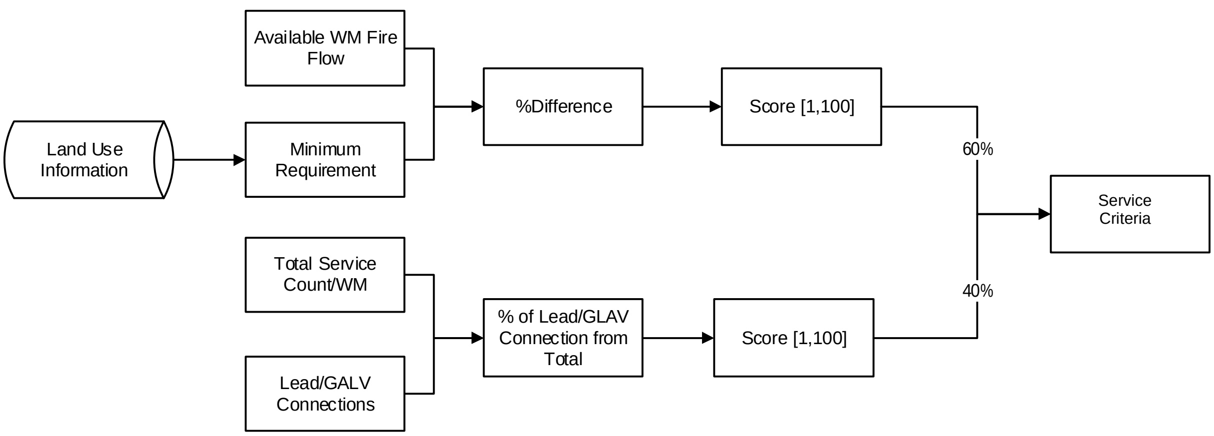


Figure 30: Service Criteria Index

Lead/Galvanized Connections

In North America, lead services were used most commonly before the mid-1950s. Exposure to lead can affect how the brain and nervous system grow. To enhance health and safety measures, many municipalities in North America established programs to replace lead services.

Galvanized steel pipes were also used in previous decades as an alternative to lead pipes for water supply lines. This type of service has a layer of zinc that protects the pipe from deterioration. Historical research documented that the grade of zinc utilized for galvanizing contained some percentage of lead and could be a long-term source of lead.

Since both types could contribute to the health and safety measures, mains connected to galvanized and lead services will have higher scores. The scoring mechanism for this parameter considers the observed number of lead/galvanized connections relative to the total number of services connected in each watermain.

The scores considered for this assignment are shown in **Table 11**. For example, a watermain that has 10 connections and four of these connections are made of lead or galvanized (40%) will have a score of 25.

Table 11: Lead/Galvanized Connection Scores

Percentage of Lead/Galvanized Service	Score
0-5%	1
5-25%	5
25-50%	25
50-75%	75
75%-100%	100

Given that the criterion is material dependent, services with unknown material types were assumed. In North America and based on past assignments, it was observed that copper services replaced lead services after 1953; therefore, services with unknown material types installed before 1953 may be lead and are at the end of their service life. For the purpose of the analysis, they were assigned as lead services.

Available Fire Flow

Ideally, the available fire flow should be determined for each building or group of similar buildings in a community. Generally, this presents challenges when looking at the overall hydraulic capacity of the water distribution system as it becomes very time consuming to determine the available fire flow for each facility. Therefore, for system-wide planning purposes, assumptions are often made for the available fire flow based on land use. The assumed minimum fire flow requirements considered in this assignment are shown in **Table 12**.

Table 12: Guidelines for Available Fire Flow Requirements for Water System Planning[4]

Land Use	gpm	L/S
Commercial	2,750	173.25
Farm	500	31.5
Government	2,750	173.25
Industrial	3,000	189
Institutional	2,750	173.25
Multiple - Residential	2,500	157.5
Single - Residential	1,000	63
Special and Exempt	3,000	189
Vacant Land	500	31.5

Through previous modelling assignments completed by AECOM[4], available fire flow capacity was determined at pipe nodes. The available fire flow capacity assigned to each watermain was compared to the considered values in **Table 12** by land use category.

To further use this information and to prioritize watermains based on available fire flow, the percentage difference between the available fire flow and the required fire flow capacity (**Table 12**) is calculated and assigned a relative score (**Table 13**).

---

[4] Refer to Memorandum titles "PUC Services Inc. – Residential Fire Flow Review" submitted by AECOM on December 31, 2018.

Table 13: Fire Flow Parameter Score

Percentage Difference of Available vs. Required Fire Flow	Score
0 or Available is more than Required	0
0 - 5%	10
5 - 10%	30
10 - 20%	50
20 - 40%	75
Greater than 40%	100

The following shows an example of assigning a score based on the calculated percentage:

If,

Watermain A available fire flow = 130 L/s; and
Watermain minimum required available fire flow (land use and fire flow assumption) = 173.25 L/s

Then,

$Difference\,\% = \frac{|130-173.25|}{173.25}\,X\,100 = 25\%$; hence, the assigned score is 75.

At this stage, the model would be able to identify watermains with a significant proportion of lead/galvanized connections as well as those watermains that might not satisfy the minimum available fire flow requirement. The factors were further used to prioritize mains supplying critical customers using the Critical Customers and Land Use data as described in Section 4.2.4.2.

4.2.4.2 Critical Use

Although each segment's criticality was computed considering environmental, economic, operational, and social factors and subfactors (refer to **Appendix B**), that analysis focused on the impact of a pipe segment's failure. These factors would not have potential contributions on many of the criticality factors. Therefore, two sub-factors from the social group were identified to highly contribute in determining the Service Criteria Index of the segment (**Figure 31**).

- Land Use
  - Industrial land is more critical than a vacant one. Thus, replacing a pipeline not satisfying the minimum available fire flow requirement in the industrial zone will be prioritized first.
- Critical Customers
  - Critical Customers – Critical customers are more important than non-critical customers (details on Critical Customer definition is available in **Appendix B**). Thereby, replacing a pipeline with a significant number of lead/galvanized connections supplying water to critical customers will be prioritized first.

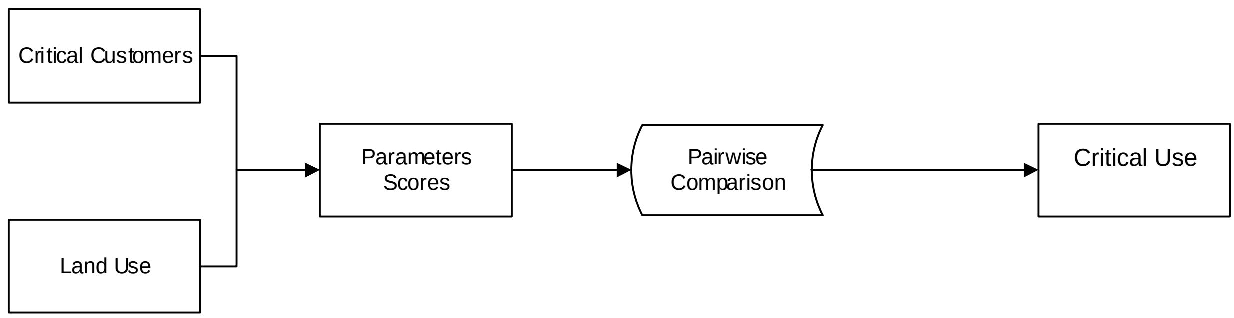


Figure 31: Segment Critical Use

To reduce the complexity of assigning newer scores and weights for these parameters, the same scores and weights determined during the CoF model development were used (refer to **Appendix B**). The weights of these two parameters were extracted from the assigned weights in the CoF model but with an additional step. The weights distribution identified for the CoF parameters were maintained in order to ensure consistency in the calculations. Therefore, the relative importance weights for the Critical Customers (CC) was estimated at 67% and the Land Use (LU) was calculated at 33%.

The scores of the two parameters could be aggregated using the following equation:

$$Critical\ Use = W_{LU}S_{LU} + W_{CC}S_{CC} \qquad [2]$$

Where:

W is the relative importance weight of each parameter
S is the score assigned for each segment

At this stage, watermains would be prioritized based on the Service Criteria Index and the Critical Use data. To align with existing practices in replacing watermains, the following methodology describes the approach used to amalgamate watermain's scores to compute the utility corridor's scores.

4.2.5 Utility Corridors and Watermain Segments

Generally, capital improvement interventions in water linear infrastructure is mostly completed between two road intersections, where a utility corridor include more than one asset within the existing right of way.

In GIS, a watermain segment is represented as a polyline connecting two nodes (e.g., watermain between two valves). Ultimately, these segments have variable lengths and typically do not represent a corridor from one road intersection to another. In an effort to utilize the already existing GIS polygons represent the segmented utility corridors in PUC's distribution network, segments within a complete polygon were identified for interventions, where applicable.

As utility corridors include one or more segments, determining the score of each corridor was based on a bottom-up approach as described in Section 4.2.5.1. The approach ensures all segments in each utility corridor have an appropriate contribution in the overall corridor score.

4.2.5.1 Utility Score Calculations

Based on the watermain segments in each utility corridor, the utility score was calculated using a weighted average method. The weights of each segment's contribution of the utility score was based on the length of each segment found within the same utility corridor. Therefore, the overall utility corridor score was mostly represented by longer segments.

Equation [3] is a general representation of the utility score aggregation. This could be applied in calculating the utility's LoF, CoF, risk, etc.

$$Utility\ Score\ =\ \frac{L_i S_i}{\sum_{i=1}^{n} L_i} \qquad [3]$$

Where:

L is the length of the segment
S is the score under consideration which can be applied to CoF, LoF, etc. to represent the overall utility corridor score.

Table 14 shows an example of applying **Equation [3]** on an arbitrary utility corridor consisting of three segments and a total length of 185 m.

Table 14: Example of Utility Score Calculation

Segments in Utility A	Length (m)	Score	Weighted Score
Segment 1	5	95	$\frac{5 * 95}{5 + 50 + 130} = 2.7$
Segment 2	50	75	20.3
Segment 3	130	35	24.6
Utility Score			**47.6**

4.2.5.2 Utility Score Breakpoints

The utility scores were prepared to identify corridors that were a good candidate for the Service Criteria interventions. Using the weighted average aggregation process, an absolute number (1,100) was calculated to describe the Utility's Service Criteria Index and Critical Use.

According to the distribution of the results, the lower and upper scores for each rank are shown in **Table 15** and **Table 16.** Due to the distribution of the indices in the Critical Use Breakpoints, the High and Very High ranks have almost the same cluster limits.

Table 15: Service Criteria Breakpoints

Rank	Lower	Upper
Very Low	0	1
Low	1	27
Moderate	27	61
High	61	70
Very High	70	100

Table 16: Critical Use Breakpoints

Rank	Lower	Upper
Very Low	0	30
Low	30	33
Moderate	33	36
High	36	37
Very High	37	100

These breakpoints were used to identify corridors that would directly be selected for a Service Criteria replacement program. The following section demonstrates the decision-based matrix used for this purpose.

4.2.5.3 Utility Corridor Decision-Based Matrix

The commonly used decision-based matrix in a risk framework consists of the CoF and LoF. These two parameters are used to prioritize pipelines that are in poor condition and have higher impacts if failed. However, the decision-based matrix presented below initially prioritizes utility corridor replacements based on service criteria rather than advanced condition assessment or risk-based replacement.

In many circumstances, municipalities upgrade their water infrastructure to respond to growth and to decrease the potential health and safety issues. In this regard, analysing the physical condition of pipelines may not be recommended as the benefit/cost ratio could be low. For example, an excellent condition pipeline that does not provide the required flow demand should still be identified for replacement regardless of its physical state.

The decision-based matrix (**Figure 32**) was a function of the Service Criteria Index and the Critical Use factor which were described in **Section 4.2.4**. Corridors ranked as high or very high in both parameters have higher priority for replacement due to Service Criteria issues.

Service Criteria Index	**Very High**	Risk Methodology	Risk Methodology	Risk Methodology	Replacement Program	Replacement Program
	High	Risk Methodology	Risk Methodology	Risk Methodology	Replacement Program	Replacement Program
	Moderate	Risk Methodology	Risk Methodology	Risk Methodology	Risk Methodology	Risk Methodology
	Low	Risk Methodology	Risk Methodology	Risk Methodology	Risk Methodology	Risk Methodology
	Very Low	Risk Methodology	Risk Methodology	Risk Methodology	Risk Methodology	Risk Methodology
		Very Low	**Low**	**Moderate**	**High**	**Very High**
		Critical Use (Land + Critical Customers)				

Figure 32: Service Criteria Decision-Based Matrix

Corridors that did not satisfy score high or very high for both service criteria were subsequently prioritized using the risk-based intervention methodology.

4.2.6 Risk-based Interventions

Pressurized pipe risk management framework is designed around the technical ramifications of operating pressurized assets that are logistically challenging to inspect and costly to replace. This framework is applicable to the entire watermain system of linear assets that were not ranked as a high priority in the Service Criteria decision matrix. The framework for pressurized pipe is comprised of (1) a replacement strategy optimized to mitigate risk; and 2) an inspection strategy that uses risk to balance a staged approach to condition assessment.

4.2.6.1 Risk-based Replacement/Rehabilitation

During the service life of the assets, interventions are required in the form of maintenance, rehabilitation, or replacement to sustain their performance and avoid sudden disruptions to the service. Excluding corridors identified for Service Criteria replacement, risk scores were utilized to prioritize corridors considering the magnitude of their CoF and LoF.

Utility corridors (i.e., intersection to intersection) have been used to identify replacement requirements which dovetails well with the City's capital improvement plan. This approach used **Equation [3]** to arrive to the utility's CoF, LoF and Risk scores as per **Section 4.2.5.1**. The breakpoints for the Utility Risk scores are shown in **Table 17**.

Table 17: Utility Corridor Risk Breakpoints

Rank	Lower	Upper
Minor	0	30
Moderate	30	45
Major	45	100

As this assignment considers a risk-based approach, the budget requirement identified a pre-defined risk score threshold that would vary depending on the available budget and the risk exposure (refer to **Figure 29**). For this purpose, the threshold was driven by the annual available budget and the major risk category to maximize the total length of the identified utility corridors that would result in minimizing the overall risk exposure.

Although there are several intervention strategies that PUC can consider, a conservative intervention in the form of replacement was used as it is the most expensive intervention when compared to other trenchless options, if applicable. The unit costs used for replacing watermains are shown in **Table 10**.

4.2.6.2 O&M and Risk-based Condition Assessment

Appendix F describes the staged-approach of condition assessment that PUC could implement to obtain condition related data. Further, **Section 6.2** lists some of the O&M activities that PUC may consider to prolong the condition of linear assets.

4.3 Funding Strategy Results

This section uses the results of **Section 4.2** to demonstrate the lifecycle costing proposed during the study period (from 2020 to 2029) for the linear water assets. The capital budget was annually constrained to the amounts included in **Table 9** to identify segments that require replacements based on service criteria and risk. O&M costs were also included during the same period considering the 2018 O&M expenses plus an additional amount to account for annual field condition assessment, where required.

4.3.1 Service Criteria Replacement Program

Pipes that have higher density of lead/galvanized services are identified in **Appendix G**. These pipes have 50% or more of their services made of lead/galvanized. The total length of these pipes is approximately 10 km. Pipes that have available fire flows of 80% or less of the minimum requirements are also identified in **Appendix H.** The total length of these pipes is roughly 42 km.

However, as shown in the decision matrix in Figure 31, pipelines identified in this analysis would be recommended for replacement if they failed to meet the available fire flow requirement, have a high proportion of lead/galvanized connections and also have higher impacts on critical customers or more important land uses. The Service Criteria replacement for the identified utility corridors would cost approximately $2.4 million; the 10-year average cost is $0.24 Million as per **Figure 33.**

Appendix I shows the utility corridors selected for replacement as per the Service Criteria methodology.

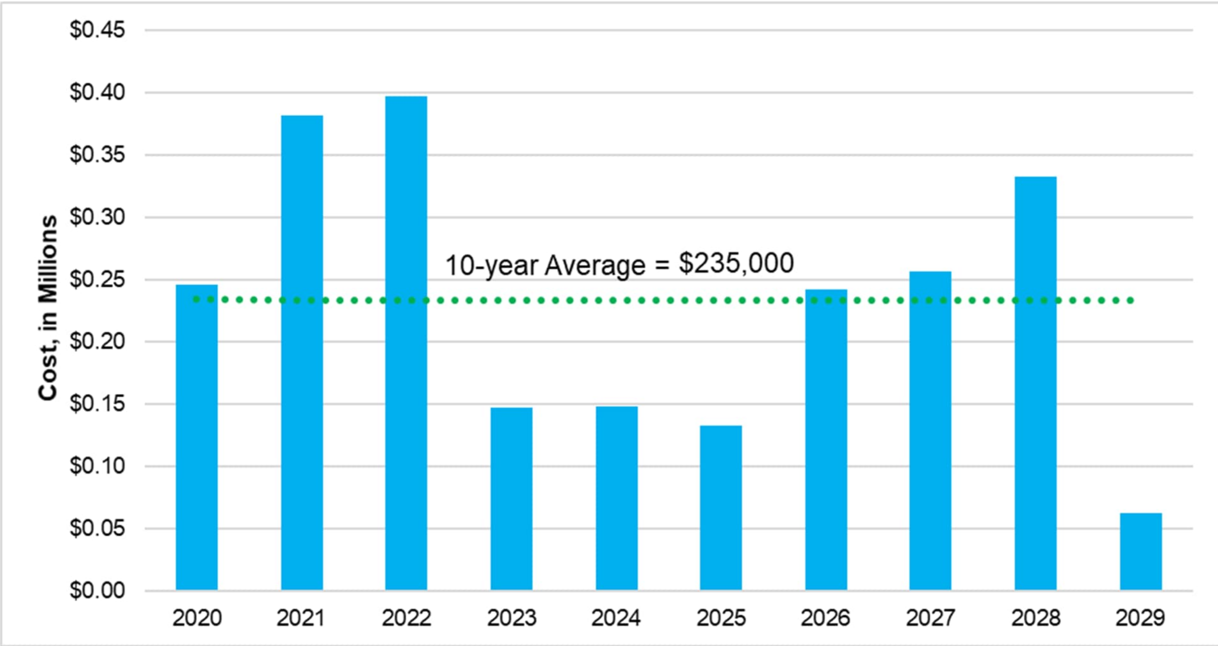


Figure 33: Service Criteria Cost

4.3.2 Risk-based Replacement Program

The risk based assessment was completed in accordance with the methodology illustrated in **Section 4.2.6.1**. The results focused on utility corridors in the major risk category as well as some utility corridors that are rated in the moderate group. The threshold used to select utility corridors was 35.7 and greater (this threshold was used to avoid exceeding the available capital budget over the 10-year period (refer to **Figure 29**). If the threshold is increased, above 35.7 the number of utility corridors identified for interventions and the required linear capital budget will decrease, and vice versa.

For comparison purposes, **Section 4.3.3** shows the capital needed to replace all assets using an age-based scenario which will result in additional financial resources.

Figure 34 shows the total replacement costs in each risk rank. The analysis considered the available budget per year by prioritizing higher risk scores and then moving to moderate risk scores. Based on this analysis, the total budget requirement was approximately $65 M with a 10-year average of $6.5 M.

All major risk utility corridors were identified for interventions. However, due to budget constraints, not all moderate risk corridors were identified in this analysis.

Appendix J maps the utility corridors identified for potential interventions.

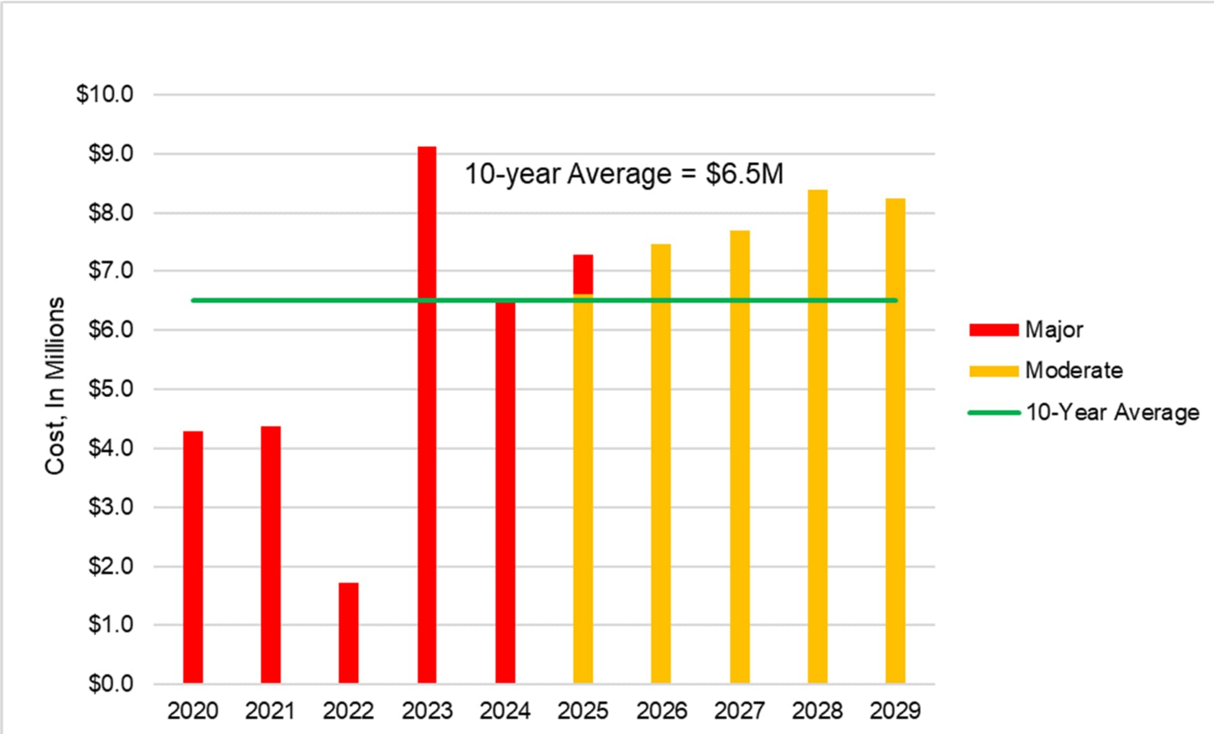


Figure 34: Risk-based Intervention

4.3.3 Age-based Capital – Additional Financial Resources

Additional financial resources, more than the funds currently budgeted for, were observed based on the analysis. Herein, it is calculated by comparing the asset age relative to the estimated service life over the analyzed study period (2020-2029). Pipes not identified for replacement in **Sections 4.3.1** and **4.3.2**, but their age exceeds the estimated service life during the 2020-2029 period are identified. Accordingly, the total length of these pipes is 95 km with a total replacement value of $172M. **Figure 35** shows the costs based on pipe diameter size of the identified pipes. Almost half of the observed additional financial resources relate to pipes 150 mm in diameter. Annually, the observed budget of capital considering an age-based scenario is approximately $17.2M.

The additional financial resources can potentially be addressed by considering less costly interventions including trenchless technology, cathodic protection, etc. or by re-evaluating the water rates based on this study's findings. Refer to the recommendations in **Sections 8.1** and **8.3**.

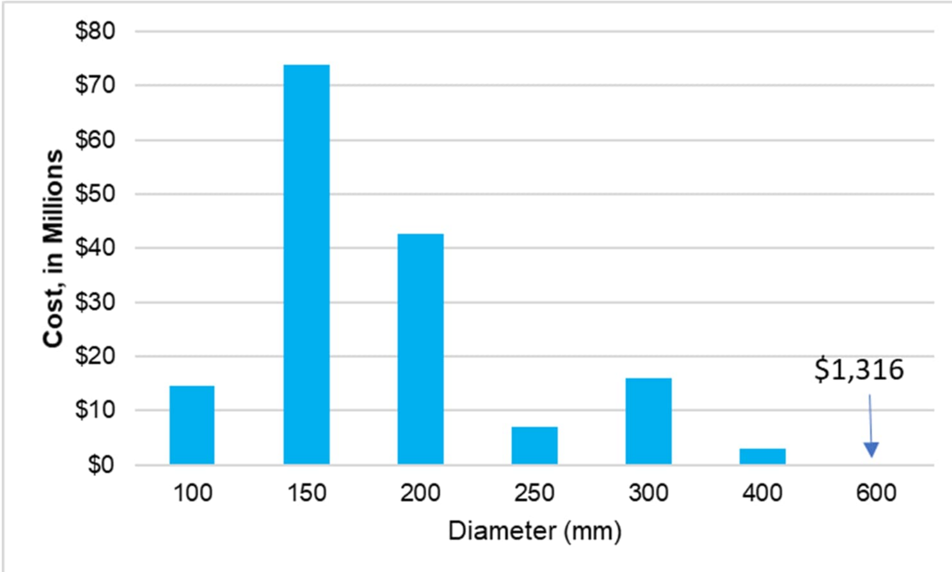


Figure 35: Total Cost by Diameter of Pipes

4.3.4 Overall 10-Year Lifecycle Costing

Figure 36 combines all lifecycle outputs by considering the O&M costs and capital replacements costs. The total expected cost for the next 10 years is approximately $151 M (i.e., capital costs of $67.0 M and O&M costs of $84 M).

Detailed results can be found in **Table 18**.

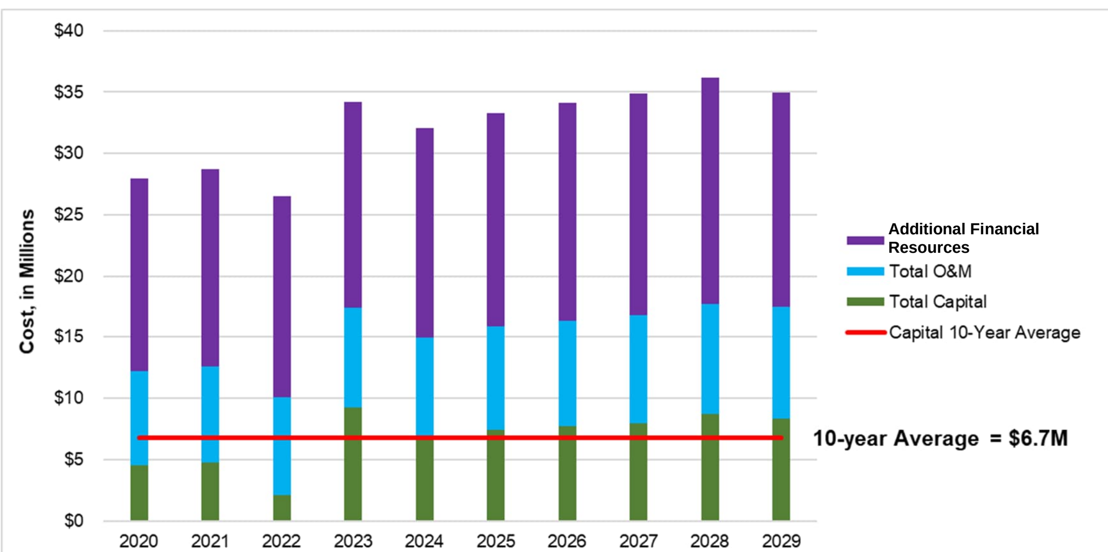


Figure 36: 10-Year Lifecycle Analysis

Table 18: 10-Year Lifecycle Costing

ID	Item	Formula	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	Total
A	Service Criteria Replacement Program	NA	$246,000	$381,000	$397,000	$147,000	$148,000	$132,000	$242,000	$257,000	$333,000	$63,000	**$2,347,100**
B	Risk-based Replacement Program	NA	$4,290,000	$4,384,000	$1,728,000	$9,132,000	$6,496,000	$7,287,000	$7,462,000	$7,710,000	$8,385,000	$8,247,000	**$65,117,000**
C	**Total Capital**	**A+B**	$4,537,000	$4,765,000	$2,125,000	$9,279,000	$6,645,000	$7,419,000	$7,705,000	$7,966,000	$8,717,000	$8,305,000	**$67,463,000**
D	**Available* Capital (Approximate)**	**NA**	**$4,560,000**	**$4,980,000**	**$5,340,000**	**$6,000,000**	**$6,720,000**	**$7,380,000**	**$7,500,000**	**$8,175,000**	**$8,911,000**	**$9,713,000**	**$69,278,000**
E	**Capital 10-Year Average**	**Average of (A+B)**	**$6,746,000**	**$6,746,000**	**$6,746,000**	**$6,746,000**	**$6,746,000**	**$6,746,000**	**$6,746,000**	**$6,746,000**	**$6,746,000**	**$6,746,000**	**$67,460,000**
F	**Calculated Additional Financial Resources ****	**NA**	**$15,800,000**	**$16,116,000**	**$16,438,000**	**$16,767,000**	**$17,102,000**	**$17,444,000**	**$17,793,000**	**$18,149,000**	**$18,512,000**	**$17,474,000**	**$171,595,000**
G	Condition Assessment	NA	$250,000	$255,000	$260,100	$265,300	$270,600	$276,000	$281,500	$287,200	$292,900	$298,800	**$2,737,000**
H	O&M (2018 PUC) - Inflated	NA	$7,407,000	$7,556,000	$7,707,000	$7,861,000	$8,018,000	$8,178,000	$8,342,000	$8,509,000	$8,679,000	$8,853,000	**$81,110,000**
I	**Total O&M**	**G+H**	**$7,657,000**	**$7,811,000**	**$7,967,000**	**$8,126,000**	**$8,289,000**	**$8,454,000**	**$8,624,000**	**$8,796,000**	**$8,972,000**	**$9,151,000**	**$83,847,000**
J	**Total**	**C+I**	**$12,194,000**	**$12,576,000**	**$10,092,000**	**$17,405,000**	**$14,934,000**	**$15,873,000**	**$16,329,000**	**$16,762,000**	**$17,689,000**	**$17,456,000**	**$151,310,000**

*In some years, some amounts of available capital are deferred to the following years. The remaining amount gets deferred to the following year (t+1). The remaining amount at t and t+1 can then be used to replace that utility corridor at t+1.
**Disregards the remaining capital from the risk-based replacement program per year but applies it on the total remaining amount of 2029 which is (9,713,000-8,305,000) = $1,408,000. Hence, the Additional financial resources in 2029 would be (18,882,000-1,408,000) = $17,474,000

5. PUC Overall Capital 10-Year Funding Needs Summary

The lifecycle costing developed for this assignment was completed by considering systematic methodologies to determine intervention requirements during a study period from 2020 to 2029.

For water vertical assets, the interventions were in the form of:

- Assess;
- Replace on failure;
- Replace or assess; and
- Detailed analysis.

From a high-level age-based analysis, the total interventions needed was approximately $63M. Considering an available capital budget during 2020-2029 of approximately $46M, the overall additional financial resources would roughly be $17M (10-year average of $1.7M). In this assignment, 410 assets were inventoried and visually assessed during the ICA exercise. These assets were located in the Surface Water Treatment Plant and Gros Cap Raw Water Pumping Station. According to the risk-based methodology, approximately $5M worth of replacements are needed with a 10-year average of $0.5M.

For linear assets, two main models were used to identify capital replacement needs:

- Service Criteria; and
- Risk-based.

The Service Criteria model selected utility corridors that could not satisfy available fire flow requirements and/or had higher lead/galvanized connections. Higher priorities were also assigned based on adjacent land uses and customers Corridors not identified in the Service Criteria were analyzed using the Risk-based model.

Corridors with risk scores exceeding a pre-defined risk threshold were identified for replacement. Based on the results, all corridors in the major risk category were identified for replacement within the period covered by the plan with some additional corridors in the moderate risk category.

The average 10-year capital replacement funding for linear assets was estimated at approximately $6.7 M which was constrained by the available linear capital budget (60% of the overall capital). With an unconstrained age-based scenario (i.e. identify replacement for pipes having an age that exceeds ESL), a 10-year average annual capital additional financial resources of $17.2M were observed to occur over the 2020-2029 period.

The resulting water infrastructure capital funding needs is summarized in **Figure 37**. Based on the figure, the average 10-year capital, considering the constrained scenario is approximately $11.5 M with a total 10-year average capital additional financial resources of $19M.

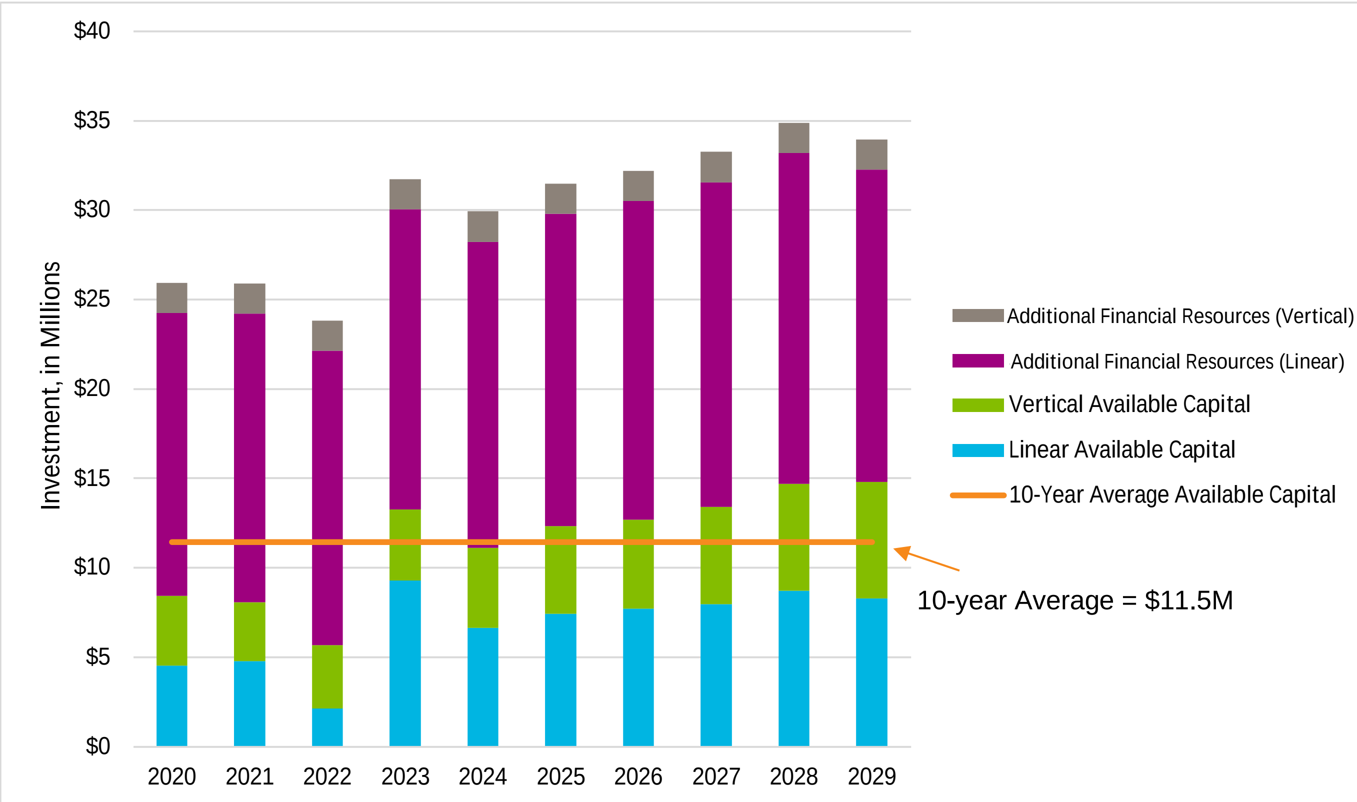


Figure 37: PUC 10-Year Water Capital Costs

6. Asset Lifecycle Strategies

6.1 Asset Acquisition Phase

PUC has made significant investments in the design and construction/acquisition of its water assets. PUC's asset inventory has, to a large extent, been constructed over the past decades through funding provided by customers and higher levels of government. PUC uses the Drinking Water Quality Management Standard (DWQMS) specifications for recurring waterworks material purchases. They are signed off by Purchasing, Engineering and the respective operating department (i.e. Distribution or treatment).

Looking towards the future, when acquiring new assets, the PUC should evaluate credible alternative design solutions that consider how the asset is to be managed at each of its lifecycle stages. Asset management and full life cycle considerations for the acquisition of new assets include, but are not limited to the following:

- The asset's operability and maintainability;
- Availability and management of spares;
- Staff skill and availability to manage the asset; and
- The asset's eventual disposal.

6.2 Asset Operation & Maintenance

Based on 2018 data, PUC reported an approximate total O&M cost of $13.3M. The cost is broken down into purification and pumping, transmission and distribution, hydrants, billing and collection and general and administration.

Table 19: O&M Expense and Type

Expense Type	2018 Budget
Purification and Pumping	$3.9M
Transmission and Distribution	$4.2M
Hydrants	$0.4M
Billing and Collection	$1.2M
General and Admin	$3.6M
Total	**$13.3M**

The above costs include activities that are undertaken to preserve and prolong the longevity and condition of PUC's water system assets. In the following subsections various O&M activities have been identified to assist in delivering high quality water to customers and enhance the service life of assets some of which are already being undertaken.

6.2.1 Watermains

- Condition assessment and inspection: Regular and scheduled condition assessment provides information about the condition and structural capacity of the pipe, highlighting possible intervention needs. Detailed information can be found in **Appendix F** and **Appendix K**;

- Watermain flushing: Seasonal watermain flushing removes sediment accumulation, improves water quality and mitigates damage to pipe infrastructure. System valves are exercised as necessary to ensure water is flowing on a one-way path. The recommended flow speed is 1 m/s. It is recommended that areas flushed to be partially isolated to prevent flow back from uncompleted areas;
- Watermain swabbing: Cleaning process which utilizes a large sponge forced through a pipe to remove debris. This methodology is proven to be effective for thermoplastic pipeline material. Swabbing is generally performed for large diameter and small diameter pipes. System valves are exercised as necessary to ensure water is flowing on a one-way path. The recommended flow speed is 1 m/s. It is recommended that areas swabbed to be partially isolated to prevent flow back from uncompleted areas;
- Water Quality Testing: Regular water sampling and testing based on regulatory requirements to ensure water quality objectives are met. Identifies water quality issues so that immediate action can be taken to protect public health;
- Cathodic Protection: Cathodic protection arrests the corrosion process on the external surface of ferrous materials. This method is highly effective in corrosive soil where the main degrading factor is the soil surrounding the pipe. As the majority of PUC's pipes are made of ferrous material, considering a cathodic protection program could be an effective option in reducing the number of breaks observed on ferrous materials. In a study performed for the City of Toronto, comparing replacement, cathodic protection and lining, cathodic protection showed a huge benefit to cost ratio when deployed as opposed to the other intervention actions. Generally, cathodic protection is deployed on low critical assets. The unit cost of installing cathodic protection on watermains is approximately $30/m. Based on PUC's water network, the total length of low consequence ferrous pipes is 205 km. Using the cathodic protection unit rate, the total cost of implementing such a program may be in the range of $6.2M.

6.2.2 Valves

- Valve Inspection and Exercising: Periodic maintenance to locate, inspect and exercise the valve, clean out valve box, paint valve lid, and record data about the valve. Such an activity ensures that valves can be easily located and operated when and as needed; and
- Valve Corrective Maintenance: Repair valve to ensure proper continued operation. It ensures valve operates as intended; prevents failure and potential loss of service.

6.2.3 Hydrants

- Hydrant Annual Inspection: Hydrant checks can include checking operation, caps, oil, pressure, sounding access, winter leakage, freezing, and string test. It ensures hydrants are in good working condition. Hydrant checks are required by the Fire Code;
- Hydrant Corrective Maintenance: Planned repairs to hydrants that have been identified as potentially defective to ensure proper continued operation. It restores hydrant operability and maintains public safety from the threat of fire;

6.2.4 Water Services

- Locate Service Boxes: Water crews to locate difficult to find service boxes on request. It ensures that service boxes are not accidently damaged from local excavation or construction activities;
- Water Service Turn On/Off: Water service turn off or on under PUC responsibility. It provides a high level of customer service;

- Water Service Box Inspect/Repair: Repairs to Water Services boxes. It ensures the continued reliability and proper functioning of Service Connections; and
- Connection Corrective Maintenance: Repairs to connections that have been identified as potentially defective to ensure proper continued operation. It restores connection operability and maintains water service to customer.

6.2.5 Vertical Assets

Unlike linear assets, O&M activities are asset-specific. Condition assessment, periodic inspections, and detailed analysis would be initial steps for proactive maintenance. The ICA in this assignment inventoried 410 assets and specific actions have been identified accordingly in the form of assess, replace or detailed analysis required. Refer to **Appendix E**.

6.2.6 O&M-related Software - CMMS

Currently, PUC relies on spreadsheets to plan for O&M activities and some financial management modules that help in scheduling and costing (i.e., Caynta). However, PUC has not been utilizing a computerized maintenance management system (CMMS) that can enhance the overall O&M activities within PUC. Ultimately, the main aim of a CMMS is to organize the processes associated with maintenance management and reduce inefficiencies that can result in increased costs and downtime of assets. The benefits of a CMMS include efficient scheduling, monitoring, resource allocation, and costing. The primary benefits can be further detailed as follows:

a. CMMS can support condition-based monitoring of assets. This can provide information into potential imminent failures;
b. CMMS can monitor and track the movement of spare parts and replacement requisitions;
c. CMMS increases the interoperability in the organization as it improves communication between operations and maintenance staff and other departments;
d. CMMS can maintain consistency of the information communicated between the departments and staff;
e. Managers will be able to obtain data in a form that allows effective control and reporting of activities;
f. CMMS supports mobile tools to complete tasks efficiently. This will increase job handling and improve staff productivity; and
g. CMMS improves scheduling and tracking of activities and is able to help in optimizing resources so that double-booking is avoided.

Generally, the cost to implement CMMS depends on the system size and specific elements incorporated into the management system. Based on similarly sized systems, the estimated cost for CMMS PUC’s system may be in the range of 600k to 800k, excluding the annual licensing.

6.3 Asset Renewal and Replacement Strategies

When estimating the timing and scope of infrastructure renewal or replacement there are many factors to consider. The right time for asset replacement will depend on expected levels of service including reliability, the ability of an organization to adjust maintenance schedules for unplanned repairs, and capital budget. Each of the following criteria should be assessed when determining whether an asset should be replaced.

- Criticality: A highly critical asset should be replaced before failure, while some non-critical assets can be run to failure and replaced as required;
- Condition: Level of refurbishment and preventive maintenance;

- Functionality: Design and operating conditions. A bad design, improper equipment specifications or poor material selection may reduce reliability or condition of an asset, triggering the need for premature asset replacement;
- Budget: Resources (funding and staffing) available to complete the project(s); and
- Planning: Adjacent infrastructure and other projects including expansion or upgrades.

6.3.1 Watermains

- Replacement using Pipe Bursting: Pipe bursting can be applied to brittle materials, and pipe splitting to ductile materials. The old pipe is ruptured and pressed into the surrounding soil while a new pipe follows the cone-ended bursting tool to replace the old pipe. The bursting tool is hammered through the host pipe by pneumatic or hydraulic means. The benefit of pipe bursting is that it allows for trenchless upsizing of the original pipe. The typical length of pipe replaced by pipe bursting is approximately 110m, but greater lengths have been accomplished. Pipe depth, soil conditions, adjacent utilities and service connections will dictate whether pipe bursting is appropriate;
- Renewal using Cured-in-Place Pipe (CIPP) Liners: Cured-in-place pipe liners have been commercially available since 1971 and are used to seal and or structurally renew existing pipes without excavation of the pipe itself. The basic CIPP liner product is a tube, impregnated with a liquid thermoset resin, inserted into a pipeline, and cured. CIPP liners were developed as a modified coating system, delivering resins in a carrying tube (often described as a "sock") that could hold the desired coating in place until the resin had time to cure. CIPP liners are either inverted, pulled in place, or manually inserted into the host pipe. All expand radially or are otherwise conformed tightly against the host pipe. Various resins are utilized including epoxy, polyester, silicate, and vinylester, and the most commonly used resins are styrene-based. Resins are either ambient cured, thermally cured (utilizing either hot water or steam), or ultraviolet light (UV) cured. PUC already has a lining program as part of its capital renewal plan. Prior to selecting pipes for lining, it is essential to perform hydraulic analysis so that the hydraulics of the lined pipe is not impacted due to decreased cross sectional area of the pipe. Mains that are deteriorated and satisfy hydraulic requirements post-lining are good candidate for CIPP; and
- Pipe Replacement through Trench Open-Cut: Pipe replacement through trench open-cut is still fairly common within most municipalities, although open-cut work is typically disruptive to the adjacent area and requires a great deal of traffic control if the trench is located in a roadway. It tends to be slower than trenchless methods and more dangerous as workers / residents risk cave-ins when in or near the trench. Finally, trench open-cut methods generally are more expensive than trenchless methods. However, trench-open could still be the best / only option when trenchless methods are not viable. Open-cut replacement consists of the traditional method of pipe installation, where an excavation crew typically digs a trench along the existing trench line using a track excavator or backhoe. The new pipe is laid, bedded and the trench is backfilled, compacted and the surface is reinstated as necessary. The unit cost of pipe replacement through open-cut excavation needs to include the cost of excavation, laying the new pipe, backfilling and reinstatement. Other factors impacting costs include the installation of appurtenances such as valves, manholes, catch basin leads and whether and how many service connections need to be re-connected. The cost of the surface reinstatement could vary significantly based on the original surface and use e.g., an arterial road or only a landscaped surface.

6.3.2 Water Meters

- Meter Replacement and Smart Meters: Aging makes water meters become less accurate, leading to a loss in revenues as water consumption is not accurately recorded. However, the premature replacement of water meters that are still reading consumption accurately is a waste of resources. Between these two economically opposing forces, there is a point that economically justifies the cost of meter replacement. As such, the optimum service life of a meter depends on prevailing water rates, rate of meter wear (and loss of accurate registration), repair and maintenance costs, and inflation and discount rates. Ultimately, there is no standard time period for meter replacement that can be broadly applied to all utilities, as local conditions such as chemical composition of the water, temperature and humidity all impact on meter life. Within Canada, there is significant variability in meter replacement schedules between water utilities and a recent survey by the Canadian Infrastructure Benchmarking Initiative found that utilities generally change out between approximately 4% and 10% of their meters per year. Due to more water being sold and revenue generated through ICI meters, some utilities might even have a different replacement cycle for these meters e.g., changing 20% of their ICI meters out per year. Approximately, 1/3 of PUC's network has been converted to smart meters. While the associated benefits of these meters have not been realized so far, generally these types of meters are expected to drive operating costs lower when compared to old models of meters. PUC may consider a program that would replace existing meters with smart meters.

6.3.3 Valves

- Valve Replacement: Replacement of valves that have deteriorated or that are no longer operable. This activity maintains the functionality of the system by ensuring all valves are operable. Generally, when watermains are replaced, valves are also replaced.

6.3.4 Hydrants

- Hydrant Replacement: Replacement of hydrants that have deteriorated to the point where they are not reliable to support fire fighting. It maintains public safety from the threat of fire. Generally, hydrants can serve 50 to 75 years depending on the O&M activities performed to preserve their service life. Generally, when watermains are replaced, valves are also replaced.

6.3.5 Water Services

- Water Service Replacement and Renewals: Replace service connections prior to or at the time of failure. Ensures proper function of service connections; and
- Lead Service Replacement Program: Replace services that are made of lead due to health-related concerns. Many municipalities across North America have established such a program to reduce any health-related concerns. In this assignment, water pipes connected to lead services have been identified as part of the Service Criteria model. **Appendix G** maps the pipes that have high density of lead/galvanized services.

6.3.6 Vertical Assets

- Replacement of Assets: Replace vertical assets based on detailed analysis and condition assessment. The replacement should follow a prioritization schedule to take best advantage of the available budget.

6.4 Decommissioning and Disposal Phase

Asset decommissioning and disposal activities are performed to decommission and dispose of assets due to ageing or changes in performance and capacity requirements. This decision process includes the consideration of costs and benefits of using a whole life approach, the impact of asset rationalisation on other infrastructure, and the processes for disposal of assets. More specifically, the following factors need to be evaluated when considering the decommissioning and disposal of assets:

- Assets not required for the delivery of services, either currently, or over the longer planning period;

- Assets that have become uneconomical to maintain or operate;
- Assets that are not suitable for service delivery and do not meet current or future proposed levels of service;
- Assets that have a negative impact on service delivery, the environment, or community;
- Assets that no longer support the PUC's service objectives due to a change in type of service being delivered or the delivery method;
- Assets where their use has become uneconomical due to the limited availability of spares or the cost of their replacement parts;
- Assets where the technology has been outdated; and
- Assets which can no longer be used for the purpose originally intended.

Considerations for asset decommissioning and disposal activities include, but are not limited to:

- Updates to asset databases such as the GIS;
- Environmental impact of disposal and implications for land rehabilitation, where applicable;
- Residual value of assets;
- Continued service delivery while a new asset is being constructed / commissioned: overlap of the start-up of new assets / facilities and the decommissioning of existing assets / facilities being replaced;
- Cost of decommissioning and disposal; and
- Other, as needed.

7. Financial Strategy

7.1 Financial Analysis

Financial analysis activities for asset management is centered on two essential elements: revenues and expenditures. Through asset operations, PUC generates its revenues through a full user pay model.

Assessing the financial implications in the decision-making process recognizes there are competing priorities and trade-offs between projects. Financial analysis informs required funding levels for the capital plan and assist in making critical decisions about service delivery while providing the greatest benefit for the community at the lowest cost.

7.2 Aligning the Financial and Non-Financial Functions of AM

ISO 55010[5] identifies that the financial and non-financial functions of asset management within organizations are generally inadequately aligned, as follows:

- **Financial Accounting Functions:** Focused on retrospective reporting of accounting / regulatory financial activities. However, there is a growing awareness in organizations of the need to focus on providing a managerial costing approach in order to support decision-making for the future; and
- **Non-Financial Functions:** Have a limited understanding of financial accounting functions but are recognizing the need to improve their understanding of the financial implications of their activities.

The lack of alignment between financial and non-financial functions can be attributed to silos in an organization, including reporting structures, functional / operational business processes, and related technical data. Silos generally bring forth the necessary level of specialization. However, with a lack of communication between the silos, organizations are at risk of inefficiencies and errors in asset management results, or asset management failures due to a lack of alignment between staff and senior management. Financial and non-financial alignment needs to work both “vertically” and “horizontally”, as follows:

- **Vertical Alignment:** Financial and non-financial asset-related directives by management are informed by accurate upward information flows, effectively implemented across the appropriate levels of the organization; and
- **Horizontal alignment:** Financial and non-financial information that flows between departments (conducting functions such as operations, engineering, maintenance, financial accounting and management) uses the same terminology and refers to the assets identified in the same way.

Figure 38 presents the key elements in a framework to address the need to achieve the alignment.

5 *International Organization for Standardization (2019): ISO 55010 - Asset management — Guidance on the alignment of financial and non-financial functions in asset management*

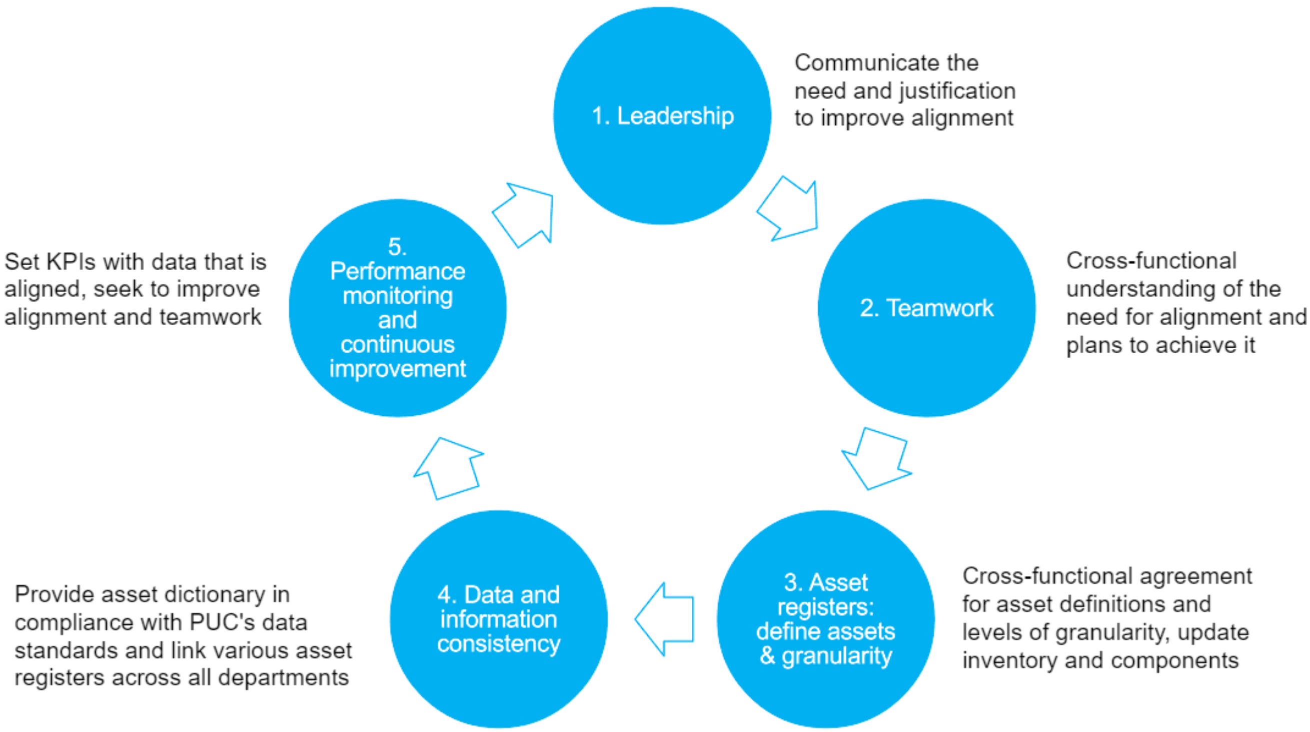


Figure 38: Key Elements of a Framework to Achieve Financial and Non-Financial Alignment

7.2.1 Long-Term Financial Planning

Strengthening PUC's asset management planning will improve the long-term financial planning, by accounting for whole life cycle costs as presented in **Section 6**. This includes all capital, annual operation and maintenance, and disposal costs over the planning timeframe, thereby aligning financial requirements with long-term level of service objectives.

The challenge is often one of agreeing on a timeframe for such planning, recognizing that the AM perspective is ideally focused on the asset life cycle, versus shorter term objectives and priorities. Accordingly, financial and non-financial staff, as well as top management and politicians, should agree on a long enough timeframe to provide useful forward planning information that aligns the financial and non-financial perspectives, as generally presented in **Figure 39**.

Figure 39: Asset Management Planning Alignment Across the Organization

PUC should have an appropriate long-term financial planning process that achieves the following:

- Stimulates long-term strategic thinking and perspective for stakeholders and decision-makers;
- Can be used as a tool to prevent or predict future financial shocks and demonstrate financial sustainability; and
- Demonstrates to internal and external stakeholders that the organization has a financial strategy in place to meet their demands, now and in the future.

The long-term financial planning process needs to involve financial and non-financial staff working together to combine the important elements of strategy development, asset management planning and financial forecasting.

7.3 PUC Financial Plan and Need of Water Rate Study

The most recent financial plan was completed in 2019 by KPMG. It was developed to forecast the financial performance of PUC's water supply services to better manage and operate this critical system. The financial plan approach considered the following:

- Infrastructure reinvestment differential;
- Future growth;
- System acquisition costs;
- Regulatory requirements and service enhancements;
- Debt principal repayment;
- Amortization of tangible capital assets at historical values;
- Interest on long-term debt; and
- Operating costs.

One of the main outputs of the financial plan is to identify near optimum water rates that can help PUC generate revenues to cover expenses in operating, maintaining and renewing the water system. As per the report, PUC's rate structure contains a basic monthly charge and a three-tiered block of rates. The monthly charge applies regardless of the amount of water used by the customer. The 2019 metered water rates are as follows:

- Up to 15 m^3: \$0.662 per m^3;
- > 15 m^3 and $<$ 250 m^3: \$1.95 per m^3; and
- Remainder of consumption: \$1.53 per m^3.

According to the same report, the projected water rates from 2020 to 2026 are summarized in **Table 20**.

Table 20: Projected Water Rates

Year	Variable/ m^3	Fixed/ m^3
2020	0.71	31.09
2021	0.76	33.11
2022	0.8	35.1
2023	0.85	37.03
2024	0.89	38.88
2025	0.93	40.82
2026	0.98	42.86

These forecasted rates were based on multiple assumptions in which any variation in one or more may impact the water rates' results. A high-level analysis of these assumptions suggested that a water rate study is recommended to be performed due to the following:

- The 2019 Financial Plan assumed that historical decline in water trend consumption would continue during the projected years (based on historical data). Due to the unprecedented period and the impact of COVID19, generally, it has been observed that utility consumption has significantly increased including the water use. Future water rate studies should evaluate if such water use historical trend is still applicable. This can be done by comparing the anticipated trend in 2020-2021 and onwards with actual recorded water use of the recent years;
- The capital funding was purely related to an age-based scenario with a fixed estimated service life of 75-years. Based on the risk management framework, that was recently deployed, along with the different parameters that were considered, the deterioration mechanism of pipes varied significantly from one another especially when considering ferrous and thermoplastic material. Thereby, some pipelines may be prioritized for replacement although their estimated service life has not yet been reached. On the contrary, some pipelines may not experience any breaks during their service life and their operations may extend beyond their designed life. When considering an age-based scenario where replacement is identified when age exceeds the estimated service life assigned per material type, the additional financial resources during 2020-2029 period is significant and higher than the capital budget assumed in the 2019 Financial Plan;
- The Service Criteria model considered available fire flow and lead/galvanized connections as part of the prioritization mechanism. The implemented Service Criteria model identified approximately 52 km of pipes that had higher scores in at least one of the Service Criteria parameters; and
- While an ICA exercise has been performed on 410 assets within the vertical infrastructure, further detailed analysis of the majority of the vertical infrastructure is prudent to determine the needed interventions. Based on any future study, vertical infrastructure capital needs may impact water rate studies. It is observed that the age of many of the vertical assets have already exceeded their estimated service life.

8. Recommendations

The recommendations are classified into General, Vertical Assets and Linear Assets.

8.1 General

1. Align asset management related tasks with the best practices identified in ISO 55000 and ISO 55001 standards including ISO 55010 for financial strategy and planning implementation;
2. Complete an updated financial plan and a water rate study which considers the risk management findings included in this report. The water rate study is suggested to be completed after performing detailed analysis of vertical infrastructure not inventoried as part of the ICA;
3. Update asset management plan for any future modifications to the risk management, asset inventory, or expansions to the network; and
4. Implement a Computerized Maintenance Management System (CMMS) to enhance existing practices and better track maintenance-related activities. Generally, the benefit/cost ratios are expected to be higher when compared to the manual or simplified approaches used in some organizations for maintenance management.

8.2 Vertical

1. Perform interventions based on risk management to ensure budgets are spent in a sustainable manner;
2. Update the risk model and inventory depending on any future updates, upgrades, or disposal of assets; and
3. Perform detailed analysis of the majority of the vertical assets not inventoried in the ICA while also documenting the O&M activities to prolong the asset life.

8.3 Linear

1. Consider implementing the risk management framework to prioritize assets for interventions to maintain sustainable funding;
2. Update the risk model and inventory depending on any future rehabilitation, replacement and advanced assessments;
3. Utilize advanced condition assessment techniques to confirm the existing state of linear assets; and
4. Evaluate cost-effective options when identifying pipes for intervention.

Appendix A

Asset Management Policy

1. BACKGROUND and PURPOSE

The Public Utilities Commission of the City of Sault Ste. Marie ("the Commission") was established under municipal by-law in accordance with the Public Utilities Act in 1917. As the legal owner of the Sault Ste. Marie Drinking Water System, the Commission is accountable to City Council for the administration of the drinking water system. PUC Services Inc. ("PUC") is accountable to the Commission for all aspects of the management, operation and maintenance, expansion and renewal of the drinking water system.

The Sault Ste. Marie Drinking Water System (DWS) is defined as being part of the core municipal infrastructure for which a Strategic Asset Management Policy and an Asset Management Plan are required, as prescribed by *O. Reg. 588/17* (Asset Management Planning for Municipal Infrastructure) pursuant to the *Infrastructure for Jobs and Prosperity Act* (*2015*).

This Strategic Asset Management Policy defines the key principles that underpin asset management practices at PUC and establishes organization-wide commitment and direction for the stewardship of DWS assets in accordance with *O. Reg. 588/17*.

2. SCOPE

This Policy applies to the lifecycle management activities of all assets of the Sault Ste. Marie DWS. Assets include the water distribution system for the Batchewana First Nation located within Rankin Reserve 15D. Assets also include vertical and linear raw water infrastructure and fire supply in Prince Township.

3. GOALS AND OBJECTIVES

PUC's goals and objectives for asset management align with its corporate mission, vision and values. Goals for asset management set out by the Policy that support this mission include:

1. Providing a level of service to customers and shareholders that delivers value and quality.
2. Managing DWS assets in accordance with formal, consistent and repeatable methods that reinforce stakeholder confidence that PUC is managing its assets in an efficient, effective and responsible manner.
3. Planning for a whole life cost approach when selecting the most appropriate asset interventions, where all costs associated with the asset are taken into consideration and not just the initial capital cost.
4. Using processes of continual improvement within asset management planning to support a culture of innovation when confronting challenges. Furthermore, managing risk and performance of the system by building data to support prioritizations, benchmarking, and alignment of PUC Financial and Operational Plans.
5. Creating a corporate culture where all employees play a part in the overall care for DWS assets by providing the necessary awareness, training, professional development, and business processes needed to support the asset management system.
6. Continuing to coordinate asset management planning for DWS assets with the City of Sault Ste Marie when it provides value to shareholders and customers.
7. Ensuring continued compliance with *O.Reg.588/17*, the *Infrastructure for Jobs and Prosperity Act*, and all other regulatory requirements applicable to the asset management of the DWS.

4. PRINCIPLES

PUC's approach to asset management is underpinned by guiding principles. In accordance with the principles described in the *Infrastructure for Jobs and Prosperity Act* (*2015*), infrastructure planning and investment should:

1. Take a long-term view, being mindful of demographic and economic trends.
2. Take into account budgets adopted under Part VII of the Municipal Act as they apply to the lifecycle activities of City of Sault Ste. Marie assets in proximity to DWS assets.
3. Clearly identify infrastructure priorities to inform infrastructure investment decisions.
4. Ensure continued provision of safe drinking water – a core service as defined by O.Reg.588/17.
5. Promote economic competitiveness, productivity, jobs, and training opportunities.
6. Ensure the health and safety of workers involved in infrastructure construction, as well as during operations and maintenance of DWS assets.
7. Foster innovation, making use of innovative technologies, services and practices when practical.
8. Be evidence-based and transparent during asset management decision making, with supporting information accessible to the public. Decision making will include the appropriate information sharing with public sector agencies.
9. Provide consideration for provincial and municipal plans and strategies such as the City of Sault Ste. Marie Official Plan, the Planning Act, the Water Opportunities Act, and the Growth Plan for Northern Ontario.
10. Promote accessibility for persons with disabilities.
11. Minimize the impact of DWS assets on the environment and be resilient to climate change.
12. Endeavor to make use of recycled aggregates.
13. Promote social and economic community benefits associated with infrastructure projects.

5. POLICY STATEMENTS

PUC is committed to the practice of asset management to provide guidance in the creation, operation, maintenance and disposal of DWS assets. PUC will:

Asset Management Practices

Develop the asset management program in alignment with corporate and municipal plans and strategies related to community growth and development, fiscal responsibility, sustainability, resiliency, accessibility, health and safety, and emergency preparedness.

Responsible Planning, Operations, and Maintenance

Practice fact-based decision making that is informed, transparent, and supported by principles of risk and lifecycle management. PUC will plan for the appropriate level of maintenance for assets to deliver drinking water services at identified Levels of Service. PUC will work to extend the useful life of assets in consideration of existing requirements, growth forecasts, and changes in risk profiles through external factors such as climate change and other socio-economic challenges.

Sustainable Funding

Apply principles of financial sustainability during financial planning, considering growth, and the total lifecycle cost of assets. PUC will ensure that budgets are driven by asset management needs and optimized using risk and criticality. PUC will use capitalization thresholds that are appropriate for the assets, based on the provision of ongoing and sustainable service delivery. PUC will ensure the alignment of the Asset Management Plan with its Drinking Water System Financial Plan.

Stakeholders and Community

Conduct asset management planning in collaboration with local partners and government agencies while informing or consulting the public when appropriate.

6. ROLES AND RESPONSIBILITIES

Roles and responsibilities for asset management establish chains of command, decision making processes, and the activities that shall be completed at different levels of the organization. It describes the framework that asset management activities operate within.

The following is the governance framework for asset management activities:

Organizational Entity	Responsibilities
Commission Board of Directors	▪ Strategic Asset Management Policy Approval
PUC Services Inc. Board of Directors	▪ Receives Strategic Asset Management Policy for information ▪ Oversight of Policy Administration
President & CEO	▪ Approves Strategic Management Policy for Approval ▪ Appoint Steering Committee ▪ Oversight of Policy Execution
Steering Committee	▪ Oversight of Policy Implementation ▪ Alignment ▪ Appoints a Working Team
Working Team	▪ Program Delivery
Customers	▪ Public expectations

7. ALIGNMENT PROCESSES

It is a requirement of *O.Reg. 588/17* that the Policy include processes to ensure alignment of asset management plans with any water and/or wastewater financial plans and Ontario's Land Use Planning Framework. The following process form part of the Policy to ensure such alignment as is required by regulation and as in the best interest of stakeholders.

Financial Plans Alignment: PUC prepares its Financial Plan for Drinking Water Assets in accordance with the requirements set forth by the *Safe Drinking Water Act* and *O.Reg.453/07*. Pursuant to *O. Reg. 588/17*, the Asset Management Plan must include a (financial) strategy to determine the cost and timeframe for capital expenditure to maintain service levels and sustainable infrastructure. Both are intended to be living documents. The AMP Steering Committee will undertake an annual review of the Financial Plan relative to the Asset Management Plan to identify any financial gap between the Financial Plan and the Asset Management Plan. The Steering

Committee will then make recommendations for updates of the respective documents to result in financial convergence and overall alignment of the Financial Plan and the Asset Management Plan, with the overall objective of infrastructure and service level sustainability.

Budget Alignment: To ensure continued alignment of Commission capital projects with municipal projects, PUC will coordinate and collaborate with the City to align DWS infrastructure planning and investment with roads and wastewater asset planning and investment.

The process for considering the asset management plan in Commission capital budgets is detailed in the Drinking Water Quality Management System Operational Plan.

Ontario's Growth and Land-Use Planning Framework Alignment: PUC will provide support to the City (who administers development planning and approvals within the City of Sault Ste. Marie through its Official Plan) on all matters that impact the DWS. This includes development approvals and planning, as well as the identification of lands best suited for development within the constraints of the DWS. PUC will use the municipal planning process to incorporate future infrastructure requirements within asset management, and ensure alignment with municipality's Official Plan, municipal growth projections and prescribed provincial plans.

8. REVIEW, UPDATE AND CONTINUOUS IMPROVEMENT

At a minimum, this policy shall be reviewed and updated (as required) every 5 years. The AM Policy shall be reviewed sooner if changes are made to PUC's operating environment in the event that:

- Changes to financing constrain the achievement of the PUC's goals and objectives for the DWS assets
- The Policy is no longer relevant or consistent with the PUC's strategic priorities

Developments in technology and emerging best practices in operations, financing, and asset management, provide opportunities for improvement of the Policy. PUC will strive to continuously improve its asset management approach by actively monitoring the effectiveness of its asset management program, and driving innovation in the development of tools, practices and solutions.

9. REFERENCES

The following documents related to corporate-wide management and procedures, form part of the PUC's overall approach to asset management:

1. Drinking Water Quality Management System, Policy, Operational Plan, and Risk Registry
2. Financial Plan for Water Supply Services
3. Service Agreements: Prince Township, Batchewana First Nation (Rankin Reserve 15D)
4. PUC Services Inc. Strategic Plan and Strategic Initiatives
5. Purchasing Policy
6. Accessibility and Health & Safety Policies
7. Corporate Emergency Preparedness

Approved: ______________________ **Date: June 26, 2019**

President & CEO

Revision History:

NOTE: A red line on the right side of document indicates a change		
Revision #	**Date**	**Description**

APPENDIX A
DEFINITIONS

Asset: In general, an asset is an item, thing or entity that has potential or actual value to an organization. For the purpose of this policy, the term refers specifically to assets that have a value and enable drinking water services to be provided.

Asset Management: The coordinated activities of an organization to realize value from its assets in the achievement of its organizational objectives.

Asset Management Program: The set of policies, governance, strategies, processes, practices and enablers (such as technology tools, data, materials, equipment and human resources) that are applied to manage assets through their life cycle.

Capitalization Threshold: "capitalization threshold" is the value of a municipal infrastructure asset at or above which a municipality will capitalize the value of it and below which it will expense the value of it. For the purposes of the Policy, the capitalization threshold is $500.

Drinking Water System (DWS): The treatment facilities, source water intakes, pumping stations, wells, control tanks, storage, distribution mains, transmission mains, appurtenances, and associated systems owned or operated by the PUC for the provision of drinking water and fire protection services.

Level of Service: the service level delivered to customers by the PUC. This can take the form of the selection of services that are provided, the standard of infrastructure in place, or the standard to which an asset is maintained (e.g., the frequency of scheduled tasks). The desire for a particular Level of Service will directly affect utility fees.

Life Cycle: The time interval that commences with the identification of the need for an asset and terminates with the disposal of the asset.

Public Utilities Commission: The Public Utilities Commission of the City of Sault Ste. Marie owns the water supply and distribution infrastructure and is responsible for the provision of safe, reliable, potable water at cost to customers within the municipal services boundary of Sault Ste. Marie, Ontario.

PUC Services Inc.: Is a utility services company operating as a wholly owned private company of the Corporation of the City of Sault Ste. Marie and is incorporated under the Ontario Business Corporations Act.

Risk: The chance of something happening that may affect the PUC's ability to achieve its strategic or operational objectives, or fulfil its regulatory requirements.

Vulnerability: Exposure to an event that could interrupt the service delivery of an asset, either through natural or man-made processes.

Appendix B

TM3 – State of the Infrastructure

AECOM Imagine it. Delivered.

Public Utilities Commission of the City of Sault Ste. Marie

Drinking Water System Asset Management Plan

Technical Memo #3A – State of the Infrastructure

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Date: July 2023

Project #: 60596267

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Revision History

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0	August 16, 2019	SS, KK	Initialize original draft
1	January 16, 2020	MS	Internal review and draft submission
2	July 14, 2020	SS, KK, MS	Final submission
3	June 12, 2023	KK	Final submission

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July 04, 2023

Project #
60596267

Dear Orlan:

Subject: Drinking Water System Asset Management Plan
Technical Memo #3A* – State of the *Infrastructure

Please find enclosed our final submission of *TM#3A – State of the Infrastructure* for the drinking water system at Sault Ste. Marie. This document has incorporated your comments and edits from draft submission.

We trust the enclosed meets your approval. Should you have any questions or require further information about our submission, please do not hesitate to contact us.

Sincerely,
AECOM Canada Ltd.

Khalid Kaddoura, PhD, PMP, PEng
Project Manager/ Senior Asset Management Consultant
khalid.kaddoura@aecom.com

Encl.
cc:

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AECOM: 2015-04-13

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Table of Contents

page

List of Figures

List of Tables

Appendices

1. Project Overview

PUC Services Inc. ("PUC") is a utility services company operating as a wholly owned private company of the Corporation of the City of Sault Ste. Marie. PUC operates a drinking water system and an electrical distribution system under service contracts between PUC and its clients. The City of Sault Ste. Marie (herein referred to as "the City") has a population of 73,368 and is projected to experience an increase in population of 9,900 by 2036 (as reported to Council in 2019). To service this population, PUC maintains a drinking water system dating back to 1916. Today, PUC supplies drinking water from both surface water and groundwater using a combination of surface water intakes and pumps, a surface water treatment plant, 6 wells, two reservoirs, and 445 kilometers of watermains.

PUC is charged with maintaining and renewing a diverse portfolio of mixed vintage infrastructure within the bounds of available funding levels. With a variety of water sources, PUC desires to align its future investments in drinking water sources, storage, and treatment facilities with growth projections while ensuring that a high quality of drinking water is provided. As well, PUC recognizes the challenges in drinking water distribution. Unlike wastewater and/or stormwater collection systems, pressurized watermains are often operationally and cost prohibitive to inspect, resulting in many municipalities possessing limited condition information, and in many cases managing them in a reactive fashion.

With the inception of *Ontario Regulation 588/17*, PUC faces an upcoming series of regulatory requirements for asset management systems that align with ongoing PUC and City initiatives to update the Financial Plan, develop a Drinking Water Master Plan, and update the City's Official Plan. Recognizing the alignment of these goals with asset management, PUC has engaged AECOM to develop a Drinking Water System Asset Management Plan. The project deliverables will provide PUC with a roadmap for establishing its asset management system and include:

1. A review of asset data and data management practices to evaluate requirements for the proposed asset management system.
2. The creation of an Asset Management Policy to serve as the top-down guidance document that defines the components of the asset management system.
3. An analysis of the State of the Infrastructure using a combination of desktop and field assessments to develop risk profiles and identify further condition assessment activities for large assets.
4. Development of PUC's current and proposed Levels of Service.
5. The consolidation of plans and projects required to achieve the objectives of the asset management system into an Asset Management Strategy.
6. The development of a Financial Strategy to evaluate the requirements for sustainably funding the asset management system, to propose funding models for meeting the needs of the system, and to support the update of PUC's Financial Plan.

1.1 This Report

Defining the State of the Infrastructure can be an exhaustive process when done for the first time. It involves quantifying the assets owned by PUC, examining their age, replacement value, and characteristics such as material type. The characteristics of PUC's asset portfolio will have implications for how assets are maintained, the upcoming cycles of replacement that may be required, and the potential risk exposure of the assets as it relates to these observations.

Accomplishing these objectives for a treatment and distribution system will produce a significant amount of documentation. As such, the decision was made to separate *Technical Memo #3* into two documents. The State of the Infrastructure was organized as follows (**Table 1**):

Table 1: Report Structure

Report Name	Objectives
Technical Memo #3A – State of the Infrastructure (This Report)	▪ Define asset quantities, age, and replacement value. ▪ Examine condition where information is available.
Technical Memo #3B – Risk	▪ Introduce concepts of risk assessment and risk management. ▪ Conduct consequence of failure and risk assessments ▪ Present the results of the assessments.

As Technical Memo #3A, this report will examine the asset inventory to establish the baseline for subsequent reports.

2. Background

2.1 What is the State of the Infrastructure?

The asset management planning process involves answering a series of basic questions that provide the "bottom-up" requirements for maintaining the inventory, and therefore the State of the Infrastructure. Ultimately, each asset portfolio is unique to the organization, and its characteristics will set a baseline for the potential renewal requirements. With a State of the Infrastructure established, PUC can then begin to make "top-down" decisions about how to manage the assets at a given Level of Service and risk tolerance. Without a State of the Infrastructure, an organization will not have the adequate information needed to make major asset management decisions.

Typically, a State of the Infrastructure report should (at a minimum) establish the quantities, replacement value, age, and condition of the assets based on the available information. The *Drinking Water Asset Management Plan* will go a step further by considering risk, and other portfolio characteristics. The typical process for examining the State of the Infrastructure is summarized as follows (**Figure 1**):

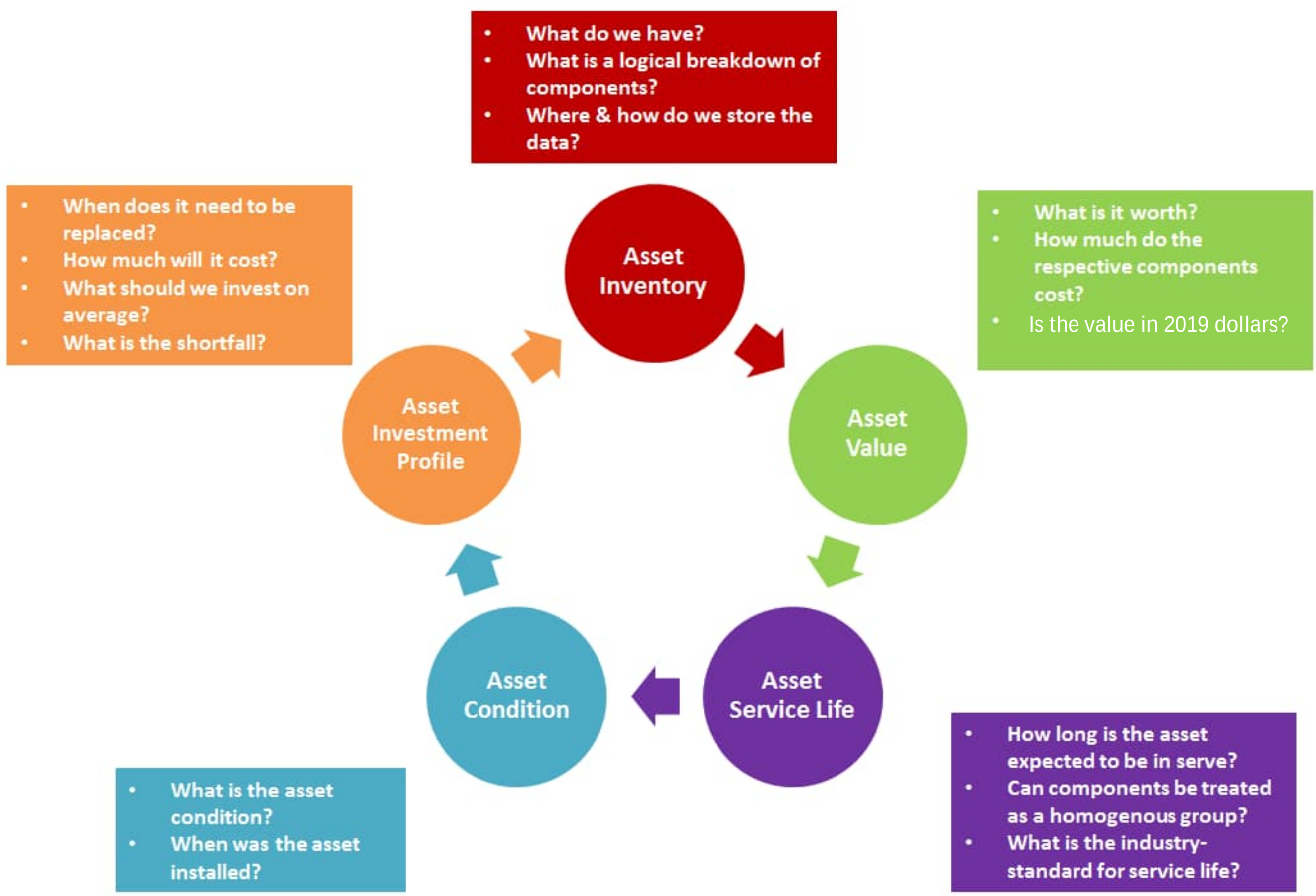


Figure 1: State of the Infrastructure Approach

The approach provided within **Figure 1** was originally developed by the National Research Council of Canada (NRC) and popularized by the National Guide to Sustainable Municipal Infrastructure's ("InfraGuide") best practice on Managing Infrastructure Assets.

2.2 Ontario Regulation 588/17 - Asset Management Planning for Municipal Infrastructure

Asset management planning is an excellent practice that PUC has historically performed (without the formalized structure provided by the *Drinking Water Asset Management Plan*). It is also a requirement of *O.Reg. 588/17*, as was introduced during *TM #1 (Background Review)* and *TM #2 (Asset Management Policy)*.

While there are many reasons for building an asset management plan, *O.Reg. 588/17* sets out the requirements for an asset management plan with a July 1, 2021 deadline. *Technical Memo #3A – State of the Infrastructure* begins the process of meeting the requirements. See how the *Drinking Water Asset Management Plan* is mapped to these requirements in **Table 2**.

Table 2: Summary of O.Reg. 588/17, 2021 Requirements

Requirement	Drinking Water Asset Management Plan
▪ **The current Level of Service being provided.**	▪ Technical Memo #4 – Levels of Service
▪ **The current performance of each asset category, based in measures established by the municipality.**	▪ Technical Memo #4 – Levels of Service
▪ **A summary of the assets, replacement cost, age, condition.**	▪ Technical Memo #3A -State of the Infrastructure (this report)
▪ **Lifecycle activities that need to be undertaken to maintain the current Level of Service over 10 years.**	▪ Technical Memo #3A -State of the Infrastructure (this report) ▪ Technical Memo #5 – Asset Management Strategy
▪ **Population and employment forecasts set out in the Official Plan.**	▪ Technical Memo #6 – Financing Strategy
▪ **Capital and operating expenditures required to maintain the current Level of Service, including those needed to accommodate growth or upgrades to existing infrastructure.**	▪ Technical Memo #5 – Asset Management Strategy ▪ Technical Memo #6 – Financing Strategy

From **Table 2**, a few observations can be made:

- This report will help PUC to achieve its regulatory objectives
- Data from the State of the Infrastructure report will feed directly into the way PUC will achieve other regulatory objectives

Regulatory requirements are important to highlight as one basis for the *Drinking Water Asset Management Plan*. More broadly, there are also common themes among Canadian infrastructure owners that create the need for a State of the Infrastructure report.

2.3 Replacing Aging Infrastructure Assets

In the developed world in general and North America in particular, the period following World War II saw a considerable investment in infrastructure to support growing populations and the accompanying economic development. Here in Canada, the 1960s, 1970s, early 1990s and 2000s were periods of economic growth and rapid development, as evinced by the large amount of infrastructure added to city and town inventories over those periods. However, no infrastructure lasts forever, and these cities are starting to see the increasing need to reinvest in their infrastructure to avoid loss of service and even catastrophic failure. In fact, it is precisely the large inventories of infrastructure built since the 1950s that are now starting to require replacement, as shown in **Figure 2**:

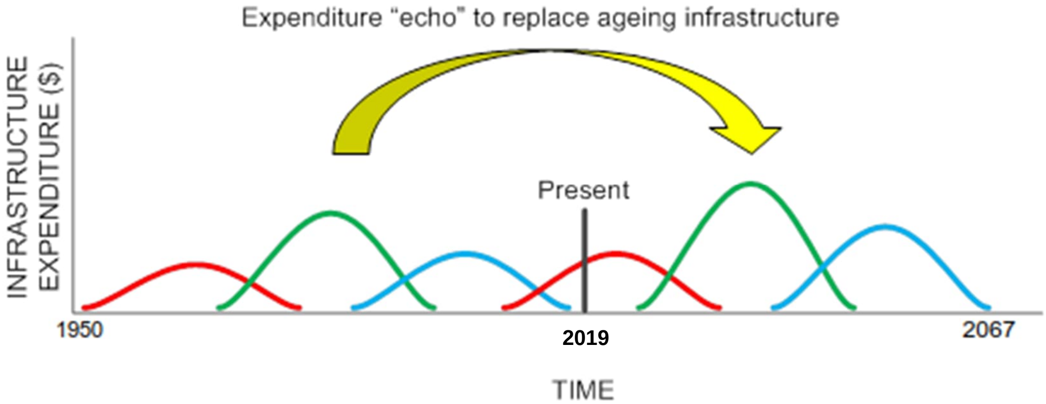


Figure 2: The Expenditure "Echo" to Replace Aging Infrastructure Assets

The preceding diagram might be an over-simplification of a very complex matter, but it serves to reveal several key points:

1. All infrastructure assets have a finite life.
2. Different types of infrastructure have different life expectancies / expected service lives. For example, water mains are expected to last in the order of 80 years before replacement is needed, whereas a pump might last between 15 and 20 years prior to refurbishment.
3. Depending on the installation date, infrastructure assets will require replacement sometime in the future predicated by its expected service life. From there the "expenditure echo" shown in the diagram.
4. The particular" mix" of infrastructure assets in need of replacement in any given year will depend on the installation date and expected service life of the respective assets.
5. A sustainable funding level could in theory be determined through a detailed review of infrastructure inventory, replacement value, condition, expected service life and investment profiling.

As such, sustainable infrastructure funding is defined as the level of funding required to sustain assets in such a manner that meet present infrastructure needs without compromising the ability of future generations to meet their infrastructure needs. Ultimately, the State of the Infrastructure should establish how the principles embodied in **Figure 2** will apply to PUC. This has been accomplished for both distribution and facility systems.

2.4 Scope

As implied by the *Introduction*, PUC Services Inc. (PUC) is the operating authority and has the role of managing, operating and maintaining a large number of assets that comprise a source intake (includes both groundwater and surface water), a treatment facility, and a distribution system. PUC uses the drinking water system to serve a population of approximately 74,000 residents via approximately 25,000 service connections. This drinking water system serves as the scope for the State of the Infrastructure report, as pictured within **Figure 3**. Quantities and locations will be reviewed in further detail in subsequent sections.

From the scope of the system, assets can largely be categorized as facilities (e.g. treatment, production, etc.) or distribution. These assets will show different approaches to defining the State of the Infrastructure. To reflect this, the report has been divided into sections for facilities (**Section 3**) and distribution (**Section 4**).

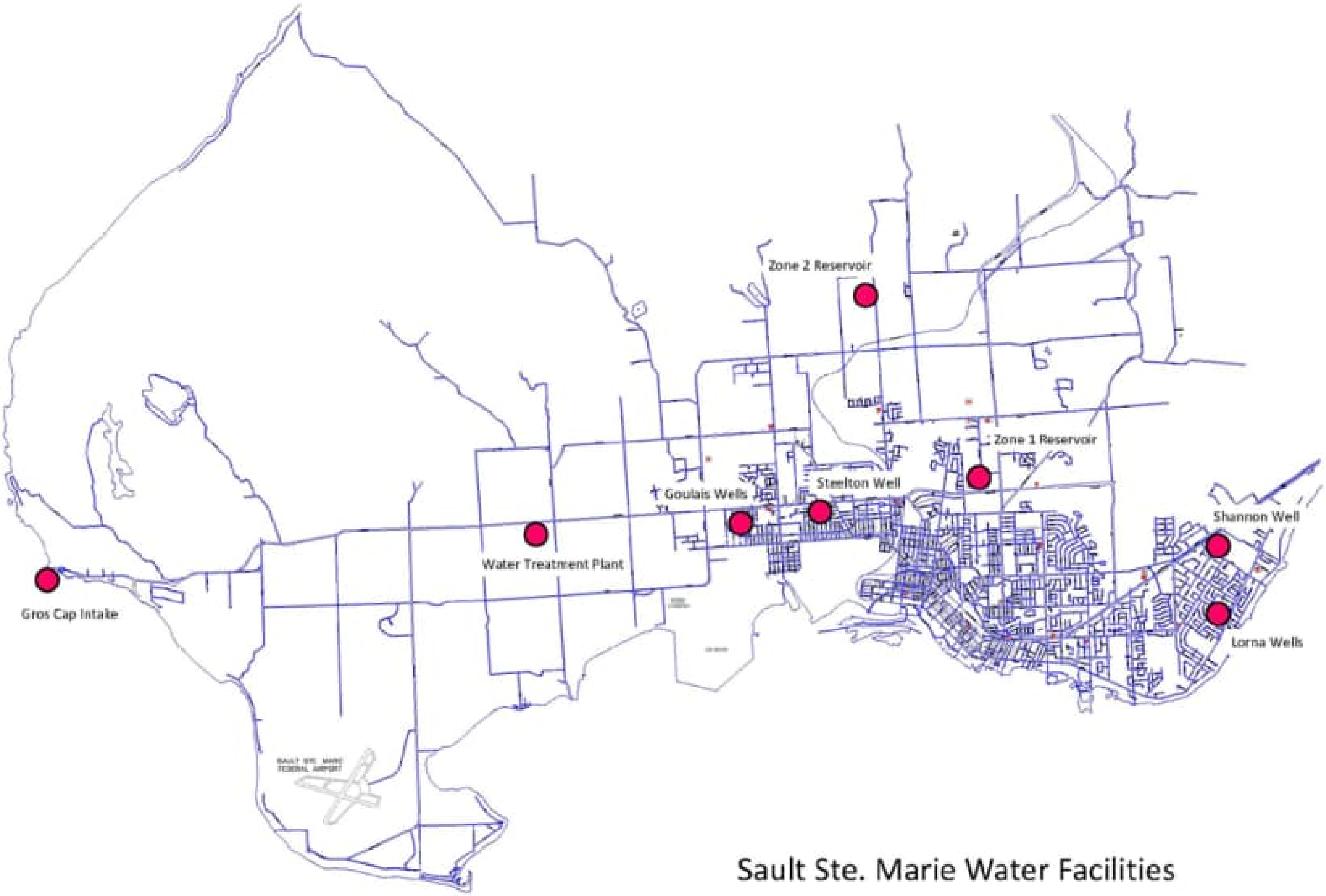


Figure 3: Map of the Drinking Water System

3. State of Drinking Water Facility Infrastructure

Establishing the State of the Infrastructure for facility assets will be accomplished by fulfilling the following objectives:

- The assets owned by PUC will be quantified.
- The age and condition will be documented
- The replacement value will be defined.
- Gaps in data and next steps will be highlighted

3.1 Facilities Overview

The Sault Ste. Marie Drinking Water System consists of surface water and groundwater supplies. Groundwater is supplied from six (6) deep wells in four (4) pumping stations located at the Steelton Pump Station, Goulais Pump Station, Shannon Pump Station and Lorna Pump Station.

Surface water is drawn from Lake Superior at Gros Cap Booster Pumping Station. The intake structure installed 15 meters below the water level surface is connected to the Raw Water Booster Pumping Station by 830 meters of 1200 mm diameter polyethylene (PE) pipe. The raw water from Lake Superior is pumped from Gros Cap to the twin control tanks on Marshall Drive and then flows by gravity through a 750 mm diameter concrete watermain to the Water Treatment Plant (filtration plant).

The direct filtration plant consists of chemically assisted coagulation, flocculation and dual media filtration and no sedimentation process. In addition to this chemically assisted filtration, the treatment plant process also includes pH adjustment to match other water supply sources, corrosion control (blended phosphates added to mitigate lead and iron corrosion) and disinfection. The plant is located on the south side of Second Line between Town Line Road and Carpin Beach Road immediately east of the Little Carp River.

The WTP has a rated capacity of 40,000 m3/day as per the Drinking Water Works Permit (DWWP) issued by the Ministry under the Safe Drinking Water Act. The firm capacity of the high lift pumping station at the WTP is in the range of 46,000 to 51,000 m3/day (i.e. the treatment train within the WTP is the capacity constraint).

Water is stored within in-ground reservoirs at three (3) locations as follows:

1. Water treatment plant in the west end of the City
2. PZ1 reservoir in the central portion of the City; and
3. PZ2 reservoir in the northern end of the City

Treated water storage at the water treatment plant forms part of the disinfection process and is not available as system storage. A schematic diagram illustrating the principle system components is included as **Figure 4**.

3.2 Methodology

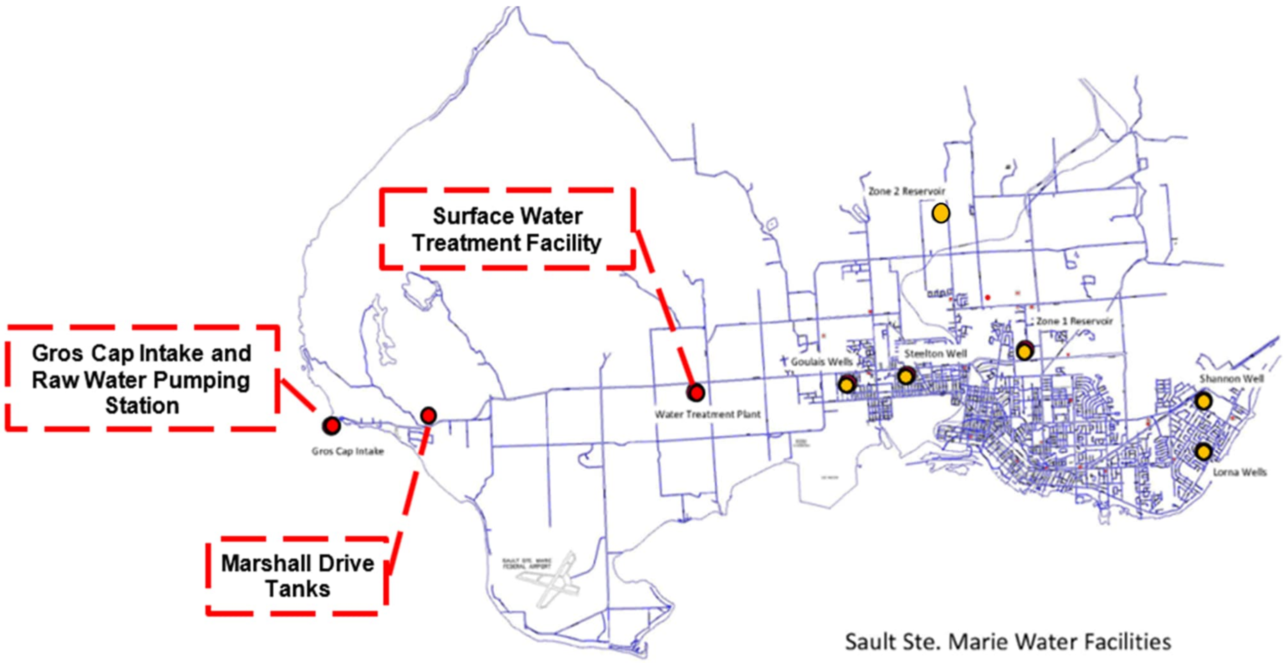
The State of the Infrastructure report is a desktop analysis based on PUC's asset data. The suitability of PUC's asset data for analysis was examined during *TM #1:Background Information Review and Gap Analysis*. This report produced key observations for facilities:

1. PUC has a facilities asset register, but it is not well maintained. All facilities have gaps with varying orders of magnitude.
2. Core asset attributes such as install year are missing for a significant number of assets.
3. All facilities have gaps, but the surface water treatment facility was identified as the largest priority and the best opportunity to address data gaps through investigation.

PUC indicated that there was a significant gap in the knowledge of condition of the water treatment plant assets when compared to other facilities. Groundwater wells are inspected every 5-7 years and reservoirs would have limited actual condition assessment as they are hard to drain. Thus, for this study, the inventory and condition assessment exercises were limited to only vertical assets located at the surface water treatment facilities listed below (**Figure 4**):

1. Gros Cap Raw Water Pumping Station
2. Marshall Drive Tanks
3. Surface Water Treatment Plant

From July 16 -19 2019, AECOM staff visited PUC and completed a facility inventory and visual condition assessment. The outcome of this process was a detailed asset register with condition data for a select number of assets.



● Surface Water Treatment Facilities ● Ground Water Treatment Facilities & Reservoirs

Figure 4: Municipal Water Facilities

3.2.1 Asset Inventory

As discussed in Appendix A, at each facility, the asset inventory and condition assessment were limited to process mechanical, process electrical, and process structural assets. For each asset, the scope of the inspection included:

- Inventory and visual, non-destructive, physical condition assessment.
- Categorize the asset within an asset hierarchy
- Determine the current condition grade using a rate scale
- Confirm installation year (using field verification or discussion with PUC staff).

An asset inventory is provided in a tabular format within **Appendix A**. All documentation of the exercise include methodology, results, and inspection records can be viewed in report format in **Appendix B**.

Appendix B may be read as a stand-alone document but should be understood as a significant contribution to the State of the Infrastructure.

3.2.2 Asset Hierarchy

Implementing a well thought out and well-constructed hierarchy of asset classifications (or "asset hierarchy") is one of the most important steps in building an effective asset management program. The asset hierarchy structure is already being used by PUC to organize assets. Typically, a hierarchy will accomplish the following:

- An asset hierarchy provides both context and organization to the information recorded in the asset registry. The asset hierarchy is the fundamental building block for asset life-cycle management.
- The asset registry records every asset with a unique identification tag ("number") along with certain asset attributes and other-asset related information. The asset registry serves as the main repository

of information about assets as they are acquired, used, inspected, maintained, replaced and retired. The way in which assets are classified will assist users in assessing groups of related assets in addition to individual assets.

- In the context of drinking water facilities, a hierarchy is necessary to distinguish assets by their facility type, drinking water process, and asset category.

Figure 5 illustrates the levels of asset hierarchy captured for this study. Assets at the equipment component level would include consumable items that are typically replaced through a preventive maintenance program and are often funded out of the operations and maintenance budget. Thus, the asset hierarchy was not broken down to an asset component level.

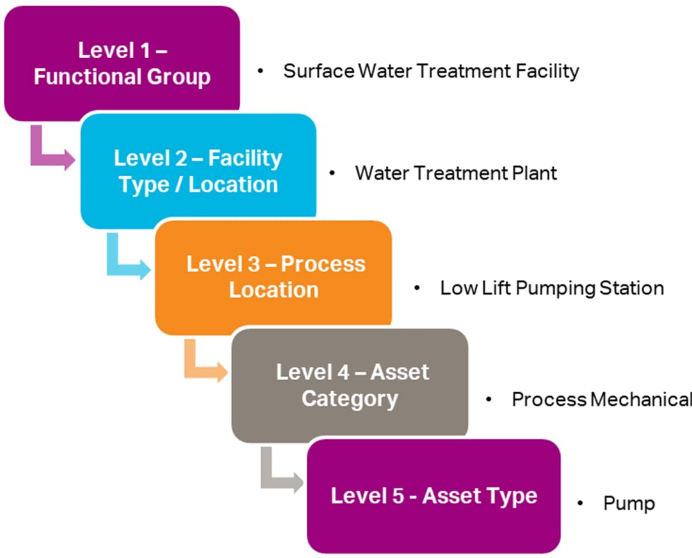


Figure 5: Asset Hierarchy Levels

3.2.3 Asset Age and Useful Life

For assets, age information should document the data of installation and any subsequent milestones in the asset lifecycle (e.g. major refurbishment, decommissioning). This information has been documented within the asset inventory and is a key input in determining the state of the infrastructure (based on the concepts of aging infrastructure introduced in **Section 2**).

Typically, asset age is based on the date it was installed. This is considered the minimum requirement for determining the State of the Infrastructure and is typically used as a representative estimate of when an asset was acquired or became operational. Using install date information should be understood as carrying a few assumptions:

1. The asset was installed at the date it was recorded at. Some construction projects can span multiple years, meaning some uncertainty can be applied to the date (although the date is considered representative).
2. The asset is still part of the system and is in service. If an asset is no longer in service but not recorded as decommissioned, the asset inventory will not reflect that PUC no longer operates the asset.
3. If a lifecycle activity such as major refurbishment, upgrade or replacement has taken place but is not recorded, the install date will not reflect this improvement. These activities could extend the life of the asset beyond what is predicted based on the original install date.

Because of these assumptions, other age-related information is generally recommended as being tracked (not captured in the current asset inventory), including refurbishment/upgrade date and retirement dates.

3.2.4 Asset Condition

Condition data is not a requirement of the State of the Infrastructure report (based on *O.Reg.588/17*), although PUC is required to set out its approach to gathering asset condition data going forward. When available, condition data is desired over age-based data because it eliminates some of the uncertainties and assumptions described above. For the State of the Infrastructure report, condition data for facility assets was gathered through the asset inventory and visual condition assessment exercise.

The assessment of the condition of large process mechanical, electrical and structural assets at the surface water treatment facilities were completed through visual non-destructive inspections by AECOM staff members in conjunction with PUC operations and maintenance staff. Each asset was graded in accordance with the condition rating scale as presented in **Table 3**.

Table 3: Condition Rating Scale

Grade	Level	Description
1	Very Good	New equipment or structure, no visible deficiencies or defects. Operable and well-maintained. Only normal scheduled maintenance required.
2	Good	Well-maintained with minor repairs needed. Operates at optimal conditions.
3	Fair	Functionally sound, but appearance significantly affected by deterioration. More minor repairs and infrequent major repairs required, or structure is marginal in its capacity to prevent leakage.
4	Poor	Deterioration has a significant effect on performance of asset due to leakage or other structural problems. Equipment is operating but defects are beginning to affect its performance. Significant repairs or likely replacement required within 2 years.
5	Very Poor	Major repair or replacement required in short-term. Equipment is no longer functioning or is a safety hazard. Unit needs a large overhaul repair or entire replacement to operate at ideal and safe conditions.

Refer to **Appendix B** – Condition Assessment Report for Surface Water Treatment Facility Assets for additional information regarding the condition assessment process and findings.

3.2.5 Expected Service Life (ESL) and Remaining Useful Life of Assets (RUL)

The expected service life (ESL) is defined as the period over which an asset is actually available for use and able to provide the required level of service at an acceptable risk; e.g., without unforeseen costs of disruption for maintenance and repair. There are different theoretical modelling tools used in the industry for predicting when an asset will fail or no longer provide useful service. For this assignment, AECOM applied a constant ESL for each asset type based on industry standards. In reality, different assets will deteriorate at different rates, however, it is important to keep in mind the level of effort required to predict failure compared with the asset value. More sophisticated deterioration modelling may be warranted for very high value assets, whilst the cost of deterioration modeling for low-value assets may very well exceed the replacement cost of the asset. The actual service life can vary significantly from the ESL. In some instances, a variation in expected vs. actual service life was evident due to the following factors:

- **Operating conditions and demands:** Some equipment is operated intermittently or even infrequently or is being operated a lower demand than its design capacity, thus the actual operating "age" of the asset is reduced.
- **Environment:** Some equipment is exposed to very aggressive environmental conditions (e.g., corrosive chemicals), while other assets are in relatively benign conditions, thus the deterioration of assets is affected differently.
- **Maintenance:** Equipment is maintained through refurbishment or replacement of components, which prolongs the service life of the asset.
- **Technological Obsolescence:** Some assets can theoretically be maintained indefinitely, although considerations such as maintenance cost, energy inefficiency and new technologies are likely to render this approach uneconomical.

The remaining useful life of an asset was calculated by deducting ESL from asset age (Refer **Equation 1** below).

$$\boldsymbol{RUL = ESL - Asset\ Age} \qquad 1$$

A high-level listing of some of the ESLs used for this assignment are provided in **Table 4**, based on actual ESLs experienced in the field.

Table 4: Estimated Service Life (ESL) of Assets

Asset Type	ESL	Asset Type	ESL
Process Mechanical		**Process Electrical**	
Compressor	20	Actuator	25
Filter	20	Breaker	20
Gate	20	Control Panel	25
Gearbox	20	Disconnect	25
Injector	20	Engine	20
Mixer	40	Feeder	30
Pressure Vessel	20	Generator	35
Pump	20	MCC	30
Regulator	20	Motor	20
Screen	25	Starter	30
Valve	35	Transformer	25
		UV Treatment	30
		Solenoid Valve	35
		Process Structural	
		Chemical Tanks	30
		Hopper	30
		Tanks / Basins	60

3.2.6 Asset Valuation

The replacement valuation for all PUC facilities assets is based on the following assumptions:

- Replacement Value: Represents the cost in 2019 dollars to completely replace all the assets to a new condition with a current / similar model of equipment / asset, as applicable. The Replacement Cost would be applicable if PUC were to purchase a similar asset that is currently installed (i.e., a pump) and install it in place of the existing asset.

- Replacement costs may be assigned to each asset based on historical cost data from previous projects, budget quotations from equipment suppliers, costs taken from recent construction projects at other water facilities and other similar projects.
  - Mechanical assets included freight to site and installation (materials, and modest time and labour costs).
  - Major electrical assets did not include the cost of installation as parts of the electrical assets would generally be replaced as part of a larger capital project, as per the assumptions from previous studies on the sewer system.
  - Structural assets were estimated based on unit construction cost estimates.
- Raw replacement values do not include site costs, demolition, or land acquisition. To account for overhead, the markups shown in **Table 5** were applied to calculate replacement costs.

Table 5: Cost Markups

Type of Markup	Percentage
Contingency	25%
Engineering + Project Management	12% + 8%
Total	**45%**

Costs considered in this assignment are prepared in the form of "Estimate Class" as per the Association for the Advancement of Cost Engineering (AACE) International Recommended Practice No 18R-97 for Cost Estimate Classification (**Table 6**). Based on this standard, cost estimates developed for this taskof the project shall be classified between 4 and 5, having an expected accuracy of +/- 50%, and suitable forconceptual cost screening.

Table 6: AACE International Recommended Practice No. 18R-97 for Cost Estimate Classification

	Primary Characteristic	*Secondary Characteristic*		
ESTIMATE CLASS	**MATURITY LEVEL OF PROJECT DEFINITION DELIVERABLES** Expressed as % of complete definition	**END USAGE** Typical purpose of estimate	**METHODOLOGY** Typical estimating method	**EXPECTED ACCURACY RANGE** Typical variation in low and high ranges [a]
Class 5	0% to 2%	Concept screening	Capacity factored, parametric models, judgment, or analogy	L: -20% to -50% H: +30% to +100%
Class 4	1% to 15%	Study or feasibility	Equipment factored or parametric models	L: -15% to -30% H: +20% to +50%
Class 3	10% to 40%	Budget authorization or control	Semi-detailed unit costs with assembly level line items	L: -10% to -20% H: +10% to +30%
Class 2	30% to 75%	Control or bid/tender	Detailed unit cost with forced detailed take-off	L: -5% to -15% H: +5% to +20%
Class 1	65% to 100%	Check estimate or bid/tender	Detailed unit cost with detailed take-off	L: -3% to -10% H: +3% to +15%

3.3 Results

3.3.1 Introduction

Using the methods outlined in **Section 3.2**, the results of establishing the State of the Infrastructure can be summarized as follows. As stated previously, several of the provided asset summaries can be used to show compliance with *O.Reg. 588/17* and will be shown at a high level within the final *Drinking Water Asset Management Plan*. The discussions that accompany each section will make observations about the State of the Infrastructure that can be used to begin devising asset management strategies (*TM #5*).

3.3.1.1 Data Gaps

Before showing the results, it should be made clear that results are based on current information, the state of which was documented during *TM #1*. As made clear in previous sections, this was remediated in part by a Facility Inventory and Condition Assessment of several PUC facilities. Data gaps remain for the other PUC facilities.

3.3.2 Asset Inventory

A total of 410 assets were recorded during the asset inventory and condition assessment exercise. Please refer **Appendix A** for a complete registry of assets recorded.

3.3.2.1 Asset Hierarchy Level

Table 7 provides a detailed breakdown of the assets recorded based on Asset Hierarchy Level 2 (Facility Location) and Level 3 (Process location). From the table it can be observed that 85% of the assets recorded were located at the Surface Water Treatment Plant. In the surface water treatment plant, the greatest number of assets (99) were recorded at the Pipe Gallery (Basement) followed by High Lift Pumping Station (75).

Table 7: Breakdown of Assets Based on Level 2 (Facility Location) & Level 3 (Process Location) Asset Hierarchy Levels

Level 2 & Level 3 Asset Hierarchy Levels	Count
Gros Cap Raw Water Pumping Station	**68**
▪ Pump Room	68
Surface Water Treatment Plant	**342**
▪ Motor Control Centre #1 (M)	3
▪ Chemical Facilities (M) - Blended Phosphate	4
▪ Chemical Facilities (M) - Alum	7
▪ Chemical Facilities (M) - Cl2 Gas	8
▪ Motor Control Centre #2 (M)	8
▪ Pressure Reducing Station	19
▪ Flocculation & Filter Chambers	28
▪ Pipe Gallery (Main Floor)	38
▪ Low Lift Pumping Station	53
▪ High Lift Pumping Station	75
▪ Pipe Gallery (Basement)	99
Grand Total	**410**

Figure 6 provides a detailed breakdown of the assets recorded based on Asset Hierarchy Level 2 (Facility Location) and Level 4 (Asset Category). From the figure it can be observed that ~62% of assets belonged to the Process Mechanical category followed by Process Electrical at ~34%.

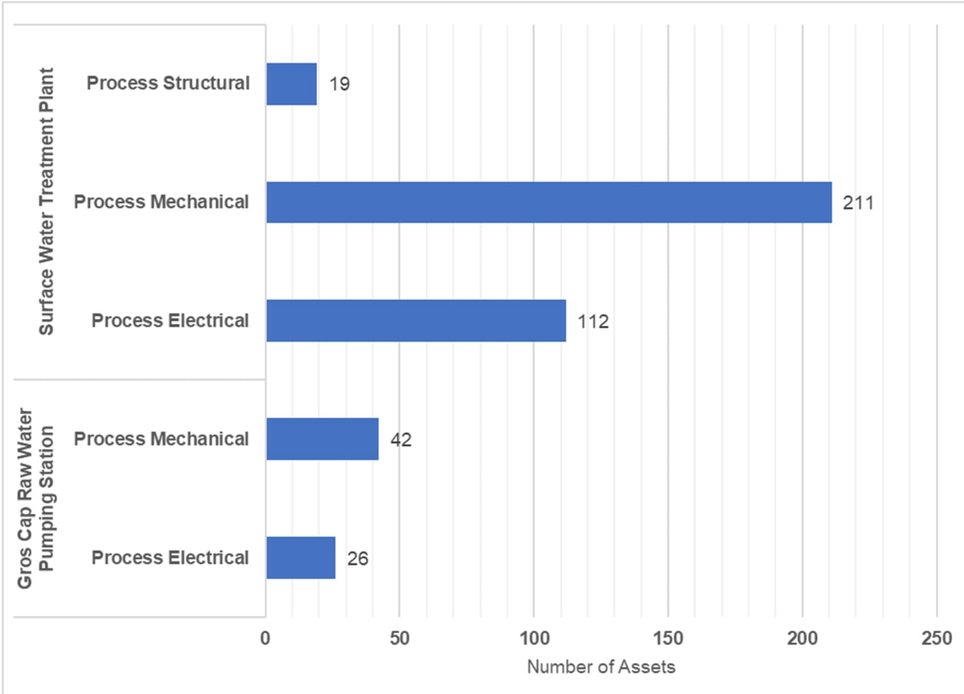


Figure 6: Breakdown of Assets Based on Level 2 (Facility Location) & Level 4 (Asset Category) Hierarchy Levels

Table 8 provides a breakdown of assets recorded based on Asset Hierarchy Level 5 (Asset Type). From the table it can be observed that 71% of the Process Mechanical assets were Valves, 35% of Process Electrical assets were Motors and 90% of Process Structural assets were Tanks / Basins.

Table 8: Breakdown of Assets Recorded Based on Level 4 (Asset Category) & Level 5 (Asset Type) Hierarchy Levels

Level 4 & Level 5 Asset Hierarchy	Count	Level 4 & Level 5 Asset Hierarchy	Count
Process Mechanical	**253**	**Process Electrical**	**139**
Compressor	3	Actuator	28
Filter	1	Breaker	3
Gate	8	Control Panel	2
Gearbox	2	Disconnect	18
Injector	6	Engine	1
Mixer	8	Feeder	1
Pressure Vessel	6	Generator	1
Pump	37	MCC	1
Regulator	1	Motor	48
Screen	2	Starter	25
Valve	178	Transformer	3
		UV Treatment	4
		Valve	4
		Process Structural	**19**
		Chemical Tanks	1
		Hopper	1
		Tanks / Basins	17

3.3.3 Asset Age and Useful Life

3.3.3.1 Installation Year

Figure 7 provides a breakdown of assets based on Installation Year. As demonstrated in the figure, most of the assets were installed in 1986 at Surface Water Treatment Plan (80%) and 1983 at Gros Cap Raw Water Pumping Station (98%) which mimics the timeline of when both facilities were commissioned.

Few assets were recorded with an installation year later than 1983 at Gros Cap. At surface water treatment plant, 20% of assets recorded were installed after 1986. Of these, most assets were installed in 2015 (27) followed by 10 assets installed in 2018.

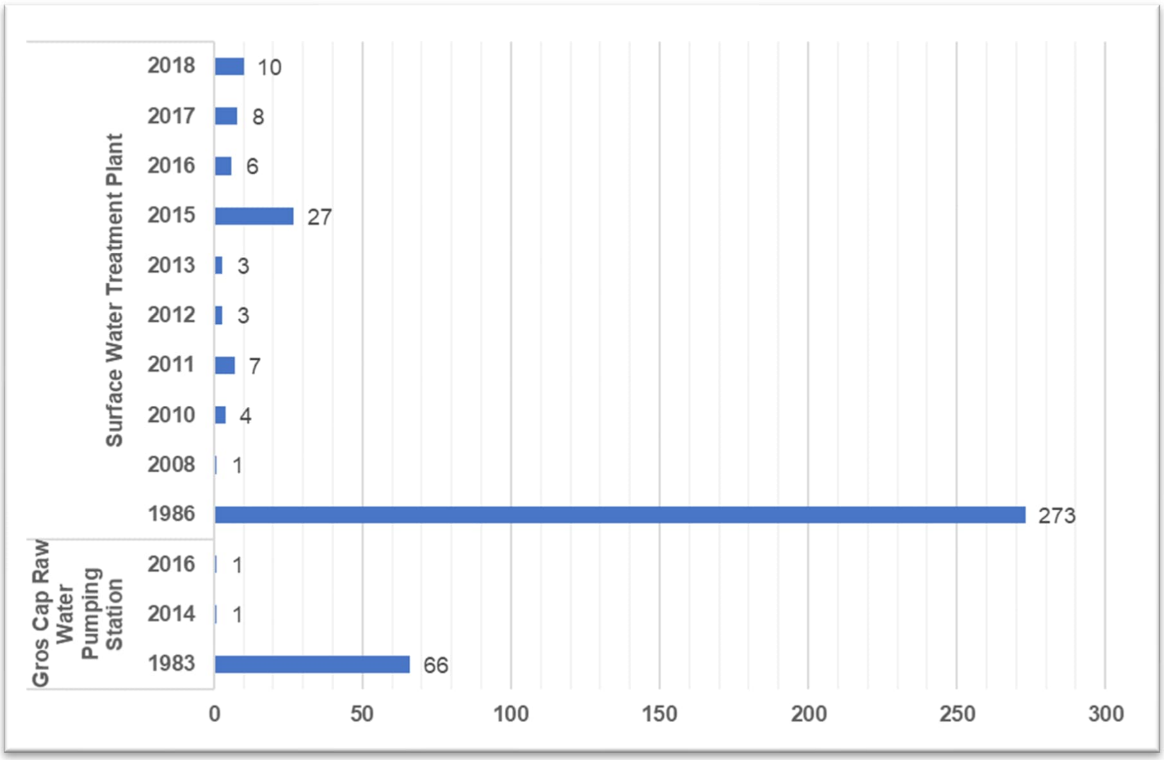


Figure 7: Breakdown of Assets based on Install Year

Table 9 provides a breakdown of assets based on ESL. It can be observed that most assets have an ESL of 35 years (45%) and 20 years (28%). This is because the majority of assets captured during this inventory exercise includes valves (44%) which have an ESL of 35 years and other process mechanical assets which have an ESL of 20 years.

Table 9: Breakdown of Assets Based on Estimated Service Life (ESL)

ESL	No. of Assets
20	116
25	53
30	33
35	183
40	8
60	17
Grand Total	**410**

Table 10 provides a breakdown of assets based on RUL calculated by deducting ESL from asset age. Of the 410 assets, 181 (44%) were observed to be past their ESL. Most of these assets are beyond the ESL are original construction, i.e., 1983 - 1986. Of the 181 assets, 50% are past ESL by more than 10 years. However, certain components of some of these assets have been refurbished over the years. Of the remaining 229 assets, 134 (56%) had less than one year of remaining useful life which are also part of original construction.

Additional condition assessment including performance evaluation is required to develop a comprehensive replacement and rehabilitation plan for a majority of the assets assessed as a part of this project.

Table 10: Breakdown of Assets Based on Remaining Useful Life (RUL)

RUL	No. of Assets
Past ESL	181
1	134
6	8
10	1
11	6
12	1
13	1
15	22
16	6
18	3
21	1
23	1
25	5
26	16
27	6
28	3
29	1
32	4
33	4
55	3
58	3
Grand Total	**410**

3.3.4 Asset Condition

Of the 410 assets recorded at both the facilities during the ICA exercise, 71% of the assets were observed to be in *2-Good* condition followed by 18% which were observed to be in *3-Fair* condition. Only 5 assets were observed to be in *4-Poor* condition and 1 asset in *5-Very Poor* condition.

Figure 8 provides a breakdown of assets based on facility. It can be observed that all assets at Gros Cap Raw Water Pumping Station had a score of *3-Fair* or lower with most of the assets with a score of *2-Good*. None of the assets at Gros Cap were observed to be in *4-Poor* or *5-Very Poor* condition. The only assets with a score of *4-Poor* or worse were observed at the Surface Water Treatment Plant.

Assets with a score of *4-Poor* and *5-Very Poor* are discussed in detail in **Appendix B – Condition Assessment Report.**

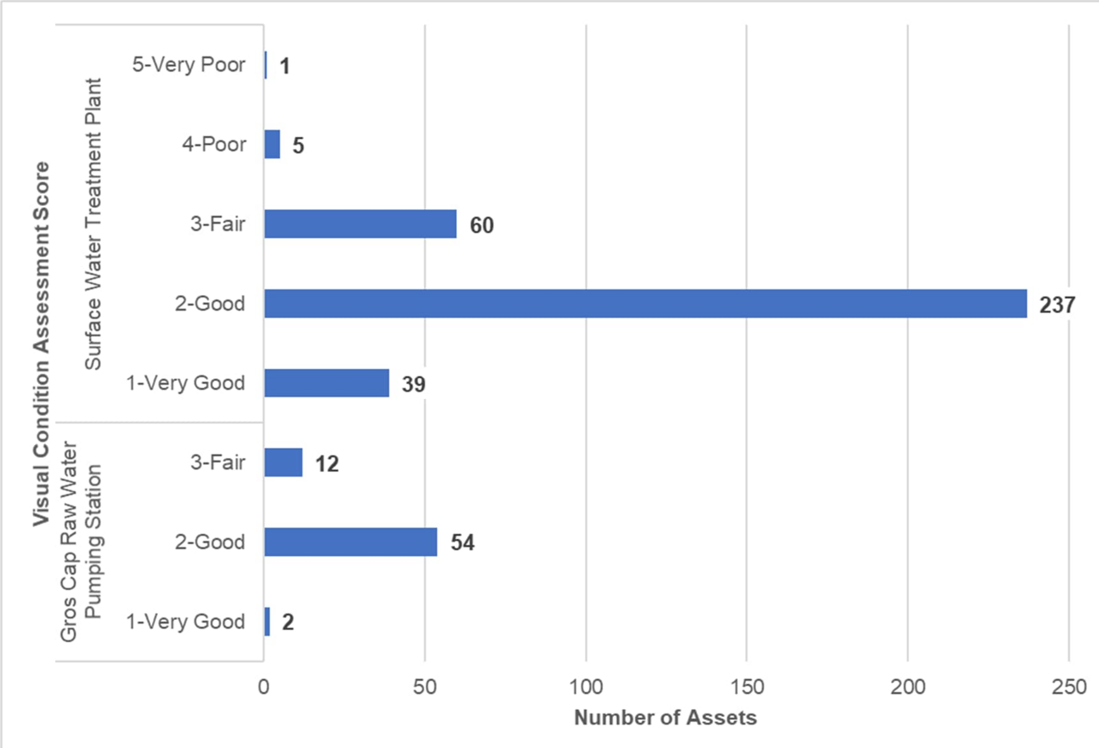


Figure 8: Breakdown of Visual Condition Assessment Score

From **Table 11**, it can be observed that all assets with a score of *4-Poor* and *5-Very Poor* are original construction (circa 1986). Most assets installed in the past decade (2008 and later) were observed to be in *1-Very Good* to *2-Good* condition.

Table 11: Breakdown of Visual Condition Assessment Scores Based on Install Year

Install Year	1-Very Good	2-Good	3-Fair	4-Poor	5-Very Poor	Grand Total
1983	2	52	12	-	-	**66**
1986	19	189	59	5	1	**273**
2008	-	-	1	-	-	**1**
2010	-	4	-	-	-	**4**
2011	1	6	-	-	-	**7**
2012	3	-	-	-	-	**3**
2013	2	1	-	-	-	**3**
2014	-	1	-	-	-	**1**
2015	4	23	-	-	-	**27**
2016	6	1	-	-	-	**7**
2017	-	8	-	-	-	**8**
2018	4	6	-	-	-	**10**
Grand Total	**41**	**288**	**75**	**5**	**1**	**410**

From **Table 12** the following can be observed:

1. Of the 5 assets in *4-Poor* condition, 3 were in Pipe Gallery (Main Floor) and 2 in Pipe Gallery (Basement). The only asset with a score of *5-Very Poor* was in Pipe Gallery (Basement).
2. All assets with a condition score of *4-Poor* or more were Process Mechanical.
3. All 5 assets with a score of *4-Poor* are Valves and the asset with a score of *5-Very Poor* is a Pump.
4. The asset types observed to be *3-Fair* included actuators, mixers, motors, pump, starter and valve. The majority of these assets (65%) were valves which formed 26% of the total valves captured.

Table 12: Surface Water Facilities Asset Condition Data

Asset Hierarchy				Visual Condition Score					
Level 2 – Facility Type / Location	**Level 3 – Process Location**	**Level 4 – Asset Category**	**Level 5 (Asset Type)**	**1- Very Good**	**2- Good**	**3- Fair**	**4- Poor**	**5- Very Poor**	**Grand Total**
Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Actuator	-	6	-	-	-	6
			Control Panel	-	2	-	-	-	2
			Disconnect	-	5	-	-	-	5
			Motor	2	6	2	-	-	10
			Starter	-	1	3	-	-	4
		Process Electrical Total		**2**	**20**	**5**	**-**	**-**	**27**
		Process Mechanical	Compressor	-	2	-	-	-	2
			Pressure Vessel	-	4	-	-	-	4
			Pump	-	2	2	-	-	4
			Screen	-	2	-	-	-	2
			Valve	-	24	5	-	-	29
		Process Mechanical Total		**-**	**34**	**7**	**-**	**-**	**41**
	Pump Room Total			**2**	**54**	**12**	**-**	**-**	**68**
Gros Cap Raw Water Pumping Station Total				**2**	**54**	**12**	**-**	**-**	**68**
Surface Water Treatment Plant	Chemical Facilities (M) - Alum	Process Electrical	Transformer	-	1	-	-	-	1
		Process Electrical Total		**-**	**1**	**-**	**-**	**-**	**1**
		Process Mechanical	Pump	-	3	-	-	-	3
		Process Mechanical Total		**-**	**3**	**-**	**-**	**-**	**3**
		Process Structural	Tanks / Basins	-	3	-	-	-	3
		Process Structural Total		**-**	**3**	**-**	**-**	**-**	**3**
	Chemical Facilities (M) - Alum Total			**-**	**7**	**-**	**-**	**-**	**7**
	Chemical Facilities (M) - Blended Phosphate	Process Mechanical	Pump	-	2	-	-	-	2
		Process Mechanical Total		**-**	**2**	**-**	**-**	**-**	**2**
		Process Structural	Tanks / Basins	-	2	-	-	-	2
		Process Structural Total		**-**	**2**	**-**	**-**	**-**	**2**
	Chemical Facilities (M) - Blended Phosphate Total			**-**	**4**	**-**	**-**	**-**	**4**
	Chemical Facilities (M) - Cl2 Gas	Process Mechanical	Injector	6	-	-	-	-	6
			Regulator	1	-	-	-	-	1
			Valve	1	-	-	-	-	1
		Process Mechanical Total		**8**	**-**	**-**	**-**	**-**	**8**
	Chemical Facilities (M) - Cl2 Gas Total			**8**	**-**	**-**	**-**	**-**	**8**
	Flocculation & Filter Chambers	Process Electrical	Disconnect	-	4	-	-	-	4
			Motor	-	3	1	-	-	4
		Process Electrical Total		**-**	**7**	**1**	**-**	**-**	**8**
		Process Mechanical	Gate	-	8	-	-	-	8
			Mixer	-	4	-	-	-	4
		Process Mechanical Total		**-**	**12**	**-**	**-**	**-**	**12**

Asset Hierarchy				Visual Condition Score					
Level 2 – Facility Type / Location	**Level 3 – Process Location**	**Level 4 – Asset Category**	**Level 5 (Asset Type)**	**1- Very Good**	**2- Good**	**3- Fair**	**4- Poor**	**5- Very Poor**	**Grand Total**
		Process Structural	Tanks / Basins	-	8	-	-	-	8
		Process Structural Total		-	**8**	-	-	-	**8**
	Flocculation & Filter Chambers Total			-	**27**	**1**	-	-	**28**
	High Lift Pumping Station	Process Electrical	Disconnect	-	2	-	-	-	2
			Engine	-	1	-	-	-	1
			Generator	-	1	-	-	-	1
			Motor	4	17	-	-	-	21
		Process Electrical Total		**4**	**21**	-	-	-	**25**
			Compressor	1	-	-	-	-	1
			Filter	-	1	-	-	-	1
			Gearbox	-	2	-	-	-	2
			Pressure Vessel	-	2	-	-	-	2
			Pump	-	9	4	-	-	13
			Valve	3	22	-	-	-	25
		Process Mechanical Total		**4**	**36**	**4**	-	-	**44**
		Process Structural	Chemical Tanks	-	**1**	-	-	-	**1**
			Hopper	-	1	-	-	-	1
			Tanks	1	3	-	-	-	4
		Process Structural Total		**1**	**5**	-	-	-	**6**
	High Lift Pumping Station Total			**9**	**62**	**4**	-	-	**75**
	Low Lift Pumping Station	Process Electrical	Actuator	-	8	-	-	-	8
			MCC	-	1	-	-	-	1
			Motor	-	5	-	-	-	5
			Starter	-	14	-	-	-	14
		Process Electrical Total		-	**28**	**-**	-	-	**28**
		Process Mechanical	Mixer	-	1	3	-	-	4
			Pump	8	-	-	-	-	8
			Valve	4	8	1	-	-	13
		Process Mechanical Total		**12**	**9**	**4**	-	-	**25**
	Low Lift Pumping Station Total			**12**	**37**	**4**	-	-	**53**
	Motor Control Centre #1 (M)	Process Electrical	Feeder	-	1	-	-	-	1
			Starter	-	2	-	-	-	2
		Process Electrical Total		-	**3**	-	-	-	**3**
	Motor Control Centre #1 (M) Total			-	**3**	-	-	-	**3**
	Motor Control Centre #2 (M)	Process Electrical	Breaker	-	3	-	-	-	3
			Starter	-	4	1	-	-	5
		Process Electrical Total		-	**7**	1	-	-	**8**
	Motor Control Centre #2 (M) Total			-	**7**	1	-	-	**8**
		Process Electrical	Actuator	-	-	4	-	-	4

Asset Hierarchy				Visual Condition Score					
Level 2 – Facility Type / Location	**Level 3 – Process Location**	**Level 4 – Asset Category**	**Level 5 (Asset Type)**	**1- Very Good**	**2- Good**	**3- Fair**	**4- Poor**	**5- Very Poor**	**Grand Total**
	Pipe Gallery (Basement)		Disconnect	-	7	-	-	-	7
			Motor	-	5	2	-	-	7
			Transformer	-	2	-	-	-	2
			UV Treatment	-	4	-	-	-	4
			Valve	-	4	-	-	-	4
		Process Electrical Total		-	**22**	**6**	-	-	**28**
		Process Mechanical	Pump	-	3	3	-	1	7
			Valve	3	26	33	2	-	64
		Process Mechanical Total		**3**	**29**	**36**	**2**	**1**	**71**
	Pipe Gallery (Basement) Total			**3**	**51**	**42**	**2**	**1**	**99**
	Pipe Gallery (Main Floor)	Process Electrical	Actuator	-	9	-	-	-	9
		Process Electrical Total		-	9	-	-	-	9
		Process Mechanical	Valve	-	19	7	3	-	29
		Process Mechanical Total		-	19	7	3	-	29
	Pipe Gallery (Main Floor) Total			-	**28**	**7**	**3**	-	**38**
	Pressure Reducing Station	Process Electrical	Actuator	1	-	-	-	-	1
			Motor	1	-	-	-	-	1
		Process Electrical Total		2	-	-	-	-	2
		Process Mechanical	Valve	5	11	1	-	-	17
		Process Mechanical Total		5	11	1	-	-	17
	Pressure Reducing Station Total			**7**	**11**	**1**	-	-	**19**
Surface Water Treatment Plant Total				**39**	**237**	**60**	**5**	**1**	**342**
Grand Total				**41**	**291**	**72**	**5**	**1**	**410**

3.3.5 Asset Valuation

Figure 9 through **Figure 12** provide a breakdown of replacement costs estimated for assets captured during the condition assessment exercise. The methodology used for estimating asset replacement values is discussed in **Section 3.2.6**.

Assets inventoried during the condition assessment exercise at Gros Cap raw water pumping station and surface water treatment plant were estimated at approximately $7.75M. **Figure 9** and **Figure 10** provides a breakdown of estimated replacement value based on facility location and process location respectively.

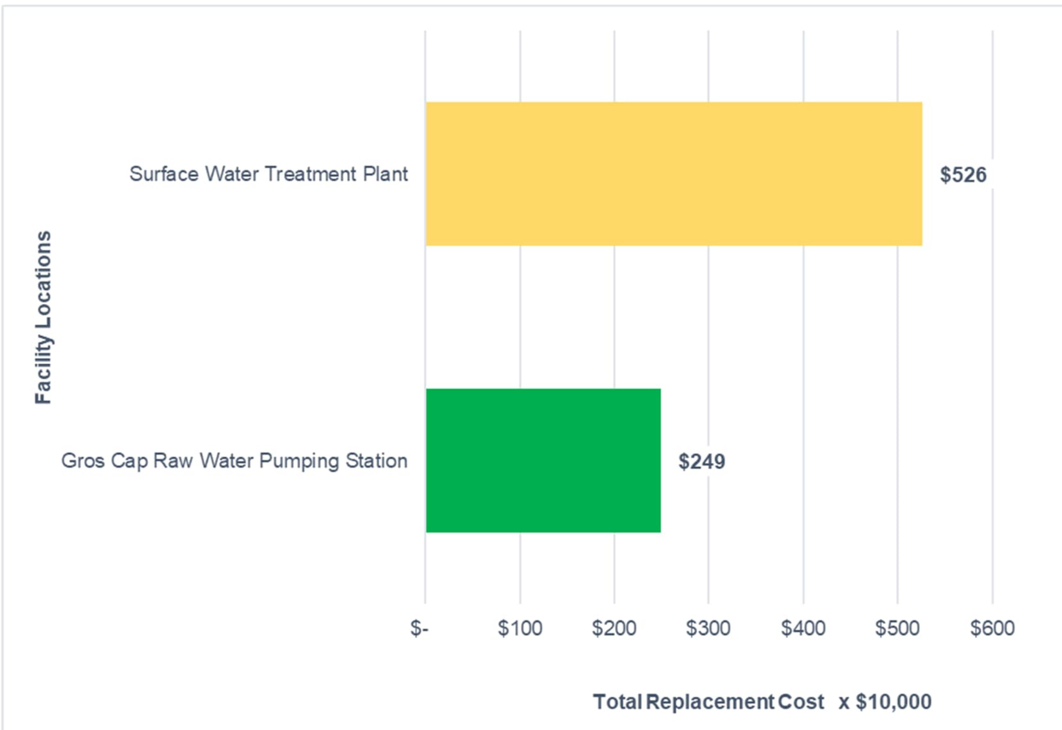


Figure 9: Asset Replacement Value by Facility Location (Hierarchy Level 2)

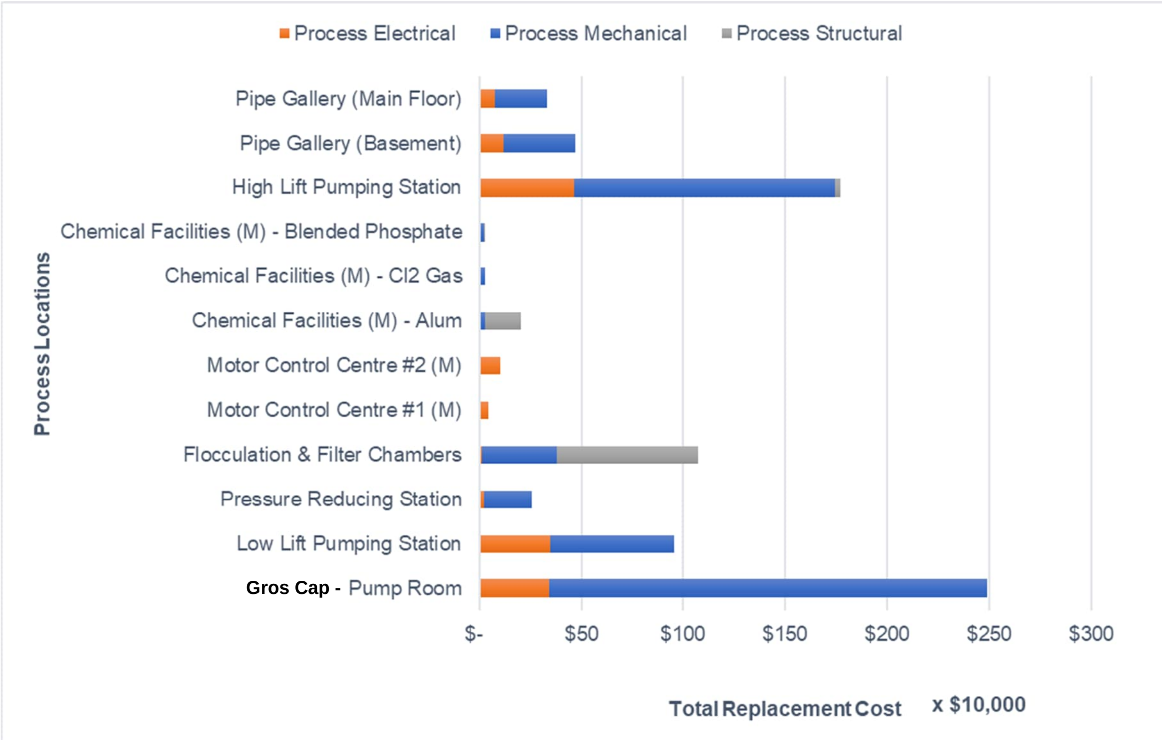


Figure 10: Asset Replacement Value by Process Location (Hierarchy Level 3 & 4)

Figure 11 provides a breakdown of asset replacement values based on asset year of installation. Since most of the assets at the facilities are from original construction, 90% of the $7.75M assets valuation was associated with assets from 1983 and 1986.

Figure 12 provides a breakdown of asset replacement value based on condition score. Assets with a replacement value of summing up to about $45,000 were observed to be in poor or very poor condition. Most of the assets were observed to be in good condition with a replacement value estimated at approximately $6.5M.

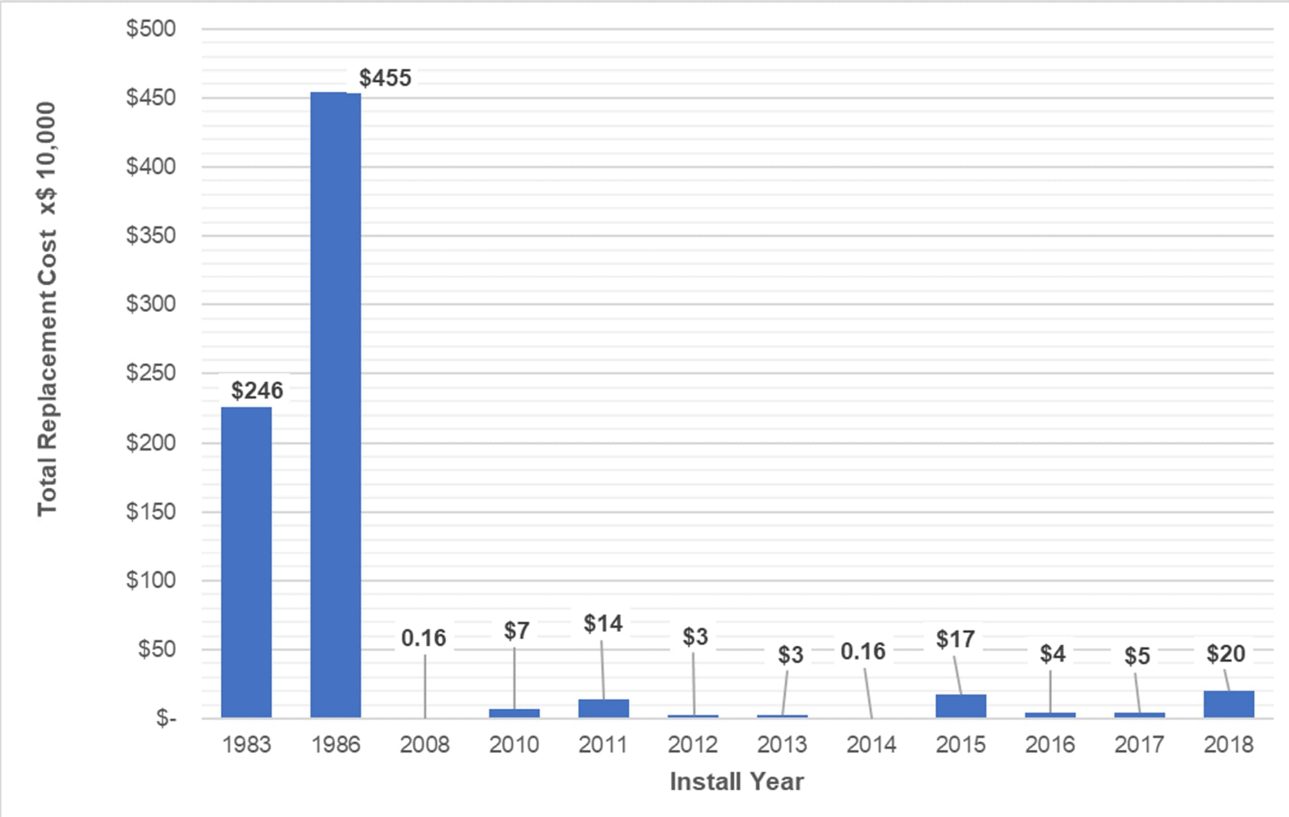


Figure 11: Asset Replacement Value by Install Year

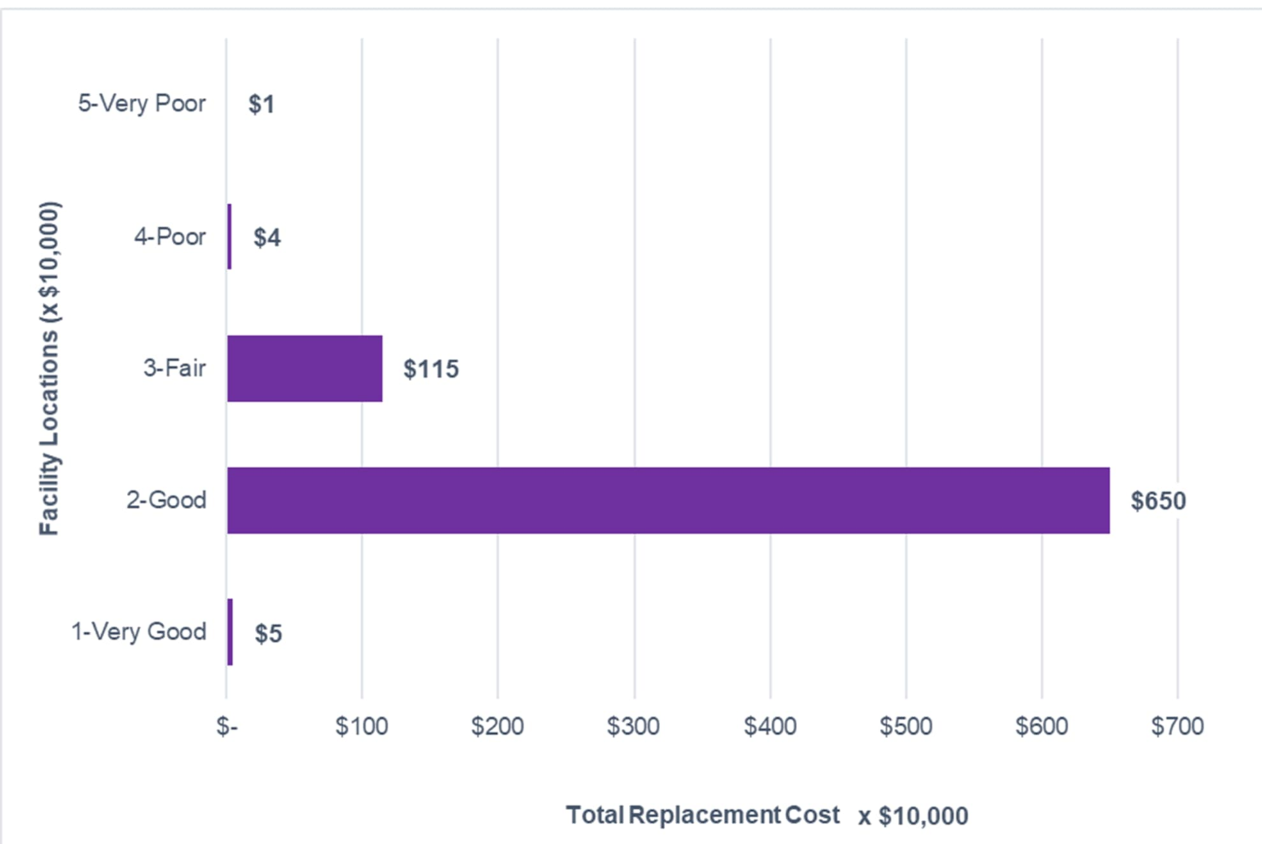


Figure 12: Asset Replacement Value by Condition Score

4. State of Drinking Water Distribution Infrastructure

Establishing the State of the Infrastructure for linear assets will be accomplished by fulfilling the following objectives:

- The assets owned by PUC will be quantified.
- The age and condition will be documented
- The replacement value will be defined.
- The replacement cycle will be forecasted, based on the available data.
- Gaps in data and next steps will be highlighted

4.1 Methodology

Water pipelines regularly operate in a state of anonymity with respect to deterioration factors such as internal and external corrosion. Reliable condition assessment methodologies allow decision-makers to pinpoint assets that require immediate interventions to avoid costly failures. Practically, applying advanced condition assessment platforms to assess the entire drinking water system would require significant budgets in which some amounts may not be justified. Therefore, a desktop-based model can be developed by considering the pipeline's degrading drivers and the surrounding environment to understand the state of the infrastructure.

Desktop-based models proved their applicability in buried infrastructure. Many researchers adopted artificial intelligence and probabilistic and deterministic models to understand the overall condition of infrastructure networks. In many instances, several researchers utilized decision-making models to aggregate several factors to come up with a condition index. The index provides an estimation of the condition of the pipelines by combining multiple factors and subfactors that are believed to impact the state of the asset during its service life. In this report, various factors and subfactors are utilized along with their corresponding relative importance weights to calculate the likelihood of failure (a proxy for asset condition). The outputs of the model developed in this report will be applied in the risk assessment framework to prioritize intervention actions in later stages of the project.

4.1.1 Asset Inventory

The water distribution network in the City of Sault Ste. Marie is composed of approximately 442 km of buried watermains, excluding private connections. Understanding the inventory of water infrastructure assets is an essential practice of asset management practices. Extensive and comprehensive data of the inventory aids in better allocation of budgets. Additionally, accurate and precise inventory enhances budget estimation through avoiding conservative considerations due to unknown attributes of certain assets. To understand the assets operated by PUC Services Inc., AECOM will provide profiles of water pipelines, service connections, water meters, hydrants, and control valves.

4.1.2 Replacement Costs

The costs considered in this assignment are prepared in the form of "Estimate Class", similar to the class and accuracy discussed in Section 3.2.6.

In many jurisdictions in Ontario, several regions use AWWA C900 PVC pressure pipelines, as a replacement option, up to 400 mm but consider concrete pressure pipes for any size that is larger than 400 mm. Replacement costs of pipelines up to 300 mm were supplied by PUC while the costs of larger pipelines where based on a high-level cost estimate. These unit rates (**Table 13**) include the costs of watermain valves.

Table 13: Watermain Unit Rates

Diameter (mm)	Unit Rate Per Meter
100	$1,000
150	$1,100
200	$1,200
250	$1,250
300	$1,300
400	$1,600
450	$1,800
600	$2,700
750	$3,015
900	$4,260
1200	$9,450

Replacement costs of hydrants (**Table 14**), services (**Table 15**), and water meters (**Table 16**) are based on PUC's data. Where missing costs are observed, AECOM used high-level cost estimates based on a relatively similar water network and location.

Table 14: Fire Hydrant Unit Rates

Asset	Unit Rate Per Asset
Fire Hydrant	$11,110

Table 15: Services Unit Rates

Services (mm)	Unit Rate Per Meter	Comment
13	$260	The replacement cost of a 19 mm water service is ~$3,325/each. Considering a water service length up to 10 m, the unit rate would be approximately $340/m. This cost was used as a benchmark to calculate the costs of other services.
16	$300	
19	$340	
25	$410	
37	$460	
50	$500	
100	$670	
150	$720	
200	$800	
250	$900	
300	$1000	
400	$1170	

Table 16: Water Meter Unit Rates

Water Meter Size (mm)	Unit Rate Per Asset	Comment
25	$440	The unit costs provided by PUC varied depending on size and model. This table shows the maximum and minimum values for some sizes. PUC installs water meters up to 25 mm. The cost of installation is approximately $31/unit. This cost was included for sizes up to 25 mm.
37	Min: $700 Max: $1,230	
50	Min: $750 Max: $2,060	
75	$2,590	
100	$2,920	
150	$4,790	
200	$7,500	
250	$10,480	

4.1.3 Likelihood of Failure as a Proxy of Asset Condition

Likelihood or probability of failure (LoF) in the context of structural failure is largely dependent on the physical condition of the asset. The following sections provide an overview of the factors used in determining the LoF of buried piped infrastructure. The LoF is determined by means of the criteria summarised in **Figure 13** and sections below.

In the calculation of the LoF, AECOM maximized available data to develop a desktop-model as a screening tool. The main parameters of the LoF model (see **Figure 13**) consist of:

- **Age** – Many previous studies linked the deterioration of the asset to the time of exposure. Failures are expected to increase when age increases.
- **Estimated Service Life (ESL)** – Depending on the type of material, ESL will differ depending on the design life or useful life. Each material is assigned an ESL based on subject matter experience of a similar project nature.
- **Breaks** – An increasing number of breaks may drive decision-makers to intervene to maintain sustainable infrastructure and minimum levels of service threshold. Pipelines that have repetitive and many breaks could indicate operational, mechanical, and/or deterioration problems.
- **Soil Corrosivity** – Soil corrosivity plays a major role in expediting the degradation mechanism of ferrous pipelines. Generally, studying the nature of the soil is performed through soil sampling and resistivity analysis. Higher resistive soil will have lower conductivity to transfer electrical currents. Therefore, it will be characterized as non/low corrosive.
- **Cathodic Protection** – Cathodic protection has proved its reliability in extending the service life of ferrous pipelines for approximately 20 years as it reduces the corrosion mechanism in ferrous watermains.

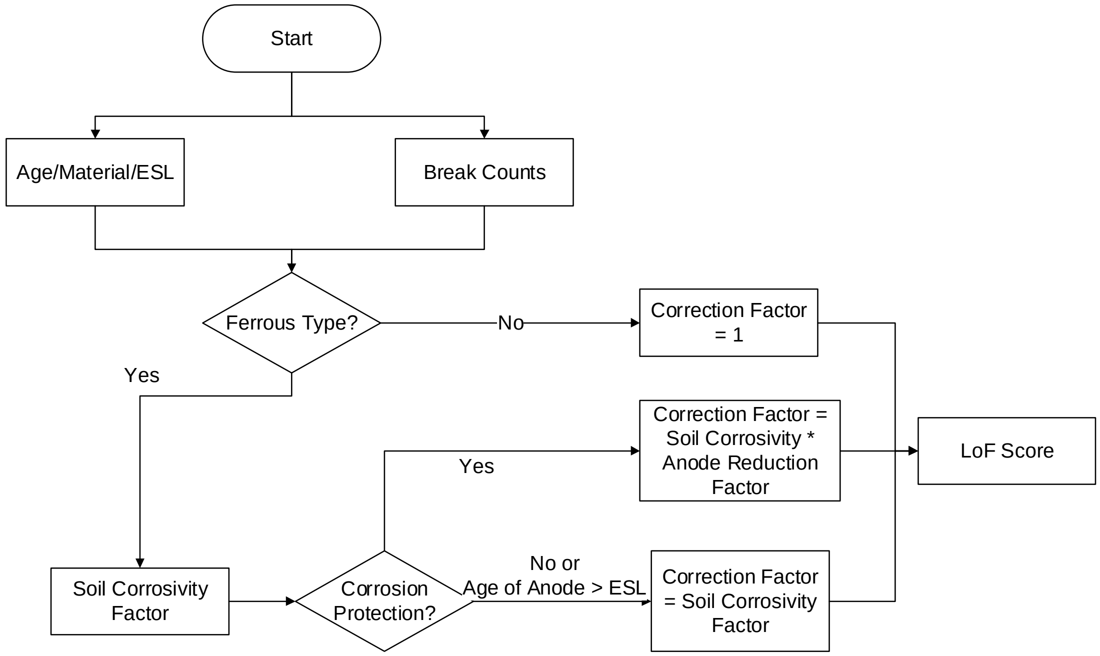


Figure 13: Linear Assets Likelihood of Failure Model

4.1.3.1 Age-Based Deterioration

The age and ESL factors are used as an indication of deterioration. The calculation of the LoF is based on the application of a two-parameter Weibull distribution. In reliability analysis, it is commonly called the survival function. The most commonly used application is modelling the failure time data. The underlying premise of the Weibull type of analysis is that while some assets fail prematurely due to severe conditions or improper installation, other assets can be long-lived, and function well beyond their theoretical life expectancy. To perform a high-order network-level analysis, it was assumed that assets would fail within an envelope approximated by a Weibull cumulative distribution. The Weibull distribution tool is utilized to describe the distribution of extreme value data. The most commonly used application is modelling the failure time data. The inherent lifetime analysis offers the user the ability to estimate the probability that the asset's lifetime exceeds any given time [P (T>t)].

The two-parameter Weibull distribution can be expressed based on equation **[1].**

$$\boldsymbol{R(t) = 1 - P(T \leq t) = 1 - F(t|\gamma, \beta) = e^{-\left(\frac{t}{\beta}\right)^{\gamma}}} \qquad \textbf{[1]}$$

Where:

R (*t*) Is the reliability at any time (*t*)
P Is the probability of failure at any time (*t*)
F Is the distribution function at any time (*t*) given a defined shape and scale factors
γ Is the shape factor; it is a non-negative value
β Is the scale factor; it is a non-negative value

In this study, the shape factor representing the slope of the line in the probability plot is considered as six (a typical input for generalized analogous deterioration in studies of infrastructure sustainability), and the scale factor is equivalent to the ESL of each material (see **Table 17**). The ESL values considered are conservative as some assets may exceed their expected service life before failure (as simulated by the Weibull distribution). These estimations and predictions can further be enhanced by having robust and extensive failure records.

Table 17: Sault Ste. Marie Watermains and ESL

Pipe Material	Pipeline Material Definition	ESL (Years)*
AC	Asbestos Cement	85
CCYL	Concrete Cylinder	85
CI	Cast Iron	85
CPP	Prestressed Concrete Cylinder Pipeline	85
CU	Copper	80
DI	Ductile Iron	50
GALV	Galvanized Steel	50
PE	Polyethylene	85
PEX	Cross Linked Polyethylene	80
PVC	Polyvinyl Chloride	85
STL	Steel Pipe	85
*These values are assumptions and may be lower or higher depending soil conditions, material class, operational aspects, etc. that may impact the service life of the pipeline negatively or positively.		

The application of the Weibull analysis will provide the cumulative deterioration of the asset from 0 to 100. At the ESL of each material type, the cumulative value will approximately be 63%. This would indicate that there is a variation in pipeline population as some may fail prior to their ESL and others may fail beyond their ESL.

Conventional scores (shown in **Table 18**) of the cumulative values were used to accommodate various ESLs after developing analogues deterioration curves. A pipeline age that produces a cumulative value of 0.27 will have a score of 30. Higher cumulative values indicate older pipelines.

Table 18: Age-based LoF Scores

Cumulative Value	Score
0-10	1
10-15	5
15-25	10
25-30	30
30-40	35
40-50	40
50-55	70
55-70	80
70-75	90
75-100	100

4.1.3.2 Normalized Breaks Count

Extensive break records were observed in the data received. Approximately, there were 3,000 recorded breaks between 1982 and 2019, except for one break recorded in 1930. The 1930 recorded break was considered an anomaly and disregarded from the data.

In many jurisdictions, the number of expected break counts per study period may drive replacements/rehabilitation decisions. Breaks can be a result of many factors, including deterioration, excessive loads, leaks, temperature, etc. Failures that occur more than once in the same watermain indicate certain deterioration drivers and hence affect the reliability of the watermain (decrease the reliability over a period of time). Obviously, a pipeline that exhibited one failure in a ten-year period will have lower break rates when compared to pipelines that encountered more than one failure (given the same pipeline length and study period).

In this study, break counts were normalized based on the length of each segment. This would provide additional information as it represents a rate rather than a count. According to Folkman (2018)[1], the relatively acceptable break rate in North America per year is on average 24 breaks per 100 miles, which would be interpreted as 0.15 break per kilometer per year. This threshold was taken into consideration in establishing likelihood of failure scores for observed normalized breaks (**Table 19)**.

Table 19: Normalized Breaks and LoF Score

Break/km	Score
0 to 0.09	1
0.1 to 0.19	25
0.2 to 0.29	50
0.3 and greater	100

[1] *Folkman. (2018). Water main break rate in the USA and Canada: A Comprehensive Study.* *https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1173&context=mae_facpub*

4.1.3.3 Soil Type

The corrosivity of soil is a function of many factors including, pH, soil organic matter, soluble chloride, total soluble salts, water content, soil aeration, and soil conductivity. Since such detailed information for Sault Ste. Marie is not available, high-level soil classification and corrosivity levels are considered.

Previous work (Correng Consulting Service Inc., 1993[2], 1999[3]) concluded that the primary environmental driver of ferrous metal corrosion in the Greater Toronto Area (GTA) was soil resistivity. Other factors examined included soil pH and the combination of redox potential. Neither factor proved to be a significant contributor as per the authors. Corrosion of buried ferrous material is an electrochemical mechanism in which wall thickness degradation is directly proportional to the flow of electrical currents from ferrous pipe material to the surrounding soil. Buried unprotected ferrous material exposed to the same corrosive environment will tend to corrode at approximately the same rate (Gerhold 1976[4] and Madison Chemical Industries 1996[5]). Since the wall thickness of ductile iron and cast iron changed over time, ductile iron (especially pressure class) would tend to break at an earlier period (given similar corrosive environment). The graphite structure, however, would determine the strength of the material itself; nodular graphite has higher strength and ductility than iron structures made of flaky graphite.

Although soil corrosivity may also have impacts on cementitious materials (depending on cement type), in North America, the main water breaks occur in ferrous pipes due to corrosion actions. By observing the data of water breaks in Sault Ste. Marie, approximately 94% of the breaks of known pipe materials occurred in DI and CI pipes. Therefore, considering the soil type and its potential corrosivity in ferrous pipes and based on the number of breaks of ferrous pipes, the analogous soil corrosivity impact is used in the calculation of the approximate condition of ferrous pipes (data-driven).

In general, smaller grain soils, such as clay and silt, have lower resistivity values (higher conductivity values) when compared to larger soil types such as sand and gravel (Testing Engineers Inc.). Ferrous watermains buried in smaller grain soils will be exposed to a higher corrosion process. Broadly, soil types are commonly characterized by gravel, sand, silt, and clay content. These soil types have almost approximate resistivity ranges. However, the soil types available in the supplied GIS included some other types (such as alluvium, fill, and glacial till) that may contain one or more soil type. The soil types have been interpreted into scores to apply them in the LoF methodology. To complete the scoring process for the available soil types, some conservative assumptions were considered as per **Table 20.**

[2] Correng Consulting Service Inc., Final Report, Watermain Corrosion Investigation for the City of York, November 1993, Correng Consulting Service Inc., Downsview, Ontario, 1993

[3] Correng Consulting Service Inc., Final Report, Watermain Corrosion Investigation for the City of Toronto – Etobicoke District, February 1999, Correng Consulting Service Inc., Downsview, Ontario, 1999

[4] Gerhold, W.F., "Corrosion Behavior of Ductile Cast-iron Pipe in Soil Environments,". AWWA Journal, December 1976.

[5] Madison Chemical Industries, Inc., Specification MCI SFSDIPI-96, Specification for Ductile-iron Pipe, 1996.

Table 20: Sault Ste. Marie Soil Classification and LoF Scores

Type of Soil	Assumptions	Qualitative Conductive Description	Score
Alluvium	Because of the river suspension, finer soils settle on the riverbank, but larger grains flow to the downstream. These finer soils would contribute to the formation of the geology of the surrounding land. Therefore, alluvium attributes are assumed as lacustrine clay.	High	90
Fill	This a generalized term as this could include any soil. Due to the unavailable information, the average value of the lowest and highest scores is taken.	Moderate	50
Glacial Till	This type of soil can have all kinds of soil materials. Since they increase the density of the soil, they have a higher potential to transfer electrical currents.	Moderate to High	60
Gravel with Sand	Lowest conductive properties	Low	5
Lacustrine Clay	Highest conductive properties	High	100
Lacustrine Sand	Low conductive properties	Low to Moderate	15
Sandstone	Since it a dense type of soil, it will have conductive properties	Moderate to High	80

These scores will impact the correction factor after calculating the LoF using the age-based and break counts scores. Since the resistivity of soil has a direct impact on corrosion levels, lower resistivities (higher scores) will amplify the calculated likelihood of failure.

Typically, the impact of resistivity and degradation of ferrous pipelines can be studied given quantitative resistivity information. In such a way, one would deduce the percentage increase in the break rate between higher and lower resistive soils. In a recent study conducted for the City of Toronto, the external pitting rate (mm/year) decreased exponentially by approximately a 100% from the lowest resistive soil to the highest resistive soil at specific ages (e.g. pitting rate in the lowest resistive soil = approximately (1+100%) x pitting rate in the highest resistive soil). Presently, numeral resistivity information is not available to mimic the external pitting decrease concluded in the previous study (a decrease of 100%). To account for the soil factor and to avoid bias (certainty in which 100% would apply), an average value is chosen. Therefore, it is assumed that the soil correction factor will magnify the LoF by 50%. By incorporating a 50% increase in deterioration, **Table 21** shows the Soil Corrosivity Correction Factors.

Table 21: Soil Corrosivity Correction Factor

Type of Soil	Soil Corrosivity Correction Factor*
Alluvium	45%
Fill	25%
Glacial Till	30%
Gravel with Sand	3%
Lacustrine Clay	50%
Lacustrine Sand	8%
Sandstone	40%
*Soil Corrosivity Correction Factor = 50% x Soil Score (**Table 20**)	

4.1.3.4 Cathodic Protection

Cathodic (corrosion) protection is used to reduce corrosion impacts of ferrous pipes. Such a strategy could extend design life by up to 20 years when properly designed and installed. Cathodic protection includes (Kleiner and Rajani 2002)[6]:

- Hotspot cathodic protection – Opportunistically installing a sacrificial anode at locations of pipe repairs.
- Retrofit cathodic protection – Systematically protecting existing ferrous pipes with galvanic protection. Pipes that are electrically discontinuous will often be connected to an anode at each pipe segment.

Although cathodic protection is not part of the original design and is installed at specific locations in the City's network, it has the potential to still reduce corrosion impacts in specific locations (where they are effective, and soil is corrosive). As an example, segment A with an installed cathodic protection at X distance will be at a lower risk than segment B with an uninstalled cathodic protection at the same distance (assuming that they have a similar length). Based on these circumstances, the impact of cathodic protection is more localized than generalized. However, this factor will relatively be more impactful in cases where anodes are installed and designed to protect pipes from corrosion mechanisms.

As a result, pipelines with localized cathodic protection may have potential in decreasing the soil corrosivity correction factor; as low resistive (high conductive) soil would increase the LoF (deterioration), cathodic protection would decrease the impact of soil corrosiveness (negative relationship) on ferrous pipelines.

Failures of electrical and mechanical components are also attributed to degradation during their service life (Guo and Liao 2015)[7] similar to any asset. Due to deterioration, the effectiveness of cathodic protection is expected to reduce. In other words, older cathodic protection would have lower impacts than newer ones, given a similar environment. The age of the cathodic protection is incorporated in the LoF computation by simulating the Weibull deterioration (similar to pipeline age-based scenario). In the case of the cathodic protection, the estimated service life, which is the scale factor, is assumed to equal 20. By computing the cumulative density functions at each age, the probabilities are plotted as per **Figure 14**. The cumulative values would be explained as the reliability of the anode in protecting the pipeline from corrosion.

[6] *Kleiner, Y., & Rajani, B. Quantifying the effectiveness of cathodic protection in water mains. In* NACE International Seminar, Northern Area, Montréal Section, Quebec City, QC*, (2002).*

[7] *Guo, H., & Liao, H. (2015, January). Practical approaches for reliability evaluation using degradation data. In* Annual Reliability and Maintainability Symposium *(Vol. 7).*

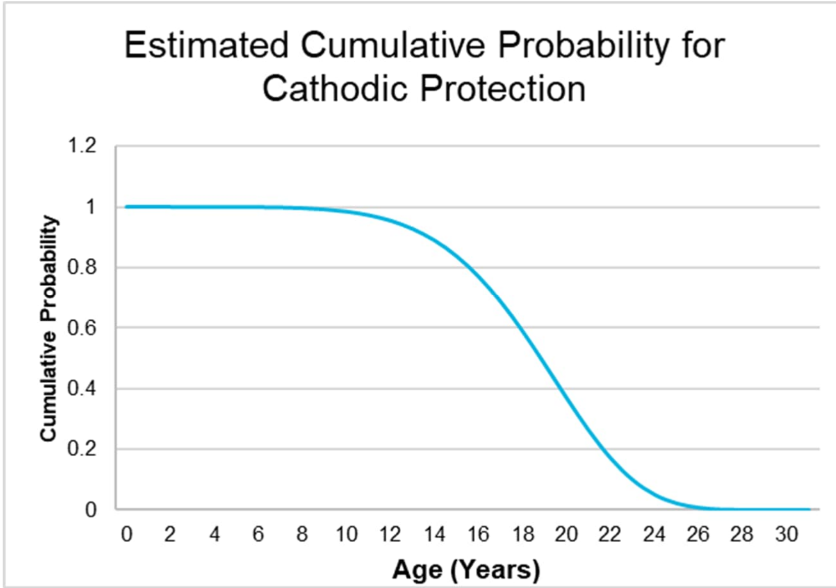


Figure 14: Cathodic Protection Simulated Deterioration

The impact of the cathodic protection on the Soil Corrosivity Correction Factor is highly dependent on its age. As per **Table 22** and in case of a very old anode (age is roughly between 25 and 30 years), the cathodic protection correction factor will be 1. In this case, cathodic protection would have minimal to no impact on Soil Corrosivity Correction Factor. However, the Soil Corrosivity Correction Factor will reduce in cases where the cumulative value was less than 75 (approximately lower than the cathodic protection estimated service life).

Table 22: Cathodic Protection Factor

Cumulative Value	Cathodic Protection Factor (0-100)
0-10	0%
10-15	4%
15-25	9%
25-30	30%
30-40	34%
40-50	39%
50-55	70%
55-70	80%
70-75	90%
75-100	100%

Therefore, the adjusted Correction Factor can be calculated as per Equation 2.

$Overall\ Correction\ Factor\ =\ Soil\ Corrosivity\ Correction\ Factor\ x\ Cathodic\ Proection\ Factor$ **[2]**

Applying the Correction Factor on lacustrine clay type of soil will produce the following Correction Factors on each cumulative value of the cathodic protection (see **Table 23**). For example, the Correction Factor, where an anode of a cumulative value of 73 and used in lacustrine clay will be 1.45.

Table 23: Correction Factor in Lacustrine Clay

Cumulative Value	Overall Correction Factor
0-10	0%
10-15	2%
15-25	5%
25-30	15%
30-40	17%
40-50	20%
50-55	35%
55-70	40%
70-75	45%
75-100	50%

4.1.3.5 Likelihood of Failure Calculation

The impacts of the break counts and the age-based methodologies were aggregated to compute the estimated LoF. In addition, the soil type along with the cathodic protection information was also incorporated in the model [Overall Correction Factors (Equation 2)]. Since the LoF scores ranged between 1 and 100, the aggregated LoF score would be within the same range. Equation 3 was used to compute the LoF score for each watermain. The equation was constrained to a maximum value of 100 due to the Correction Factor multiplier.

$Likelihood\ of\ Failure\ =\ Overall\ Correction\ Factor\ [(W_{Age})Score_{Age} + (W_{Breaks})Score_{Breaks}]\ \leq 100$ **[3]**

Where W_{Age} and W_{Breaks} are the relative importance weights for the age-based and break counts scores. In this assignment, the weight was taken as 30% for W_{Age} and 70% for W_{Breaks}.

4.1.3.6 LoF Rating Definition

A qualitative grading system is used to relate scoring to PUC's ability to respond to asset failure, should it occur. **Table 24** describes the LoF category results based on Very Poor, Poor, Fair, Good and Very Good. It is noteworthy to mention that the calculations should never be interpreted as a definitive rating for a pipe, but rather as a way to evaluate potential condition relative to similar assets of varying ages and soil type within a portfolio until field-verified data can be obtained.

Table 24: General LoF Rating Definition

Category	Definition
Very Good	▪ Sound/acceptable physical condition ▪ No wear and tear, no physical failure. ▪ No substantial deterioration is likely over the next 10 years.
Good	▪ Acceptable physical condition ▪ Minor wear and tear, no physical failure. ▪ No substantial deterioration is likely over the next 5-10 years.
Fair	▪ Acceptable physical condition ▪ Moderate wear and tear, moderate risk of physical failure. ▪ Failure unlikely within the next two years but further deterioration is likely to happen
Poor	▪ High wear and tear ▪ Failure may be observed in the next two years ▪ Substantial work is required in the short term
Very Poor	▪ Poor physical condition/failure imminent; heavy wear and tear, failure is likely in the short term. ▪ Substantial work is required in the short term.

4.1.3.7 LoF Breakpoints

An absolute aggregated number (1,100) is calculated to describe an asset's LoF using the scoring scheme described earlier. This number must be contextualized by the quantile distribution for the system, and the general benchmarks expressed in **Section 4.1.3.6**. When the LoF is computed for the system, the percentile method is applied to determine where individual points lie in the LoF distribution. To better conceptualize the rating system, percentile breakpoints are assigned through the LoF distribution to categorize an asset's calculated score considering the five-point scale.

Breakpoints are set dynamically to ensure they are reflective of a dynamic risk portfolio. This method of setting breakpoints proves a useful and consistent method to conceptualize LoF scores that combines benchmarked conceptions of LoF, statistical interpretation, and graphical interpretation. Any classification of a score using breakpoints will be subjective to the given tolerance for risk and may be adjusted by the users to reflect their specific level of tolerance.

Furthermore, assets can vary in their scores within a given scoring category (for example, two assets with a score of 60 and 70, respectively, could both be classified as fair), meaning that in the context of asset prioritization, absolute scores will prove most useful in identifying priorities within a cohort of assets. Assigning breakpoints and classification provides a reasonable way to conceptualize LoF on a system-wide level in a user-friendly manner. **Table 25** displays the LoF breakpoint ratings for the system based on the current LoF distribution. For example, a calculated overall LoF with a value of 64 will be rated as fair.

Table 25: LoF Breakpoints

Definition	Lower Limit	Upper Limit
Very Good	1.0	3.3
Good	3.3	19.0
Fair	19.0	72.7
Poor	72.7	88.9
Very Poor	88.9	100

4.1.4 Deterioration-Based Intervention Prediction

To predict the economic intervention year, the cumulative value was taken into consideration, along with the Overall Correction Factor to calculate the deterioration of the water network in a 10-year study period (2020-2029). This methodology was strictly dependent on the calculated LoF in each year. The intervention considered in this task was in the form of replacement.

Broadly, replacement costs are higher when compared to rehabilitation techniques (based on the Greater Toronto Area). Since the main aim of this generic task is to understand the deterioration and intervention costs, the costly intervention action was assumed in the analysis (replacement). The “do nothing” variable is one alternative considered, in which the asset would continue deteriorating without any action, given a pre-defined threshold or an asset did not reach its estimated service life. However, the replacement variable was the other intervention action that would restore or extend the condition of the pipeline after the deterioration rate reaches a pre-defined threshold. In this study, the intervention decision was assumed to occur whenever a watermain reached approximately 63% keeping the same number of breaks in the study period or if an asset reached its service life (for services, water meters, and hydrants). In an age-based approach, at the ESL of each pipeline, depending on the deterioration curve, the LoF would approximately be 63% (condition or reliability is 37%). Since the condition of some ferrous pipelines will degrade earlier than its expected service life (corrosive soil), a cumulative density function of 63% will occur before the pipeline reaches the ESL (conservative assumption). Therefore, whenever a pipeline reaches an LoF equivalent to 63%, an intervention action will be recommended; otherwise, the “do nothing” alternative dominates. This constraint is summarized as follows:

$$Decision\,Variable \;=\; \begin{cases} Do\ Nothing & R(t) > Threshold \,=\, 37\% \\ Replace & Otherwise \end{cases} \qquad \textbf{[4]}$$

For example, **Figure 15** shows the deterioration of a CI pipeline laid in a corrosive soil (ESL of CI = 85 years but replacement occurred at 56 years). Before an ESL of approximately 56 years, the “do nothing” decision variable is dominating as the *R(t)* is larger than 37%. By reaching the ESL, an intervention action would be performed.
As an example, the same figure shows that upon reaching the ESL, a replacement decision would be performed. It was assumed that such a strategy would restore the reliability of the pipeline to 100% (LoF is 0%).

Figure 15: Deterioration and Time of Intervention (Illustration)

Additionally, an age-based intervention study was also developed for water services, water meters, and hydrants. The estimated service life of water services was estimated based on **Table 17**; however, the estimated service life for water meters was assumed 20 years and for hydrants, 40 years.

4.2 Data Collection

The methodology developed to calculate the LoF depends on the data collected from PUC. **Table 26** provides the geodatabase files used as inputs to the developed model.

Table 26: Attribute Data Used and the Associated Files

Parameter Used	GIS Dataset	Attribute Field Name
Soil type	SSM_GeoTechnicalSurvey_1977	SOILTYPE
Breaks	WAT_PipeMaintenance	WATERMAINID, BREAK_COUNT, BREAK_DATE
Anodes	WAT_Anode	WATERMAINID, Material, WEIGHT
Watermain attributes (age, material, length, diameter)	WAT_Watermain	INSTALLDATE, MATERIAL, PIPEDIAMETER, SHAPE_Length

After conducting a gap analysis on the linear data, missing information was observed for a number of pipelines, including installation year, material type, etc. (**Table 27**). The total number of as-built drawings is a maximum of 35 drawings (assuming each segment is present in a drawing profile). These drawings could provide information about diameter, year of installation, and material.

To complete a comprehensive desktop-based model, all pipelines required attribute data. Therefore, pipelines with missing data were assigned attributes using the following assumptions:

1. To determine unknown installation dates, average installation dates for each material type was found and assigned to missing pipelines. For example, the average installation date for AC pipelines was 1960.

Therefore, missing installation AC pipelines were assigned the year of 1960. The same was performed for the rest of pipeline materials.

2. To determine unknown/missing diameters, average values (rounded to the nearest 50 mm) of material types were assigned. For example, the average diameter of AC pipelines was 300 mm.
3. For entries with missing pipeline material, a conservative assumption was made. All pipelines with missing pipeline material attributes were assumed to be ferrous (in the LoF, ferrous pipes have a correction factor for corrosive soil). Pipelines installed before 1970 were assumed to be made of CI (two pipelines assumed to be CI and the same was recorded in the GIS file "From PUC Potential CI"). Ferrous pipelines installed in 1970 onwards were assumed to be made of DI.
4. Pipelines with diameter less than 100 were excluded from the assessment.
5. Anodes with installation year labels of 9999 were excluded from the assessment (e.g. the age was unknown)
6. Anodes with "blank" data fields were excluded from the calculation.
7. Anodes not associated with a watermain ID were excluded (294 counts).
8. Break data occurring before the installation of the main were disregarded.

Table 27: Watermains Missing Information

Watermain ID	Length (m)	Installation	Material	Diameter
382	34.63	🟢	🟢	🔴
384	50.15	🟢	🟢	🔴
471	7.84	🟢	🔴	🔴
474	7.63	🟢	🔴	🔴
480	6.75	🟢	🔴	🔴
975	14.36	🟢	🔴	🔴
1249	2.17	🟢	🟢	🔴
6316	6.66	🟢	🔴	🟢
15809	71.74	🟢	🔴	🔴
16259	70.24	🟢	🔴	🔴
82574	40.45	🟢	🔴	🔴
82585	38.05	🟢	🔴	🔴
82586	37.88	🟢	🔴	🔴
82587	39.9	🟢	🔴	🔴
82913	6.88	🟢	🔴	🔴
87816	45.82	🟢	🔴	🔴
182525	0.73	🟢	🔴	🟢
188186	7.94	🟢	🔴	🟢
87818	45.34	🟢	🔴	🔴
89451	10.70	🟢	🟢	🔴
110190	82.30	🟢	🔴	🟢
110191	21.85	🟢	🔴	🟢
120870	1.00	🟢	🔴	🟢
120871	9.50	🟢	🔴	🟢
144268	10.22	🔴	🔴	🟢
144671	5.37	🔴	🔴	🟢
150336	12.37	🟢	🔴	🟢
150337	1.59	🟢	🔴	🟢
150338	3.18	🟢	🔴	🟢
159704	9.42	🔴	🔴	🟢
163723	0.77	🟢	🔴	🟢
165352	0.27	🟢	🔴	🟢
176001	18.15	🔴	🟢	🟢
182068	4.26	🔴	🔴	🟢
182069	0.93	🔴	🔴	🟢

4.3 Results

4.3.1 Distribution Main Asset Inventory

4.3.1.1 Age

Age of an asset in the context of its design standard may play a role in a preliminary screening of its condition due to the general assumption that an older asset will have a higher likelihood of failure (LoF) than a newer one. Additional complexity is introduced as different eras of the same material type can experience subtle differences in potential failure in a counterintuitive manner. Improvements to the manufacturing process of cast iron (CI), and its evolution to ductile iron (DI), for example, resulted in the manufacturing of thinner pipe walls that, due to corrosion, failed in shorter time periods than earlier versions of the same material with thicker pipe walls. Subtle changes in many material standards such as in asbestos cement (AC) and polyvinyl chloride (PVC) pipes have also resulted in lower safety factors being used in later years of construction when using the same material types.

In the absence of more details, the age of an asset is a screening factor to represent its condition. In fact, in some studies, the age alone was considered in the calculation of the LoF in buried pipelines (Halfawy, Dridi, & Bajer, 2008)[8]. Within materials of unique characteristics (for example, in instances when the change in standard or manufacturing processes can be clarified), age is definitely a useful proxy.

Within PUC's distribution network, watermains were installed between 1900 to 2019 (based on GIS data). **Figure 16** illustrates the total length of watermains that were installed in specific periods. According to the figure and from the total length of 442 km, the majority of the pipelines were installed between 1950 and 1990 with a total length of 301 km (68%). It was observed that 0.03 km of watermains had missing installation dates.

[8] Halfawy, M., Dridi, L., & Bajer, S. (2008). Integrated Decision Support System for Optimal Renewal Planning of Sewer Networks. *Journal of Computing in Civil Engineering*, 360-372

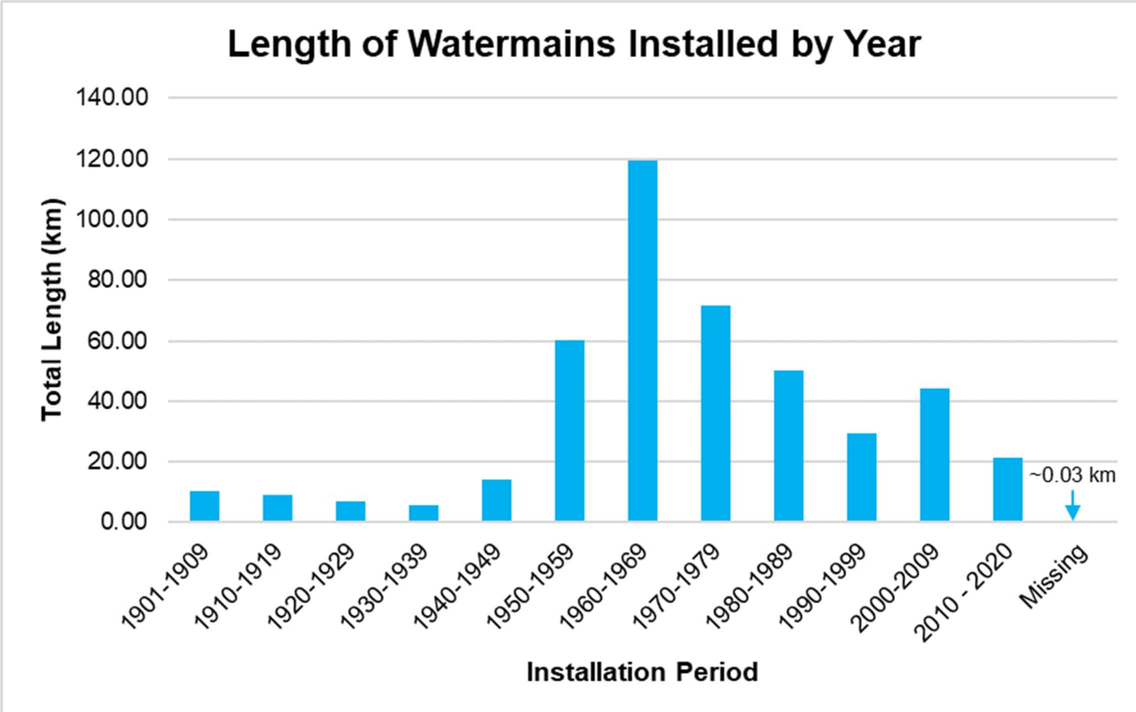


Figure 16: Length of Watermain Installed by Year

4.3.1.2 Material

The primary observation that could be made from this categorization was that the majority of watermains were constructed of ferrous materials, specifically DI and CI **(Table 28)**. Some pipeline total length was not observed as they were either privately or City owned and/or less than 100 mm diameter (e.g. GALV, PEX, and STL).

Table 28: Watermain Material Types by Length (km)

Material	Material Definition	Length (km)
AC	Asbestos Cement	7.1
CCYL	Concrete Cylinder	37.8
CI	Cast Iron	200.0
CPP	Prestressed Concrete Cylinder Pipeline	0.6
CU	Copper	0.0
DI	Ductile Iron	106.5
GALV	Galvanized Steel	0.0
PE	Polyethylene	0.9
PEX	Cross Linked Polyethylene	0.0
PVC	Polyvinyl Chloride	88.9
STL	Steel Pipe	0.0
Missing		0.6

A more representative material type distribution within the watermain inventory could be observed in **Figure 17**. More than half of the total length of watermains was constructed using ferrous materials (69%, 307 km). Approximately, 20% (90 km) was constructed using PVC material, and roughly 8% (38 km), 2% (7 km) and 0.13% (0.6 km) were laid using CCYL, AC, and CCP, respectively.

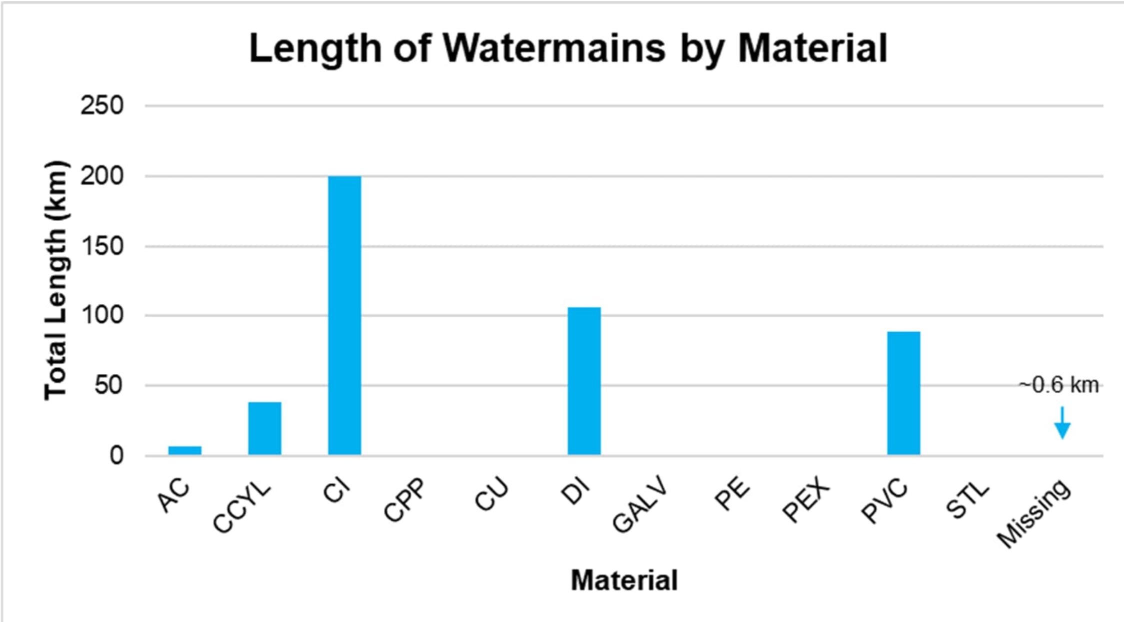


Figure 17: Length of Watermain by Material

When the watermain material is compared with the year of installation, one can draw some general conclusions about the failure risk exposure when there is existing background knowledge of the average useful life of the watermain materials within the local condition. **Figure 18** demonstrates the period in which a group of watermains are constructed along with their material type and total length. According to the figure, the majority of pipelines installed from 1900 to 1970 were constructed of CI. Installation of DI started in the 1970s with a significant increase afterwards until the 1990s. Thermoplastic pipelines started to emerge in the period of 1980-1990 and were drastically used after that period in the watermain network. It should be noted that some materials were observed in periods were the same material type was not available in the market (e.g. PVC pipelines observed in 1900-1920 period but in small quantities).

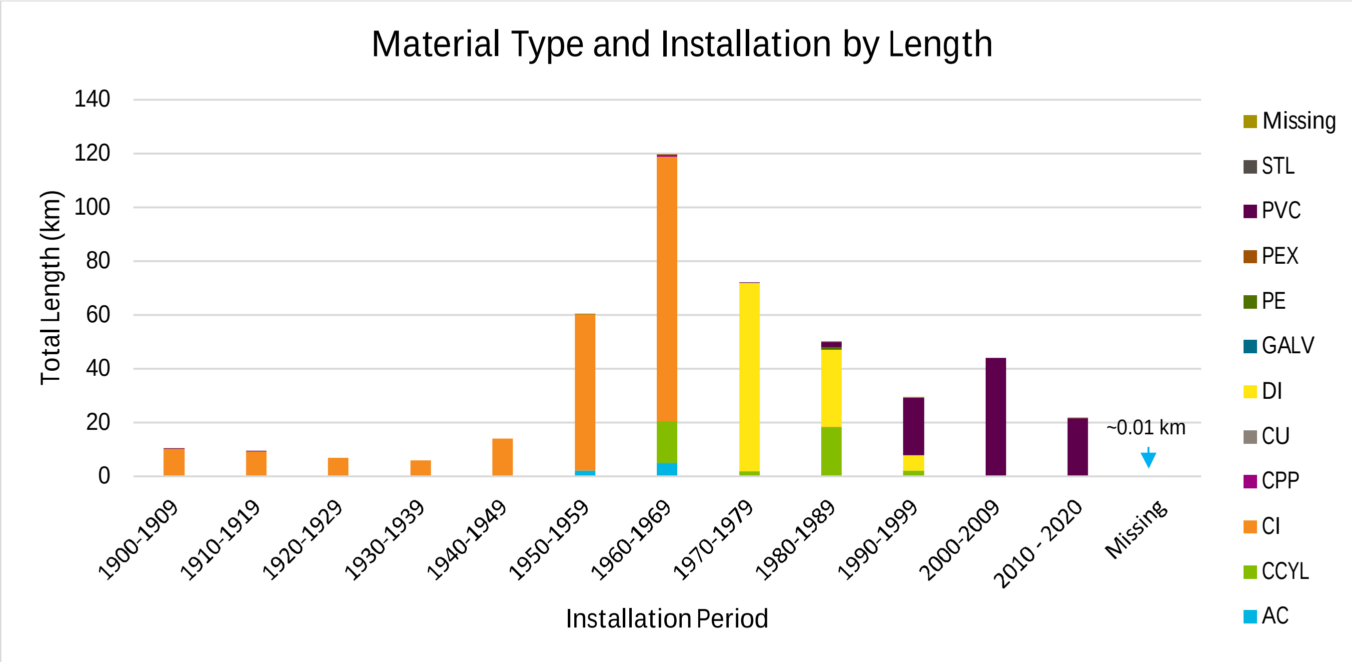


Figure 18: Length of Watermain by Material and Installation Period

4.3.1.3 Diameter

Larger diameters present greater risk exposure when considering economic, environmental, operational, and social risk indicators. As an indicator, obtaining diameter information is essential for further applications in the assessment methodology.

From **Figure 19**, approximately 88% (389 km) of the water network consisted of pipelines with diameter sizes of 100 mm and 300 mm. In specific, diameter sizes ranging between 100 mm and 150 mm occupied the majority (47%) of the network with a total length of 210 km. Around 68% of CI ranged between 100 mm and 150 mm, with a total length of 137 km. PVC pipelines dominated the 100 mm and 300 mm range with a total length of roughly 84 km. Larger pipelines (750 mm and 1200 mm) were mainly observed in CCYL, PE, and CPP with a total length of approximately 24 km.

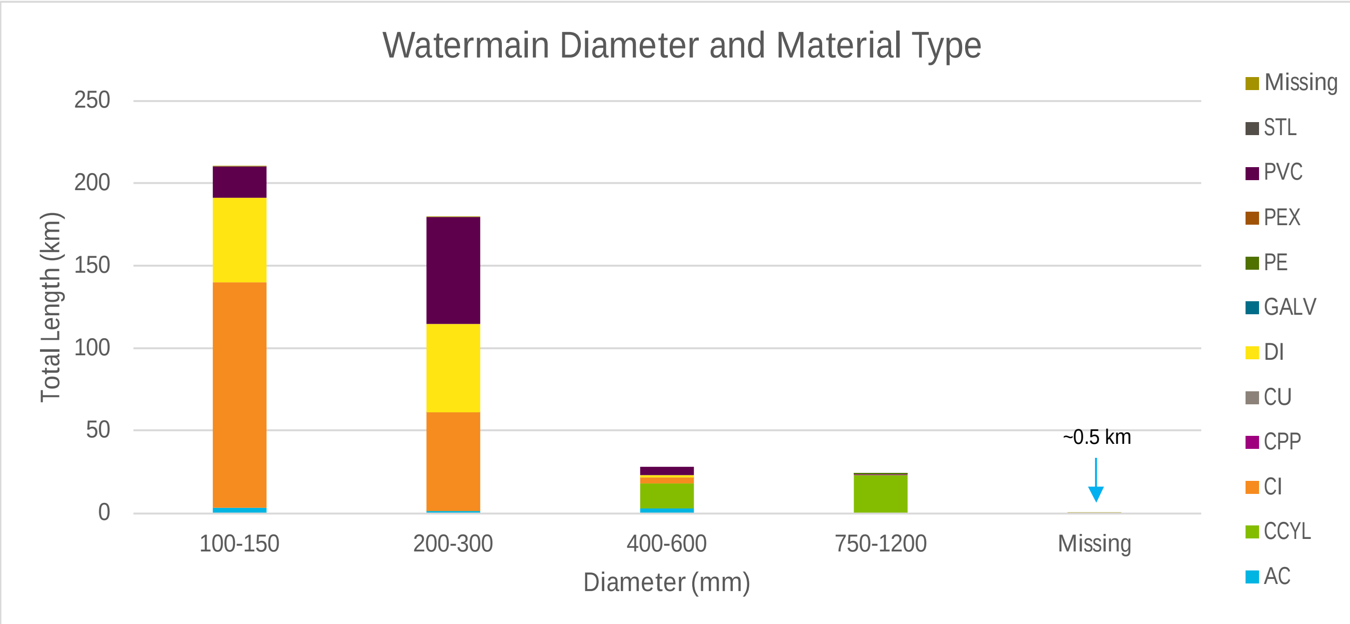


Figure 19: Length of Watermain by Diameter and Material Type

4.3.2 Service Connections Asset Inventory

The analysis is performed on service connections that are owned by PUC.

4.3.2.1 Age Profile

Figure 20 shows the distribution of age by length. The total length of service connections is approximately 255 km. According to the figure, more than half of the service connections were installed between 1950 and 1980 (~145 km). Roughly, 0.1 km of service connections is of unknown year of installation.

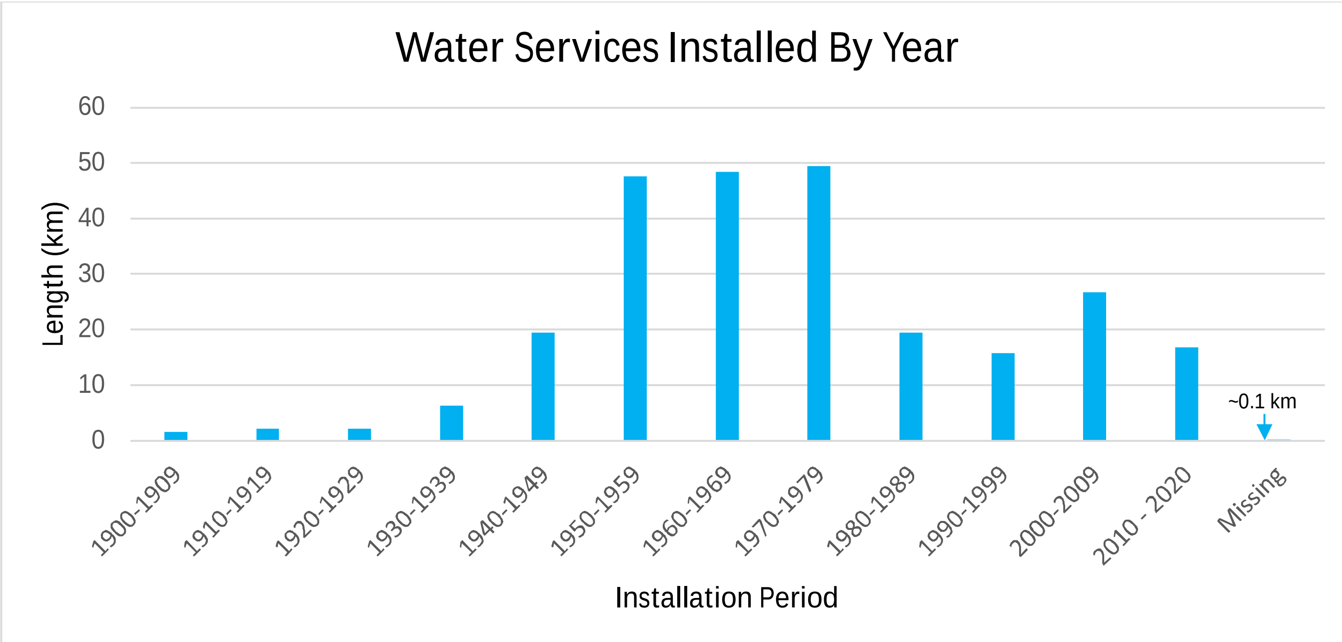


Figure 20: Length of Service Connections by Year

4.3.2.2 Material Profile

Based on the records, eight material types were observed in the GIS data. According to **Figure 21**, the majority of installed service connections were made of copper (~178 km). However, the data includes significant quantity of service connections of unknown material types (~70 km). Most larger services (100 mm and greater) are made of PVC, DI, and CI with a total length of 4 km (96% of large services total length).

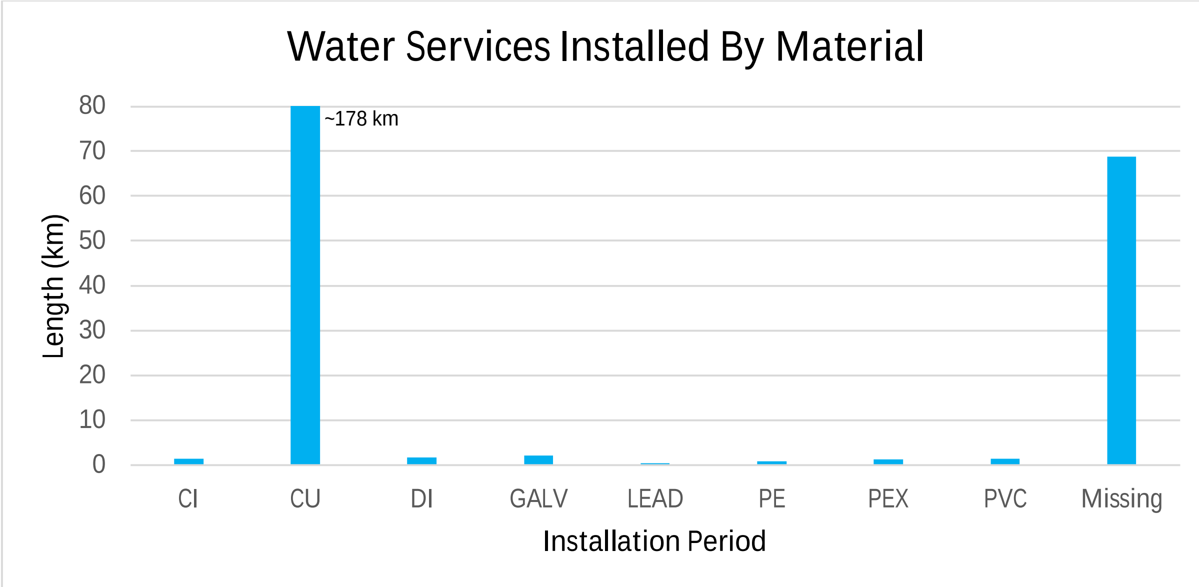


Figure 21: Length of Service Connections by Material

4.3.3 Non-Linear Asset Inventory

4.3.3.1 Water Meters

According to the records, there are 26,409 water meters installed in the water network. The data includes the year of installation which spans from 1950 to 2019. According to **Figure 22,** 28% (quantity of 7,342) of water meters were installed between 1980 and 1990. The same percentage of water meters counts was also found in the period between 2010 and 2020 (quantity of 7,337).

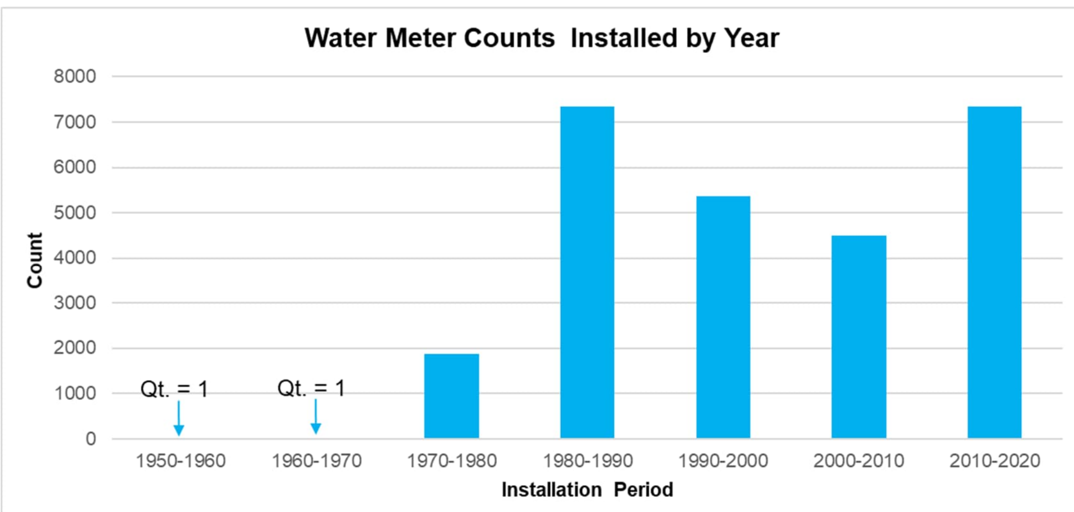


Figure 22: Water Meters Installed by Year

4.3.3.2 Fire Hydrants

There are 2,211 hydrants within the water network. Based on the records, only two hydrants have unknown installation dates. According to **Figure 23**, 11 hydrants were installed between 1910 and 1950. The majority of the hydrants were installed between 1960 and 1980 (quantity = 997).

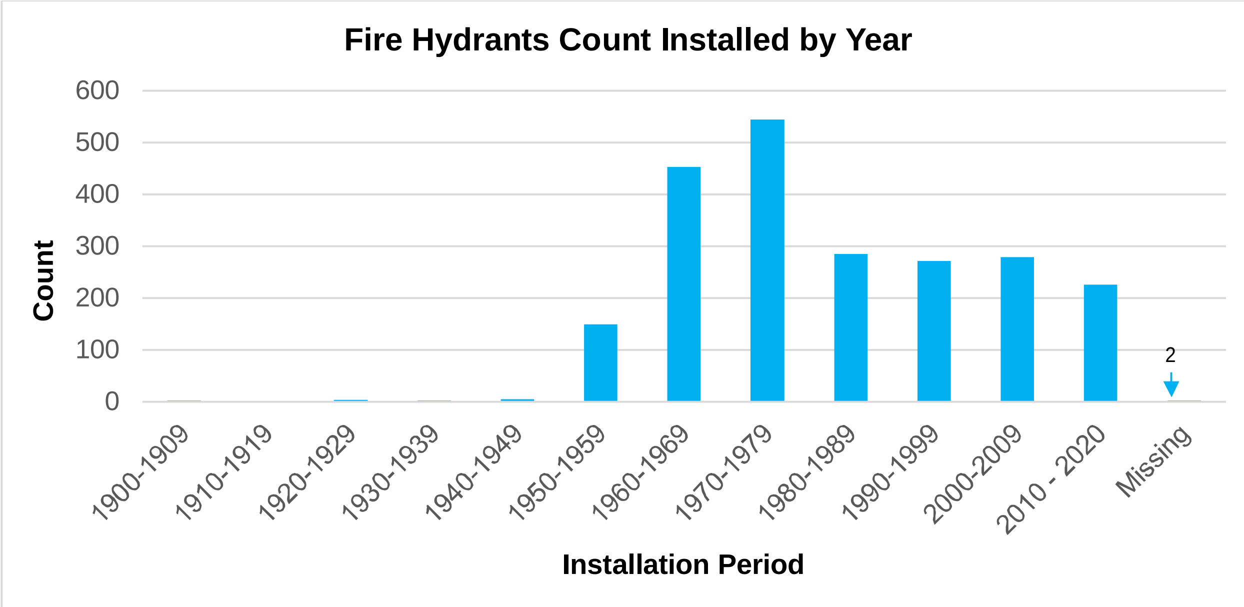


Figure 23: Fire Hydrants Count by Year

4.3.3.3 Control Valves

There are 2,059 control valves owned and operated by PUC. Roughly, half of the control valves range between 13 mm and 50 mm. Valves identified with an installation date of 1900 were considered to be anomalies and assigned as being in the "Missing" category (**Figure 24**).

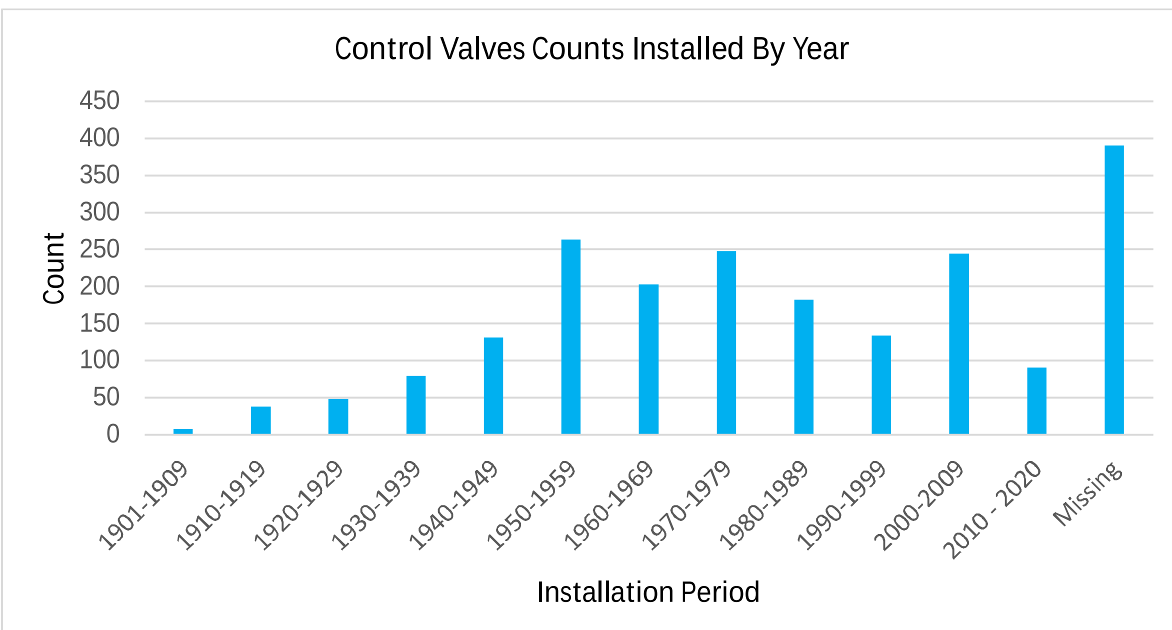


Figure 24: Control Valves Count by Year

4.3.4 Replacement Cost

The unit rates of each asset along with their quantities were used to estimate the approximate replacement values of existing water linear infrastructure. Based on the considered approximate costs, quantities and existing infrastructure, the total value was estimated at roughly $758 M as per **Figure 25**. Obviously, the dominant asset was the watermain followed by the services. More than 67% of the water network's replacement cost was dominated by pipelines equal to 300 mm and smaller (**Figure 26**). The total replacement cost of the watermains, fire hydrants, water meters and services were $650 M, $25 M, $6 M, and $78 M, respectively. Detailed replacements costs of watermains and services are shown in **Figure 26** and **Figure 27**. Even distribution of assets with missing attribute was considered as some assets had unknown diameters.

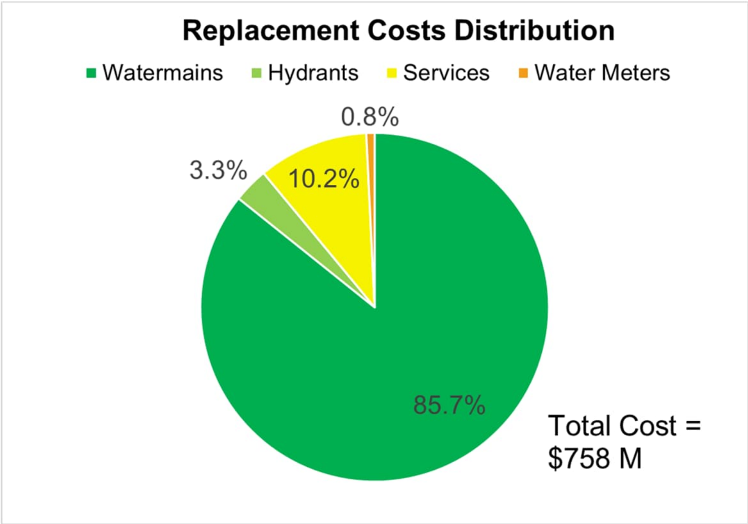


Figure 25: Water Linear Infrastructure Replacement Value Distribution

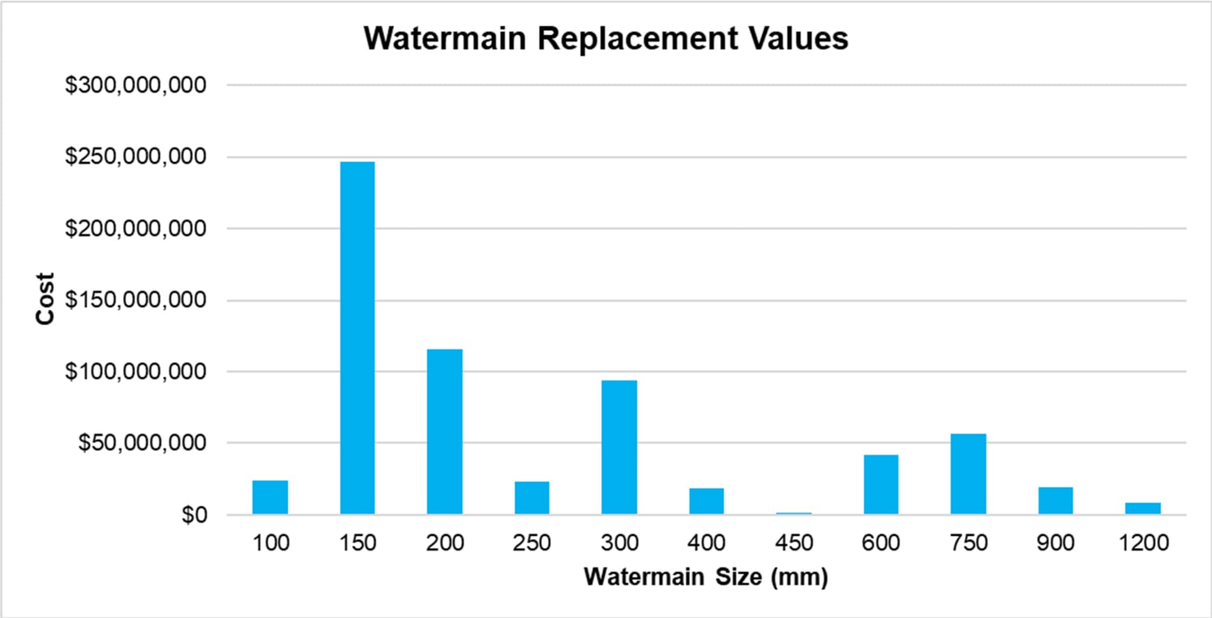


Figure 26: Watermain Replacement Costs

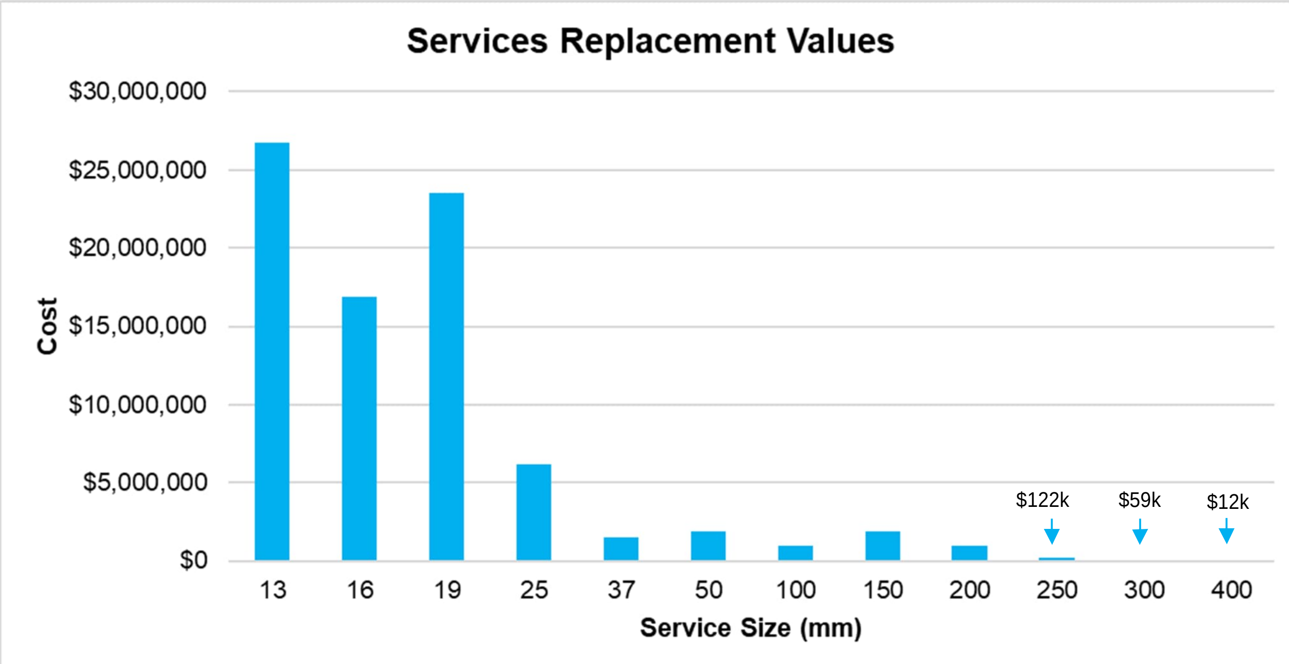


Figure 27: Water Service Replacement Values

4.3.5 Likelihood of Failure (LoF)

The desktop-based model was developed using several parameters that contribute to the calculation of the LoF (a proxy for condition information). These parameters assisted in categorizing the pipelines in severity groups that would help decision-makers to understand the state of the drinking water infrastructure and hence plan for the required interventions.

The methodology considered the age and the break counts as the main contributors in estimating the LoF. The aggregation of the scores were based on 30% of age-ESL scores and 70% of the break counts scores. For ferrous pipelines, a correction factor was estimated to account for the cathodic protection and soil corrosivity impacts. Depending on the degree of the assumed corrosivity of soil, the calculated LoF of ferrous pipelines would be amplified. However, the availability of anodes to certain pipelines would decrease the correction factors as illustrated in **Section 4.1.3.4**. All results were also mapped in **Appendix C**, which shows the scores assigned to each pipeline.

After implementing the methodology presented in **Section 4.1.3.4**, the LoF scores were computed and categorized based on a five-point scale. The scale ranged from Very Poor to Very Good with intermediate scales of Good, Fair and Poor. Based on **Figure 28**, the total length of the Very Poor LoF was approximately 39 km, while the total length of the Very Good category was roughly 215 km. **Figure 29** shows that the Very Poor category was mainly observed in diameter sizes of 200 mm and smaller with a total length of approximately 34 km. **Figure 30** illustrates that the majority of the Very Poor and Poor categories were observed in the CI and DI with a total length of roughly 77 km.

Further analysis was performed to check the CI and DI LoF scores at different time steps from 1910-2019. According to **Figure 31**, the majority of the pipelines' total length in Poor and Very Poor categories were installed between 1950 and 1980. In specific, approximately 47 km of CI pipelines installed between 1950-1970 dominated the majority of the two categories. Also, the majority of the Poor and Very Poor LoF of DI pipelines were installed between 1970-1980. In general, the wall thickness of CI and DI pipelines has tended to get thinner over time as manufacturing processes improved overall mechanical properties. The changes to manufacturing processes and design standards occurred at specified points in time resulting in “eras of construction” with associated pipe classes and wall thicknesses for each nominal diameter of pipe.

Two of the most important transitions were the introduction of centrifugal casting methods for cast iron pipe (as opposed to pit casting methods), and the replacement of grey CI with DI. In addition, in the early 1950s, the iron pipeline manufacturing process observed a transition in using copper services instead of lead services. The introduction of copper services into the metallic material manufacturing process changed the corrosion patterns from more generalized patterns to more localized forms due to galvanic effects. These changes, the decrease in wall thickness and the copper services, contributed significantly to increasing break rates in different jurisdictions in North America.

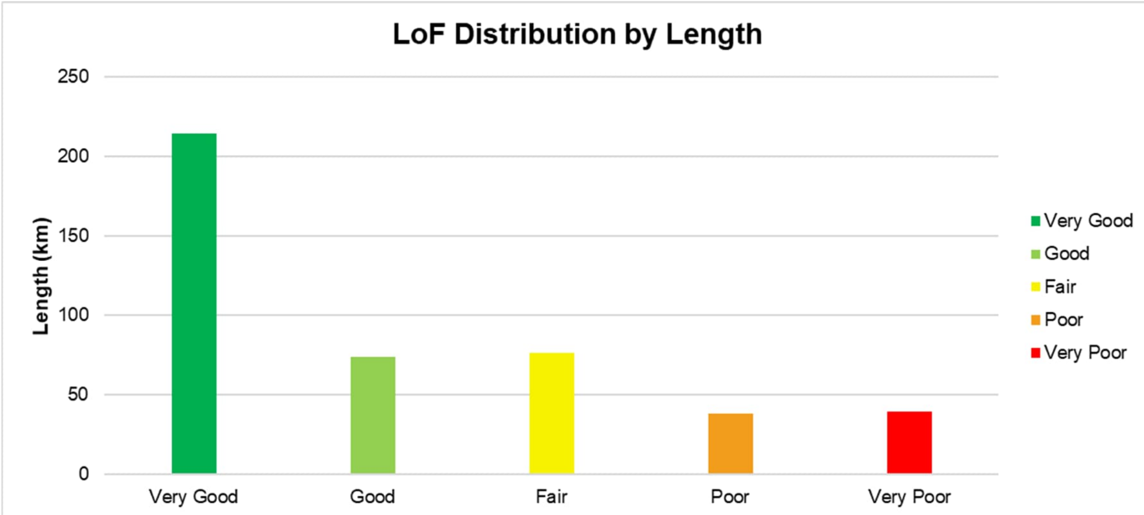


Figure 28: LoF by Length

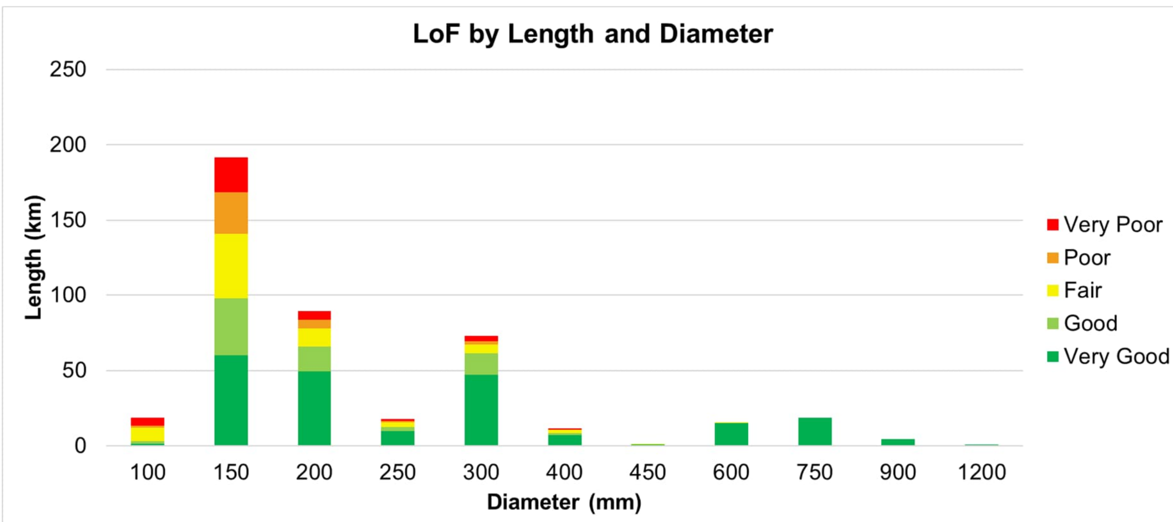


Figure 29: LoF by Length and Diameter

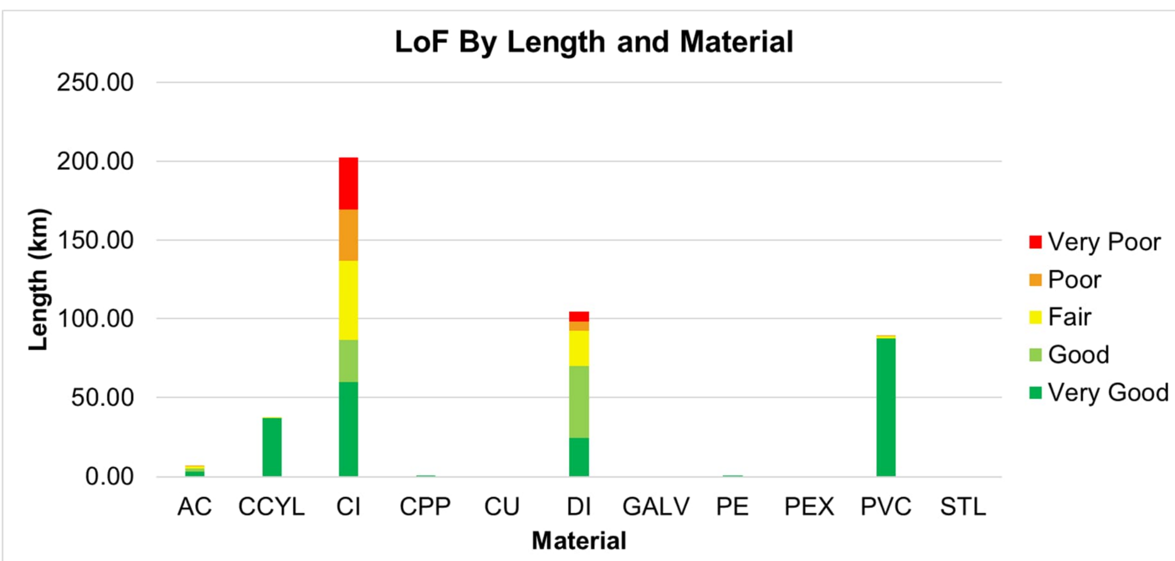


Figure 30: LoF by Material and Length

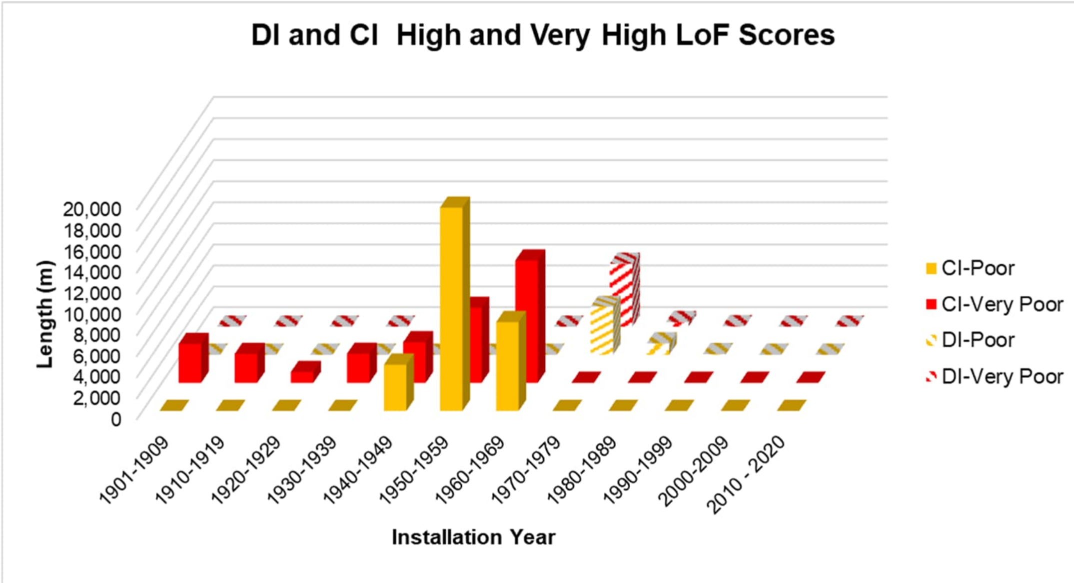


Figure 31: DI and CI Poor and Very Poor LoF Scores by Installation Year

4.3.6 Deterioration-Based Intervention Prediction

4.3.6.1 Investment Backlog

In developing an investment profile, the modes of analysis explored above focused on forecasting the future interventions (LoF/age-based) of the assets by extrapolating the current state/age of the inventory. However, it is also important to recognize that in the absence of dedicated programs for maintaining existing infrastructure, examining forgone requirements of assets from the past must form the second consideration for developing an investment profile. Generally, it is expected that assets that occupy this "backlog" must be addressed to avoid sudden failures.

In this analysis, backlog is presented for watermains, services, and hydrants, where watermain replacement costs also include control valves costs. As the oldest water meter was installed in 2000 and the ESL of water meters is approximately 20 years, no backlog was observed in water meters.

Based on the analyzed assets (watermains, services, and hydrants), the total backlog was approximately $72 M. As per **Figure 32**, watermain backlog dominated the total backlog amount with approximately $38 M. The other half of the total backlog was distinctly distributed on hydrants and services.

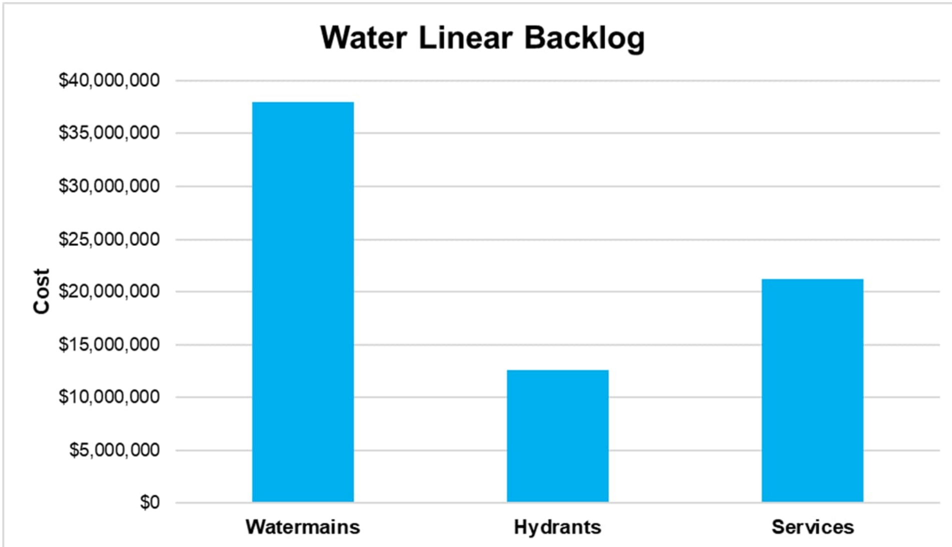


Figure 32: Backlog of Water Linear Asset

4.4 10-Year Deterioration-Based Intervention Costs

The presented methodology considered the replacements costs and the required intervention upon reaching an estimated service life or the intervention threshold (63%). The ESL was used for watermains, services, water meters, and hydrants as illustrated earlier. For example, a hydrant that reached an age of 21 in 2025 will be replaced in 2025.

Based on this analysis, expected replacements in the next 10 years total approximately $118 M with an average annual reinvestment (AAR_{10}) of $12 M (**Figure 33**), excluding backlog. With backlog included and distributed evenly during the 10 year period, the AAR_{10} would increase to approximately $19 M (**Figure 34**).

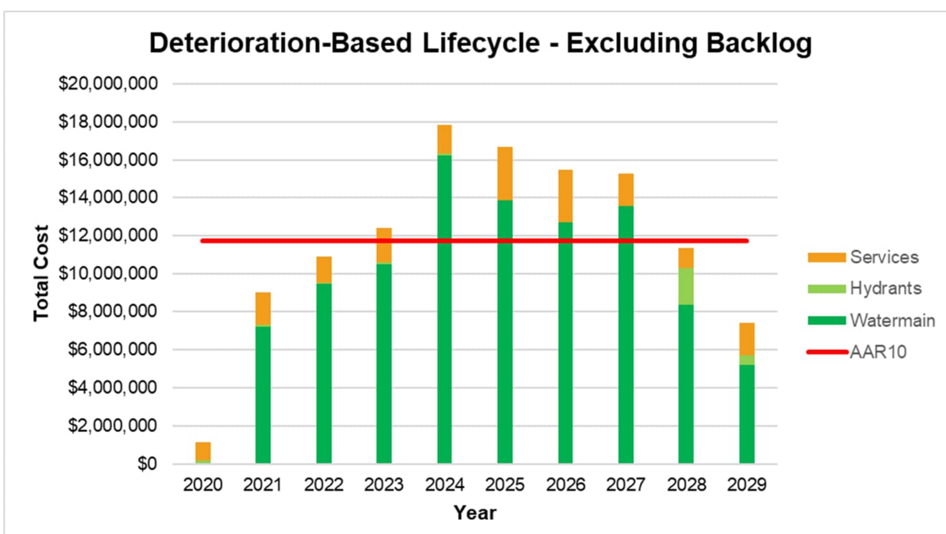


Figure 33: Deterioration-Based Lifecycle Intervention Costs – Excluding Backlog

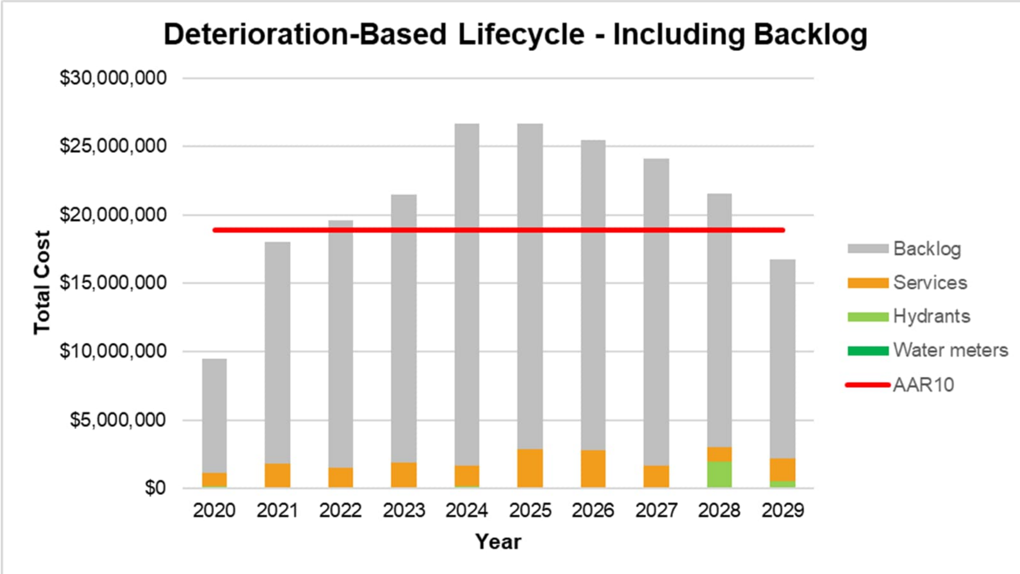


Figure 34: Deterioration-Based Lifecycle Intervention Costs – Including Backlog

While the backlog is observed to be extensive, it was prepared by only focusing on age and estimated service life. PUC has established a strategy to address this backlog by including a risk management approach to address highest priorities. PUC continues intervening to restore the conditions of the pipes by considering several technologies that are cost effective (watermain lining).

5. Data Verification and Condition Assessment Policies

5.1.1 Overview

Watermain condition assessment is an essential subject in water infrastructure asset management. It aids decision-makers in understanding the state of buried pipelines by either providing crisp measurements or visual observations. Methods range from desktop models, to leak detection programs, to high resolution and accurate scans via internal inspections. The selection of the type of technique used relies on many parameters such as:

- Direct costs
- Indirect costs
- Enabling work requirement
- Accuracy
- Resolution
- Productivity of the tool
- Risk of failure while inspection

Generally, best practices in assessment most of the pressure pipelines are based on a staged approach. Watermain condition assessment begins with simpler and less-costly inspections. Based on the results, advanced inspection tools that provide additional information and crisps values are implemented.

By conducting condition assessments, PUC may be able to:

1. Estimate the structural state of watermains and understand the ability of the pipeline to provide a satisfactory service now and in the future. This can be done by predicting the remaining service life based on a set of evaluation and measured parameters
2. Conclude optimal and justifiable decisions regarding watermain intervention actions to restore the condition of the water network. In such a case, PUC may be able to extend the service life of host pipes through a variety of rehabilitation methods. By understanding the condition of the pipeline and their structural state, PUC may avoid sudden failures, reduce annual number of breaks and increase the levels of service.
3. Reduce non-revenue water by detecting leaks once initiated.
4. Improve intervention judgements by matching certain rehabilitations depending on the failure mechanism of the mains
5. Verify alignment of buried watermains

By conducting advanced condition assessment platforms, PUC may be able to collect and verify data similar to the following:

1. Identify and measure loss of structural integrity through measurement of stiffness in hoop direction to estimate average remaining wall thickness through the application of acoustic platforms. Acoustic platforms, depending on the vendor, are able to detect and locate leaks within +/-1 m.
2. Locate evidence of liner and coating failure through the application of tethered platforms equipped with a camera.

3. Recognize visually if a pipe is deformed or not.
4. Estimate wire breaks of pre-stressed concrete cylinder pipes and verify the impact of such losses with existing applied loads.

5.1.2 Condition Assessment and Risk

One of the major parameters that warrant sustainable funding is associating the consequence of failure with the likelihood of failure, known as risk. Risk assessment is developed and calculated for each watermain asset to understand the adverse impacts in case the pipeline failed. For example, a pipeline located in vacant land and the another in the downtown will be treated differently. The latter pipeline, because of its sensitive location, will be prioritized to precisely understand its condition to avoid failure and disrupt the public. Such condition estimation is accomplished by utilizing advanced assessment platforms to understand the state of the pipelines.

One of the most adopted practices is the use of a stage-approach by relating the probability of failure with the consequence of failure to justify condition assessment requirements. Given the cost associated with many assessment techniques, it is important that the assessment of pressure pipe truly considers the combined risk of an asset, beginning with desktop assessment and progressing to more advanced methods of establishing condition where required. This progression should be driven by risk, material, observations, and suspected deterioration process. This is illustrated in **Figure 35**, demonstrating how the approach to condition assessment could scale with risk.

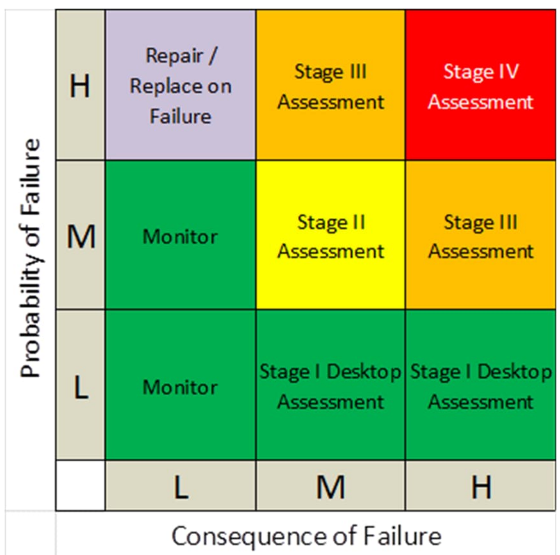


Figure 35: Risk Driven Staged Approach to Condition Assessment

Evident from **Figure 35** is that only high-risk assets may rationalize certain types of advanced condition assessment. The highest criticality assets must be managed proactively to avoid catastrophic failure. Doing so requires an accurate understanding of the asset's deterioration mechanisms, which can only be achieved through significant commitment of time and resources over its lifecycle. Different stages correspond to the degree of asset risk. Although advanced stages of assessment are expected to provide higher resolutions, the direct and indirect costs may be higher.

6. Summary and Recommendations

6.1 Summary

6.1.1 Facilities

A visual condition assessment of non-linear assets at the Gros Cap raw water pumping station and surface water treatment plant was conducted by AECOM between July 16 – 19, 2019. The condition scores for each asset were assigned based on a condition rating scale discussed in Section **3.2.4.** These condition scores will be used as a proxy for likelihood of failure (LoF) when calculating the risk scores.

This analysis will aid in building an informative risk-framework, AECOM's next steps, to prioritize interventions and condition assessment plans. By integrating the LoF with the consequence of failure (CoF), sustainable funding will be distributed along different study periods.

The summary below is only limited to assets captured by AECOM during condition assessment exercise due to the lack of updated asset inventory information. Refer to *TM#1 – Background Information Review and Gap Analysis* and Appendix B for additional details regarding the data limitations and scope of the condition assessment exercise.

6.1.1.1 Asset Inventory

- A total of 410 assets were recorded during the asset inventory and condition assessment exercise at Gross Cap raw water pumping station and surface water treatment plant. The assets captured were limited to process mechanical, process electrical and process structural.
- 85% of the assets recorded were located at the Surface Water Treatment Plant.
- In the surface water treatment plant, the greatest number of assets (99) were recorded at the Pipe Gallery (Basement) followed by High Lift Pumping Station (75).
- 62% of assets belonged to the Process Mechanical category followed by Process Electrical at ~34%.
- 71% of the Process Mechanical assets were Valves, 35% of Process Electrical assets were Motors and 90% of Process Structural assets were Tanks / Basins.
- 80% of the assets were installed in 1986 at Surface Water Treatment Plan and 98% of assets were installed in 1983 at Gros Cap.
- Of the 410 assets inventoried, 117 assets (~29%) had asset ID tags missing.
- There was no standard protocol followed for tagging asset IDs. For instance, while some valves had separate asset ID tags for the actuator and mechanical valve, others had a single asset ID tag.

6.1.1.2 Asset Condition

- Of the 410 assets recorded at both the facilities during the ICA exercise, 71% of the assets were observed to be in 2-Good condition followed by 18% which were observed to be in 3-Fair condition.
- Only 5 assets were observed to be in 4-Poor condition and 1 asset in 5-Very Poor condition. The only assets with a score of 4-Poor or worse were observed at Surface Water Treatment Plant.
- All assets with a score of *4-Poor* and *5-Very Poor* are original construction (circa 1986).
- Most assets installed in the past decade (2008 and later) were observed to be in 1-Very Good to 2-Good condition.

- Of the 5 assets in *4-Poor* condition, 3 were in Pipe Gallery (Main Floor) and 2 in Pipe Gallery (Basement). The only asset with a score of *5-Very Poor* was in Pipe Gallery (Basement).
- All assets with a condition score of *4-Poor* or more were Process Mechanical.
- All 5 assets with a score of *4-Poor* are Valves and the asset with a score of *5-Very Poor* is a Pump.
- All assets at Gros Cap Raw Water Pumping Station had a score of *3-Fair* or lower with most of the assets with a score of *2-Good*.

6.1.1.3 Asset Valuation

- Assets scored as *4-Poor* and *5-Very Poor* had replacement value of approximately $45,000.
- Most assets had a condition score of 2-Good which totalled approximately $6.5M.
- 90% of the $7.75M asset valuation was associated with assets installed during 1983 and 1986 (original construction).

6.1.2 Distribution System

The linear asset condition assessment was based on calculating the likelihood of failure (LoF) as a proxy to obtain an overview of the condition of the water pipelines. The methodology was based on a set of parameters, including age, break counts, soil types and corrosion protection. The calculated scores were categorized into five different groups: Very Poor, Poor, Fair, Good, and Very Good.

This analysis will aid in building an informative risk-framework, AECOM's next steps, to prioritize interventions and condition assessment plans. The LoF calculations will be a vital parameter in the risk equation as, in this report, it is considered as a proxy for condition estimation. By integrating the LoF with the consequence of failure (CoF), sustainable funding will be distributed along different study periods.

6.1.2.1 Asset Inventory

Age Inventory:

- Watermains in Sault Ste. Marie were installed between 1900 to 2019.
- Most of the pipelines were installed between 1950 and 1990 with a total length of 301 km (68% of the analyzed network).
- More than half of the service connections were installed between 1950 and 1980.
- Around 28% of water meters were installed between 1980 and 1990 and the same percentage was observed between 2010 and 2020.
- The majority of the hydrants were installed between 1960 and 1980.

Material Inventory:

- More than half of the total length of watermains was constructed using ferrous materials (69%, 307 km).
- Approximately, 20% (89 km) was constructed using PVC material, and roughly 9% (38 km), 2% (7 km) and 0.1% (0.6 km) were laid using CCYL, AC, and CCP, respectively.
- The majority of pipeline installed from 1900 to 1970 was constructed of CI.
- Installations of DI started in the 1970s with a significant increase afterwards.
- Thermoplastic pipelines started to emerge in the period of 1980-1990 and PVC was mostly used post 1990.
- The majority of installed services are made of copper.
- Approximately, 69 km of service connections are of unknown material type.

Diamater Inventory

- Approximately 88% (390 km) of the water network consisted of pipelines with diameter sizes of 100-300 mm.
- Diameter sizes ranging between 100 - 150 mm are most common in the network (47%) with a total length of 210 km.
- Around 68% of CI ranges between 100-150 mm with a total length of 137 km.
- Larger pipelines were mainly observed in CCYL, PE, and CPP.

6.1.2.2 Asset Condition

- Based on the estimated service life and from the analyzed pipelines, DI would deteriorate faster than other types.
- The total length of the Very Good category was roughly 215 km.
- The Very Poor category was observed in diameter sizes of 300 mm and smaller with a total length of approximately 39 km.
- The majority of the Very Poor and Poor categories were observed in the CI and DI.
- The majority of CI and DI pipelines' total length in Poor and Very Poor categories were installed between 1950 and 1980.

6.1.2.3 Asset Valuation

- The total replacement cost of watermains is estimated at approximately $650 M.
- The total replacement cost of water services is estimated at approximately $78 M.
- The total replacement cost of hydrants and water meters are estimated at approximately $29 M and $6 M, respectively.
- The total backlog is estimated at approximately $72 M. The majority of the backlog value may be due to watermains.
- The average annual reinvestment based on a10-year study period was approximately $12 M, excluding the backlog.
- The average annual reinvestment based on a 10-year period was approximately $19 M after distributing the $72 M backlog evenly over the 10-year period.

6.1.3 Recommendations

Based on task findings and observations, AECOM submits the following recommendations:

6.1.3.1 Facilities

1. As highlighted in *TM#1*, an updated asset inventory list with core asset attribute information is missing for most facilities. Thus, it is highly recommended that an asset inventory exercise, like the one performed for this project, be performed for all facilities. The asset inventory exercise detailed in **Appendix B** can be utilized to develop a framework for performing an asset inventory exercise and identify key asset attribute information to be recorded.
2. PUC must ensure all asset information recorded on paper must be compiled in electronic format such as CMMS.
3. Perform additional condition assessment including performance evaluation through manufacturers and suppliers is required to develop a comprehensive replacement and rehabilitation plan for a majority of the assets reaching their ESL that were assessed as a part of this project.

4. While the asset inventory exercise was limited to large process electrical, mechanical and structural assets, tasks in the future to capture asset inventory and condition assessment exercise must include all building and process assets.
5. All assets with missing unique asset IDs must be tagged.
6. Develop a standard protocol for assigning unique asset IDs. The protocol must define what assets and asset components are assigned a unique ID (for instance if an asset has large components with different ESLs (E.g., motors & mixers / valves & actuators), then each component must be tagged separately. This will enable an easier way of tracking O&M activities and assigning work orders within CMMS.
7. Develop a list of standard facility / asset naming convention to be used by all staff.
8. A work process is needed whereby all data collected in field books gets updated in CMMS.
9. PUC needs to ensure on an ongoing basis that as-built information is correctly uploaded to CMMS.
10. A document management system is needed to store O&M manuals.
11. Develop standards, procedures, and controls to clearly identify and define what infrastructure asset data exists, who is accountable for managing it, methods of data collection, and ensuring data quality. Benefits of such “data governance standards” will include:
    - Improved confidence in decision making and reporting on the CVRD’s infrastructure assets.
    - Improved enforcement of asset data integrity for engineering and financial analysis.
12. Develop a strategy for the management and documentation of “Inactive” assets to minimize risks (i.e. safety and environmental) and costs associated with their decommissioning / disposal.

6.1.3.2 Distribution System

1. Perform inventory review and updates of missing attributes. In some instances, the installation years of pipelines, diameter sizes, pipeline types were missing. Since the LoF methodology was directly dependent on these factors, the LoF values of individual pipelines may be impacted.
2. Conduct soil investigation and analysis to investigate the corrosivity of soil to obtain numeral data. Understanding the actual attributes of soil may promote the utilization of corrosion protection interventions rather than costly rehabilitations/replacements. In many instances, implementing corrosion protection was a cost-effective solution in low consequence areas.
3. Advanced condition assessment tools are recommended to be utilized to determine the actual conditions of the pipelines. However, to lessen the inspection costs, it is recommended to develop a consequence of failure model that will help to prioritize inspections.
4. Based on the likelihood of failure model, acoustic based technology platforms that measure the average wall thickness would be potential candidates for advanced inspections. As these technologies provide a discrete output (average), they would be effective in inspecting pipes with a generalized form of corrosion.
5. It is recommended to perform root-cause analysis on the extracted failed coupons to understand the exact causes of failure. It is also recommended to build a coupon database that stores the measurements of the coupon samples that can later be used for statistical analysis and predictions.
6. It is recommended to review the different classes and types of pipelines as some classes of material types are vulnerable.
7. It is recommended to perform an applied load analysis that integrates the internal and external pressure along with the deterioration aspects to have a better understanding of the remaining factor of safety values.

This concludes Technical Memo #3A – State of the Infrastructure.

Appendix TM3A

Appendix A

Asset Inventory List with Condition Scores

Item ID	Asset Description	Level 1 – Functional Group	Level 2 – Facility Type / Location	Level 3 – Process Location	Level 4 – Asset Category	Level 5 (Asset Type)	Unique ID	Nameplate Present?	Install Year	Refurbishment Year	Manufacturer	Model	Serial Number	Size / Capacity	Unit of Measure	Operating Conditions	Condition Score (1 to 5 Scale)	CoF Score (1 to 5 Scale)	CoF Score Comments	Age	ESL	RUL	Replacement Cost (2020)	Project Cost (includes Markup)	Risk Score (1 to 25 Scale)
1	Booster Pump#304	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Pump	Missing	Yes	1983	NA	Brier Hydraulics Limited	NA	83-4003	5548	GPM	1170 RPM, TDH = 210	3	3	• Raw Water Pump • 347 L/S (30 MLD) pump (Water Permit) & Plant Firm Capacity is 40 MLD and RW Total Pumping Capacity is 90 MLD • Remaining redundancy is 50%	37	20	-17	$ 75,000	$ 108,750	9
2	Motor Pump#304	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000065	Yes	1983	NA	US Motors	NA	J2990309 640711-855	400	HP	575 Volts, Ph 3, Hz 60, 1180 RPM	2	3	• Raw Water Pump • 347 L/S (30 MLD) pump (Water Permit) & Plant Firm Capacity is 40 MLD and RW Total Pumping Capacity is 90 MLD • Remaining redundancy is 50%	37	20	-17	$ 35,000	$ 50,750	6
3	Motor Pump#303	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	Missing	Yes	1983	NA	US Motors	NA	J2990309 640710-855	400	HP	575 Volts, Ph 3, Hz 60, 1180 RPM	2	3	• Raw Water Pump • 347 L/S (30 MLD) pump (Water Permit) & Plant Firm Capacity is 40 MLD and RW Total Pumping Capacity is 90 MLD • Remaining redundancy is 50%	37	20	-17	$ 35,000	$ 50,750	6
4	Booster Pump 303	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Pump	Missing	Yes	1983	NA	Brier Hydraulics Limited		83-4002	5548	GPM	1170 RPM, TDH = 210	3	3	• Raw Water Pump • 347 L/S (30 MLD) pump (Water Permit) & Plant Firm Capacity is 40 MLD and RW Total Pumping Capacity is 90 MLD • Remaining redundancy is 50%	37	20	-17	$ 75,000	$ 108,750	9
5	Booster Pump 302	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Pump	Missing	Yes	1983	NA	Brier hydraulics limited	Not available	83-4005	2774	GPM	18000 m^3/day	2	3	• Raw Water Pump • 147 L/S (15 MLD) pump (Water Permit) & Firm Capacity is 40 MLD and Total Capacity is 90 MLD • Remaining redundancy is 87%	37	20	-17	$ 60,000	$ 87,000	6
6	Booster Pump Motor 302	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000063	Yes	1983	NA	U.S. motors	Not available	CJ2990274 840657-823	200	HP		2	3	• Raw Water Pump • 147 L/S (15 MLD) pump (Water Permit) & Firm Capacity is 40 MLD and Total Capacity is 90 MLD • Remaining redundancy is 87%	37	20	-17	$ 18,500	$ 26,825	6
7	Booster Pump 301	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Pump	Missing	Yes	1983	NA	Brier hydraulics limited	Not available	83-4004	2774	GPM	18000 m^3/day	2	2	• Raw Water Pump • 147 L/S (15 MLD) pump (Water Permit) & Firm Capacity is 40 MLD and Total Capacity is 90 MLD • Remaining redundancy is 87%	37	20	-17	$ 60,000	$ 87,000	4
8	Booster Pump Motor 301	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000062	Yes	1983	NA	U.S. motors	Not available	CJ2990274 840658-823	200	HP	575V, 60Hz, 3 Ph	2	2	• Raw Water Pump • 147 L/S (15 MLD) pump (Water Permit) & Firm Capacity is 40 MLD and Total Capacity is 90 MLD • Remaining redundancy is 87%	37	20	-17	$ 18,500	$ 26,825	4
9	Check Valve (BP 302) R.W. 8	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000080	Yes	1983	NA	Val-Matic	9800	Not available	16	in		3	3	• Valve failure will cause RW Pump 302 Priming to fail • Redundancy drop to 87% The 88% was based on the raw water pump flow rates with 30 MLD for pumps 3 and 4 and 15 MLD for pumps 1 and 2. The firm capacity of the plant is 40 MLD so if we lose one of the 15 MLD pumps then your redundancy will be (30+30+15-40)/(40)=87%	37	35	-2	$ 20,000	$ 29,000	9
10	Air relief valve (BP 302) RW 10	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000146	Yes	1983	NA	GA Industries	XGH21-KT	83-3649	2	in		2	3	• Valve failure will cause RW Pump 302 Priming to fail and it is advisable not to operate without priming • Redundancy drop to 87%	37	35	-2	$ 1,000	$ 1,450	6
11	Check Valve (BP 301) R.W. 14	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000079	Yes	1983	NA	Val-Matic	9800	Not available	16	in		3	3	• Valve failure will cause RW Pump 302 Priming to fail • Redundancy drop to 87%	37	35	-2	$ 20,000	$ 29,000	9
12	Air relief valve (BP301) RW 16	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000145	Yes	1983	NA	GA Industries	XGH21-KT	1503933649	2	in		2	3	• Valve failure will cause RW Pump 302 Priming to fail and it is advisable not to operate without priming • Redundancy drop to 87%	37	35	-2	$ 1,000	$ 1,450	6
13	Butterfly Valve BV-5 901	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000067	No	1983	NA	Not available	Not available		18	in		2	3	• Valve failure will cause RW Pump 301 Priming to fail and it is advisable not to operate without priming • Redundancy drop to 87%	37	35	-2	$ 8,000	$ 11,600	6
14	Actuator Butterfly Valve RW 13	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Actuator	100000066	Yes	1983	NA	Limitorque	H, LCT-1356/32	350112				2	3	• Valve failure will cause RW Pump 301 Priming to fail and it is advisable not to operate without priming • Redundancy drop to 87%	37	25	-12	$ 6,000	$ 8,700	6
15	Butterfly Valve, Actuator BV-4 901 BP301	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Actuator	100000067	No	1983	NA	Limitorque	Not available	2160030	24	in		2	3	• Valve failure will cause RW Pump 303 Priming to fail and it is advisable not to operate without priming • Redundancy drop to 50%	37	25	-12	$ 6,000	$ 8,700	6
16	Butterfly Valve BV-4 902 BP302	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000073	No	1983	NA	Limitorque	Not available	2160030	24	in		3	3	• Valve failure will cause RW Pump 303 Priming to fail and it is advisable not to operate without priming • Redundancy drop to 50%	37	35	-2	$ 12,000	$ 17,400	9
17	Actuator Butterfly Valve RW 7	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Actuator	100000074	Yes	1983	NA	Limitorque	H	350111				2	3	• Valve failure will cause RW Pump 303 Priming to fail and it is advisable not to operate without priming • Redundancy drop to 50%	37	25	-12	$ 6,000	$ 8,700	6
18	Butterfly Valve Motorized Manifold (BV3 RW1)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000148	No	1983	NA	Limitorque	Not available	Not available	30	in		2	3	• Valve failure will cause the raw water header to fail • Redundancy drop to 50% • Long term operation of the plant will be affected due to limited raw water storage	37	35	-2	$ 18,500	$ 26,825	6
19	Actuator Butterfly Valve RW 1 BV3	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Actuator	Missing	Yes	1983	NA	Limitorque	4	M030778	1700	RPM	575 V, 60 Hz, 1/3 HP	2	3	• Valve failure will cause the raw water header to fail • Redundancy drop to 50% • Long term operation of the plant will be affected due to limited raw water storage • Can be reduced to 2 if manual operation of the valve is approved	37	25	-12	$ 6,000	$ 8,700	6
20	Butterfly Valve BV2 RW12	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000139	No	1983	NA	Limitorque	Not available	Not available	30	in		2	4	• Valve failure will cause pumps 1 and 3 to be isolated and inoperable • Redundancy drop to 0% • Long term operation of the plant will be affected due to limited raw water storage No redundancy; will leave other processes running over capacity	37	35	-2	$ 18,500	$ 26,825	8
21	Plug Valve BV9 SW1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000140	No	1983	NA	Jenkins	200 WOG	Not available	6	in		2	3	• Valve failure will isolate surge tank 2 • Redundancy drop to 50%	37	35	-2	$ 1,200	$ 1,740	6
22	Plug Valve SW3 (BV 8)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000138	No	1983	NA	Jenkins	200 WOG	Not available	6	in		2	3	• Valve failure will isolate surge tank 1 • Redundancy drop to 50%	37	35	-2	$ 1,200	$ 1,740	6

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23	Air relief valve (cooling water line)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000151	Yes	1983	NA	Val Matic	100	Not available	1	in		2	1	• Failure will not affect the operation of the cooling water line	37	35	-2	$ 600	$ 870	2
24	Air Compressor 1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Compressor	Missing	Yes	1983	NA	Ingersoll Rand	242-5C	543788				2	3	• Compressor failure will fail surge tank 1 • Redundancy drop to 50%	37	20	-17	$ 8,700	$ 12,615	6
25	Motor Air Compressor Fan 1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000121	Yes	1983	NA	Baldor	36B01Z65	M5218T-5	5	HP	575V, 3Ph, 60Hz	2	3	• Compressor failure will fail surge tank 1 • Redundancy drop to 50%	37	20	-17	$ 2,000	$ 2,900	6
26	Compressor Tank 1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Pressure Vessel	100000119	Yes	1983	NA	Ingersoll Rand	Not available	458793	30	Gallon	600V, 3Ph, 60Hz	2	3	• Compressor failure will fail surge tank 1 • Redundancy drop to 50%	37	20	-17	$ 800	$ 1,160	6
27	Compressor Disconnect 1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Disconnect	1E+09	Yes	1983	NA	Westinghouse	Not available	JHU361	20	HP	600 V, 3 Ph, 30 A	2	3	• Compressor failure will fail surge tank 1 • Redundancy drop to 50%	37	25	-12	$ 1,000	$ 1,450	6
28	Compressor Tank 2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Pressure Vessel	100000118	Yes	1983	NA	Ingersoll Rand	Not available	458817	30	Gallon		2	3	• Compressor failure will fail surge tank 2 • Redundancy drop to 50%	37	20	-17	$ 800	$ 1,160	6
29	Motor Air Compressor Fan 2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000120	Yes	1983	NA	Baldor	36B01Z65	M3218T-5	5	HP	575V, 3Ph, 60Hz	2	3	• Compressor failure will fail surge tank 2 • Redundancy drop to 50%	37	20	-17	$ 2,000	$ 2,900	6
30	Air Compressor 2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Compressor	Missing	Yes	1983	NA	Ingersoll Rand	2475	4017589				2	3	• Compressor failure will fail surge tank 2 • Redundancy drop to 50%	37	20	-17	$ 9,100	$ 13,195	6
31	Compressor Disconnect 2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Disconnect	100000116	No	1983	NA	Westinghouse	Not available	JHU361	20	HP	600 V, 3 Ph, 30 A	2	3	• Compressor failure will fail surge tank 2 • Redundancy drop to 50%	37	25	-12	$ 1,000	$ 1,450	6
32	Screen 1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Screen	100000089	Yes	1983	NA	Rexnord	SC 409	Not available				2	3	• Raw water screens has a redundancy of 100% as the plant has two screens (one working + one standby) • Raw water screen 1 failure will cause redundancy to drop to 0% but the plant would still meet its firm capacity	37	25	-12	$154,000	$ 223,300	6
33	Gear box and motor Screen 1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000089	Yes	1983	NA	Falk	1040FZK4A S-281.0	83200-20303-01				2	3	• Raw water screens has a redundancy of 100% as the plant has two screens (one working + one standby) • Raw water screen 1 failure will cause redundancy to drop to 0% but the plant would still meet its firm capacity 50% redundancy; duty & stand-by; can still operate if 1 screen fails.	37	20	-17	$ 2,000	$ 2,900	6
34	Bar screen 1 disconnect	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Disconnect	100000113	Yes	1983	NA	Westinghouse	Not available	JHU361	20	HP	600 V, 3 Ph, 30 A	2	3	• Raw water screens has a redundancy of 100% as the plant has two screens (one working + one standby) • Raw water screen 1 failure will cause redundancy to drop to 0% but the plant would still meet its firm capacity 50% redundancy; duty & stand-by; can still operate if 1 screen fails	37	25	-12	$ 1,000	$ 1,450	6
35	Motorized Ball Valve, Screen 1 (Valve)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000142	No	1983	NA	Not available	Not available	Not available	2	in		3	3	• Raw water screens has a redundancy of 100% as the plant has two screens (one working + one standby) • Raw water screen 1 failure will cause redundancy to drop to 0% but the plant would still meet its firm capacity	37	35	-2	$ 1,100	$ 1,595	9
36	Motorized Ball Valve, Screen 1 (Motor)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000142	Yes	1983	NA	Canadian worcester controls	10M 754 W	73 series	2	in	115V/0.7A/60Hz	3	3	• Raw water screens has a redundancy of 100% as the plant has two screens (one working + one standby) • Raw water screen 1 failure will cause redundancy to drop to 0% but the plant would still meet its firm capacity 50% redundancy; duty & stand-by; can still operate if 1 screen fails.	37	20	-17	$ 2,000	$ 2,900	9
37	Screen 2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Screen	100000090	Yes	1983	NA	Rexnord	SC 409	Not available				2	3	• Raw water screens has a redundancy of 100% as the plant has two screens (one working + one standby) • Raw water screen 1 failure will cause redundancy to drop to 0% but the plant would still meet its firm capacity 50% redundancy; duty & stand-by; can still operate if 1 screen fails.	37	25	-12	$154,000	$ 223,300	6
38	Gear box and motor Screen 2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000090	Yes	1983	NA	Falk	1040FZK4A S-281.0	83200-20303-02				2	3	• Raw water screens has a redundancy of 100% as the plant has two screens (one working + one standby) • Raw water screen 1 failure will cause redundancy to drop to 0% but the plant would still meet its firm capacity 50% redundancy; duty & stand-by; can still operate if 1 screen fails.	37	20	-17	$ 2,000	$ 2,900	6
39	Motorized Ball Valve, Screen 2 (Valve)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000143	No	2014	NA	Not available	Not available	Not available	2	in		2	3	• Raw water screens has a redundancy of 100% as the plant has two screens (one working + one standby) • Raw water screen 1 failure will cause redundancy to drop to 0% but the plant would still meet its firm capacity 50% redundancy; duty & stand-by; can still operate if 1 screen fails.	6	35	29	$ 1,100	$ 1,595	6
40	Motorized Ball Valve, Screen 2 (Motor)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000143	Yes	1983	NA	Canadian worcester controls	10M 754 W	73 series	2	in	115V/0.7A/60Hz	3	3	• Raw water screens has a redundancy of 100% as the plant has two screens (one working + one standby) • Raw water screen 1 failure will cause redundancy to drop to 0% but the plant would still meet its firm capacity 50% redundancy; duty & stand-by; can still operate if 1 screen fails.	37	20	-17	$ 2,000	$ 2,900	9
41	Barr screen 2 disconnect	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Disconnect	100000114	Yes	1983	NA	Westinghouse	Not available	JHU361	20	HP	600 V, 3 Ph, 30 A	2	3	• Raw water screens has a redundancy of 100% as the plant has two screens (one working + one standby) • Raw water screen 1 failure will cause redundancy to drop to 0% but the plant would still meet its firm capacity 50% redundancy; duty & stand-by; can still operate if 1 screen fails	37	25	-12	$ 1,000	$ 1,450	6
42	Starter Pump 303 Raw Water	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Starter	100000099	Yes	2016	NA	SAF	MS6-420-C	15 04 896	420A		600V, 3 Ph, 60 Hz	2	3	• Raw Water Pump • 347 L/S (30 MLD) pump (Water Permit) & Firm Capacity is 60 MLD and Total Capacity is 90 MLD • Remaining redundancy is 50%	4	30	26	$ 16,000	$ 23,200	6
43	Starter Pump 304 Raw Water	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Starter	100000098	Yes	1983	NA	SAF	SR6-700-6	15-6422	700A		600V, 3 Ph, 60 Hz	3	3	• Raw Water Pump • 347 L/S (30 MLD) pump (Water Permit) & Firm Capacity is 60 MLD and Total Capacity is 90 MLD • Remaining redundancy is 50%	37	30	-7	$ 16,000	$ 23,200	9

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44	Starter Pump 302 Raw Water	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Starter	100000097	Yes	1983	NA	SAF	SR6-700-6	15-6422	700A		600V, 3 Ph, 60 Hz	3	3	• Raw Water Pump • 147 L/S (15 MLD) pump (Water Permit) & Firm Capacity is 40 MLD and Total Capacity is 90 MLD • Remaining redundancy is 87%	37	30	-7	$ 16,000	$ 23,200	9
45	Starter Pump 301 Raw Water	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Starter	100000096	Yes	1983	NA	SAF	SR6-700-6	15-6422	700A		600V, 3 Ph, 60 Hz	3	3	• Raw Water Pump • 147 L/S (15 MLD) pump (Water Permit) & Firm Capacity is 40 MLD and Total Capacity is 90 MLD • Remaining redundancy is 87%	37	30	-7	$ 16,000	$ 23,200	9
46	Monorail disconnect	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Disconnect	100000102	Yes	1983	NA	Westinghouse	Not available	JHU361	20	HP	600 V, 3 Ph, 30 A	2	2	• Monorail failure will not affect operation but can hinder repair activities which is minor	37	25	-12	$ 1,000	$ 1,450	4
47	Check Valve (on p/p#304) R.W. #3	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000081	Yes	1983	NA	ValMatic	9800	NA	24	in	150 PSI	3	3	• Valve failure will cause RW Pump 304 to fail • Redundancy drop to 50%	37	35	-2	$ 26,000	$ 37,700	9
48	Check Valve (on p/p#303) R.W. #19	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000078	Yes	1983	NA	ValMatic	9800		24	in	150 PSI	2	3	• Valve failure will cause RW Pump 303 to fail • Redundancy drop to 50%	37	35	-2	$ 26,000	$ 37,700	6
49	Valve Butterfly (Pump #4)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000076	Yes	1983	NA	Not Available			24	in		2	3	• Main valve isolating LLP 4 based on the photos and valve size • Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	37	35	-2	$ 12,000	$ 17,400	6
50	Operator Butterfly Valve (RW#2) (Pump#4)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Actuator	100000075	Yes	1983	NA	LimiTorque	SMC 04	M030F69			0.33 HP, 60 HZ	2	3	• Main valve isolating LLP 4 based on the photos and valve size • Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	37	25	-12	$ 6,000	$ 8,700	6
51	Valve Butterfly BV 4-903 (Pump #3)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000070	Yes	1983	NA	Not Available			24	in		2	3	• Main valve isolating LLP 4 based on the photos and valve size • Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	37	35	-2	$ 12,000	$ 17,400	6
52	Operator Butterfly Valve (RW#18) (Pump#4)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Actuator	100000069	Yes	1983	NA	LimiTorque	SMC 04	19030770			0.33 HP, Freq 60 HZ	2	3	• Main valve isolating LLP 4 based on the photos and valve size • Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	37	25	-12	$ 6,000	$ 8,700	6
53	Valve Butterfly (RW#24)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000141	No	1983	NA	Vanessa			16	in		2	5	• Based on the photo, this seems to be the valve isolating Surge Tank 2 (BV-9) • Based on the PUC comment that the surge tanks should have a criticality of 5 and that both tanks are needed then it was assigned a score of 5	37	35	-2	$ 6,500	$ 9,425	10
54	Valve Butterfly (BV8) (RW#23)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000137	No	1983	NA	Vanessa			16	in		2	5	• BV 8 in the drawings of Gross CAP is the valve isolating Surge Tank 1 • Based on the PUC comment that the surge tanks should have a criticality of 5 and that both tanks are needed then it was assigned a score of 5	37	35	-2	$ 6,500	$ 9,425	10
55	Surge Tank #1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Pressure Vessel	100000114	Yes	1983	NA	O'Connor Tanks Limited	H-5176.5	5.635993			200 PSIG/F	2	4	• Water surge system redundancy drop to 0%	37	20	-17	$241,200	$ 349,740	8
56	Surge Tank #2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Pressure Vessel	100000115	Yes	1983	NA	O'Connor Tanks Limited	H-5176.5	5.635994			200 PSIG/F	2	4	• Water surge system redundancy drop to 0%	37	20	-17	$241,200	$ 349,740	8
57	Air Valve Surge Tank #2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000160	No	1983	NA	Conbraco Industries			1	in		2	4	• Valve failure will affect the operation of the surge tank • The shown valves in the photos are for the level indicator and not air relief. Those ones are not critical and are just isolation valves. Score should remain low in my opinion	37	35	-2	$ 1,000	$ 1,450	8
58	Air Valve Surge Tank #2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000161	No	1983	NA	Conbraco Industries			1	in		2	4	• Valve failure will affect the operation of the surge tank • The shown valves in the photos are for the level indicator and not air relief. Those ones are not critical and are just isolation valves. Score should remain low in my opinion	37	35	-2	$ 1,000	$ 1,450	8
59	Control Panel Surge Tank #2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Control Panel	100000133	No	1983	NA	Hammond Manufacturing	1418-D8				120 volt	2	4	• Failure of the Panel will affect the surge protection Tank #2	37	25	-12	$ 5,500	$ 7,975	8
60	Air Valve Surge Tank #1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000158	No	1983	NA	Conbraco Industries			1	in		2	4	• Valve failure will affect the operation of the surge tank • The shown valves in the photos are for the level indicator and not air relief. Those ones are not critical and are just isolation valves. Score should remain low in my opinion	37	35	-2	$ 1,000	$ 1,450	8
61	Air Valve Surge Tank #1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000159	No	1983	NA	Conbraco Industries			1	in		2	4	• Valve failure will affect the operation of the surge tank • The shown valves in the photos are for the level indicator and not air relief. Those ones are not critical and are just isolation valves. Score should remain low in my opinion	37	35	-2	$ 1,000	$ 1,450	8
62	Control Panel Surge Tank #1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Control Panel	100000132	No	1983	NA	Hammond Manufacturing	1418-D8				120 volt	2	4	• Failure of the Panel will affect the surge protection Tank #1	37	25	-12	$ 5,500	$ 7,975	8

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63	Valve Limitorque (Main)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000131	Yes	1983	NA	LimiTorque	VBT9.5/8	M002454	1200 x 1200	mm	NA	2	3	• Gate valves used for isolating the raw water screens • Based on 100% redundancy of the two screens and the interconnectivity of the two raw water wells, this won't affect production The photos don't show which valve is this but they seem to be the gate valves used in the gross cap station to isolate the screens. Based on 100% redundancy of the screens this was given a score of 3. Those are 6 valves but only 5 are in the gross cap PS drawings	37	35	-2	$ 34,000	$ 49,300	6
64	Valve Limitorque	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000130	Yes	1983	NA	LimiTorque	VBT9.5/8	M002450	1200 x 1200	mm	NA	2	3	• Gate valves used for isolating the raw water screens • Based on 100% redundancy of the two screens and the interconnectivity of the two raw water wells, this won't affect production The photos don't show which valve is this but they seem to be the gate valves used in the gross cap station to isolate the screens. Based on 100% redundancy of the screens this was given a score of 3. Those are 6 valves but only 5 are in the gross cap PS drawings	37	35	-2	$ 34,000	$ 49,300	6
65	Valve Limitorque	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000128	Yes	1983	NA	LimiTorque	VBT9.5/8	M002455	1200 x 1200	mm	NA	2	3	• Gate valves used for isolating the raw water screens • Based on 100% redundancy of the two screens and the interconnectivity of the two raw water wells, this won't affect production	37	35	-2	$ 34,000	$ 49,300	6
66	Valve Torque	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000126	Yes	1983	NA	LimiTorque	VBT9.5/8	M002446	1200 x 1200	mm	NA	2	3	• Gate valves used for isolating the raw water screens • Based on 100% redundancy of the two screens and the interconnectivity of the two raw water wells, this won't affect production The photos don't show which valve is this but they seem to be the gate valves used in the gross cap station to isolate the screens. Based on 100% redundancy of the screens this was given a score of 3. Those are 6 valves but only 5 are in the gross cap PS drawings	37	35	-2	$ 34,000	$ 49,300	6
67	Valve Torque	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000127	Yes	1983	NA	LimiTorque	VBT9.5/8	M002448	1200 x 1200	mm	NA	2	3	• Gate valves used for isolating the raw water screens • Based on 100% redundancy of the two screens and the interconnectivity of the two raw water wells, this won't affect production The photos don't show which valve is this but they seem to be the gate valves used in the gross cap station to isolate the screens. Based on 100% redundancy of the screens this was given a score of 3. Those are 6 valves but only 5 are in the gross cap PS drawings	37	35	-2	$ 34,000	$ 49,300	6
68	Valve Torque	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000129	Yes	1983	NA	LimiTorque	VBT9.5/8	M002452	1200 x 1200	mm	NA	2	3	• Gate valves used for isolating the raw water screens • Based on 100% redundancy of the two screens and the interconnectivity of the two raw water wells, this won't affect production The photos don't show which valve is this but they seem to be the gate valves used in the gross cap station to isolate the screens. Based on 100% redundancy of the screens this was given a score of 3. Those are 6 valves but only 5 are in the gross cap PS drawings	37	35	-2	$ 34,000	$ 49,300	6
69	Air Relief Low Lift 1	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000404	Yes	1986	NA	Not available	Not available	1502843683	1	in		2	2	• Valve failure will cause LL Pump 1 Priming to fail • Redundancy is 100%	34	35	1	$ 600	$ 870	4
70	Air Relief Valve low lift 2	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000415	Yes	1986	NA	Not available	Not available	1502843683	1	in		2	3	• Valve failure will cause LL Pump 2 Priming to fail • Redundancy drop to 87%	34	35	1	$ 600	$ 870	6
71	Air Relief Valve low lift 4	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000444	Yes	1986	NA	Not available	Not available	1502843683	1	in		2	3	• Valve failure will cause LL Pump 4 Priming to fail • Redundancy drop to 87%	34	35	1	$ 600	$ 870	6
72	Air Relief Valve low lift 3	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000428	Yes	1986	NA	Not available	Not available	1502843683	1	in		2	3	• Valve failure will cause LL Pump 3 Priming to fail • Redundancy drop to 87%	34	35	1	$ 600	$ 870	6
73	Low Lift Pump #1	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Pump	300000407	Yes	1986	NA	Peerless Pump	16HH	244570	175	L/s		2	2	• Total LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Redundancy is 100%	34	20	-14	$ 25,000	$ 36,250	4
74	Low Lift Pump Motor #1	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Pump	300000401	Yes	1986	NA	U.S. Motors	RUE WPI	9402981-940 R2119182 K0460257	30	HP	575V/60Hz/3Ph	2	2	• Total LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Redundancy is 100%	34	20	-14	$ 3,500	$ 5,075	4
75	Low Lift Pump #2	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Pump	300000419	Yes	1986	NA	Peerless Pump	20HH	244582	350	L/s		2	3	• Total LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Redundancy drop to 87%	34	20	-14	$ 35,000	$ 50,750	6
76	Low Lift Pump Motor #2	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Pump	300000418	Yes	1986	NA	U.S. Motors	RUE WPI	9403070-943 R2119261 K0460264	60	HP	575V/60Hz/3Ph	2	3	• Total LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Redundancy drop to 87%	34	20	-14	$ 5,500	$ 7,975	6
77	Low Lift Pump #3	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Pump	300000431	Yes	1986	NA	Peerless Pump	20HH	244581	350	L/s		2	3	• Total LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Redundancy drop to 87%	34	20	-14	$ 35,000	$ 50,750	6
78	Low Lift Pump Motor #3	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Pump	300000430	Yes	1986	NA	U.S. Motors	RUE WPI	9403070-943 R2119260 K0460264	60	HP	575V/60Hz/3Ph	2	3	• Total LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Redundancy drop to 87%	34	20	-14	$ 5,500	$ 7,975	6
79	Low Lift Pump #4	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Pump	300000447	Yes	1986	NA	Peerless Pump	20HH	244583	350	L/s		2	3	• Total LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Redundancy drop to 87%	34	20	-14	$ 35,000	$ 50,750	6
80	Low Lift Pump Motor #4	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Pump	300000446	Yes	1986	NA	U.S. Motors	RUE WPI	9403070-943 R2119262 K0460264	60	HP	575V/60Hz/3Ph	2	3	• Total LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Redundancy drop to 87%	34	20	-14	$ 5,500	$ 7,975	6
81	Mixer Inlet Blender #3	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Mixer	300000398	Yes	1986	NA	Lightnin	8-LBS-5	180159				3	3	• Plant Firm Capacity is 40 MLD according to water permit • Mixer is installed on pump outlet and losing a mixer will take the pump offline • Redundancy drop to 87%	34	40	6	$ 35,600	$ 51,620	9

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82	Mixer Inlet Blender Motor #3	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Motor	300000397	Yes	1986	NA	Brook crompton Parkinson Ltd	2425209-01		5	HP	575V/60HZ/3Ph	2	3	• Plant Firm Capacity is 40 MLD according to water permit • Mixer is installed on pump outlet and losing a mixer will take the pump offline • Redundancy drop to 87%	34	20	-14	$ 2,000	$ 2,900	6
83	Mixer Inlet Blender #4	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Mixer	300000439	Yes	1986	NA	Lightnin	8-LBS-5	480157				3	3	• Plant Firm Capacity is 40 MLD according to water permit • Mixer is installed on pump outlet and losing a mixer will take the pump offline • Redundancy drop to 87%	34	40	6	$ 35,600	$ 51,620	9
84	Mixer Inlet Blender Motor #4	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Motor	300000439	Yes	1986	NA	Brook crompton Parkinson Ltd	2425209-01		5	HP	575V/60HZ/3Ph	2	3	• Plant Firm Capacity is 40 MLD according to water permit • Mixer is installed on pump outlet and losing a mixer will take the pump offline • Redundancy drop to 87%	34	20	-14	$ 2,000	$ 2,900	6
85	Mixer Inlet Blender #1	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Mixer	300000424	Yes	1986	NA	Lightnin	8-LBS-5	480160				3	2	• Plant Firm Capacity is 40 MLD according to water permit • Mixer is installed on pump outlet and losing a mixer will take the pump offline • Redundancy is 100%	34	40	6	$ 35,600	$ 51,620	6
86	Mixer Inlet Blender Motor #1	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Motor	300000423	Yes	1986	NA	Brook crompton Parkinson Ltd	2425209-01		5	HP	575V/60HZ/3Ph	2	2	• Plant Firm Capacity is 40 MLD according to water permit • Mixer is installed on pump outlet and losing a mixer will take the pump offline • Redundancy is 100%	34	20	-14	$ 2,000	$ 2,900	4
87	Mixer Inlet Blender Motor #2	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Motor	300000411	Yes	1986	NA	Brook crompton Parkinson Ltd	2425209-01		5	HP	575V/60HZ/3Ph	2	3	• Plant Firm Capacity is 40 MLD according to water permit • Mixer is installed on pump outlet and losing a mixer will take the pump offline • Redundancy drop to 87%	34	20	-14	$ 2,000	$ 2,900	6
88	Mixer Inlet Blender #2	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Mixer	300000412	Yes	1986	NA	SPXFLOW	8-LBS-5	34701				2	3	• Plant Firm Capacity is 40 MLD according to water permit • Mixer is installed on pump outlet and losing a mixer will take the pump offline • Redundancy drop to 87%	34	40	6	$ 35,600	$ 51,620	6
89	Isolation Sluice Gate Valve S.G. 1	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	Missing	Yes	1986	NA	Limitorque	VBT3/5	M003505	5	in		3	3	• This gate isolates raw water well#1 and well#2 and losing this gate will take two of the pumps offline • Redundancy drop to 50%	34	35	1	$ 25,200	$ 36,540	9
90	Valve gate east inlet surge relief	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000741	No	1986	NA	Jenkins	200 WOG		12	in		2	5	• Losing the surge relief valve will affect the protection of the raw water wells Also protect transmission main between marshal drive tanks and treatment plant. If failed, if start and stop flow from marshal drive it could rupture transmission main or damage piping in the plant. • In the drawing and the drinking water permit there is no explanation if the surge relief system has any redundancy or nor. The assumption was that one surge relief tank will be sufficient and that's why a low score of 2 was assigned. If both tanks has to be in service, then a score of 5 is acceptable. • Based on the drawings from the gross cap PS, I would be more inclined to assume that one tank is enough. The drawings show that each two pumps have their own surge tank and there is a valve to switch to the other tank but I can't confirm	34	35	1	$ 4,000	$ 5,800	10
91	Valve gate east inlet surge relief	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000743	No	1986	NA	Jenkins	200 WOG		12	in		2	5	• Losing the surge relief valve will affect the protection of the raw water wells Also protect transmission main between marshal drive tanks and treatment plant. If failed, if start and stop flow from marshal drive it could rupture transmission main or damage piping in the plant. • In the drawing and the drinking water permit there is no explanation if the surge relief system has any redundancy or nor. The assumption was that one surge relief tank will be sufficient and that's why a low score of 2 was assigned. If both tanks has to be in service, then a score of 5 is acceptable. • Based on the drawings from the gross cap PS, I would be more inclined to assume that one tank is enough. The drawings show that each two pumps have their own surge tank and there is a valve to switch to the other tank but I can't confirm	34	35	1	$ 4,000	$ 5,800	10
92	Valve gate west inlet surge relief	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000744	No	1986	NA	Jenkins	200 WOG		12	in		2	5	• Losing the surge relief valve will affect the protection of the raw water wells	34	35	1	$ 4,000	$ 5,800	10
93	Valve gate west inlet surge relief	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000746	No	1986	NA	Jenkins	200 WOG		12	in		2	5	• Losing the surge relief valve will affect the protection of the raw water wells	34	35	1	$ 4,000	$ 5,800	10

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94	Valve, Inlet surge relief west	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000745	No	1986	NA	GA industries inc			12	in		2	5	• Losing the surge relief valve will affect the protection of the raw water wells Also protect transmission main between marshal drive tanks and treatment plant. If failed, if start and stop flow from marshal drive it could rupture transmission main or damage piping in the plant. • In the drawing and the drinking water permit there is no explanation if the surge relief system has any redundancy or nor. The assumption was that one surge relief tank will be sufficient and that's why a low score of 2 was assigned. If both tanks has to be in service, then a score of 5 is acceptable. • Based on the drawings from the gross cap PS, I would be more inclined to assume that one tank is enough. The drawings show that each two pumps have their own surge tank and there is a valve to switch to the other tank but I can't confirm	34	35	1	$ 4,000	$ 5,800	10
95	Valve Inlet surge relief east	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000742	No	1986	NA	GA industries inc			12	in		2	5	• Losing the surge relief valve will affect the protection of the raw water wells	34	35	1	$ 4,000	$ 5,800	10
96	Valve ball raw water isolating	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000748	Yes	1986	NA	Bingham-Willamette co	84012	15028436	24	in		2	5	• Losing this valve will disrupt raw water supply to the plant and affect plant firm capacity	34	35	1	$ 20,000	$ 29,000	10
97	Actuator for Valve ball raw water isolating	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Electrical	Actuator	300000748	Yes	1986	NA	Limitorque	SMC 00 003-172	L375071	24	in		2	5	• Losing this valve will disrupt raw water supply to the plant and affect plant firm capacity • As it was found that this is the only raw water isolation valve on the header within the gross cap PS building then it has zero redundancy and was elevated to 5	34	25	-9	$ 6,000	$ 8,700	10
98	Motor for Valve ball raw water isolating	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Electrical	Motor	300000748	Yes	1986	NA	Limitorque		77V6874M-7K	75	HP		2	5	• Losing this valve will disrupt raw water supply to the plant and affect plant firm capacity As it was found that this is the only raw water isolation valve on the header within the gross cap PS building then it has zero redundancy and was elevated to 7	34	20	-14	$ 11,000	$ 15,950	10
99	Actuator Low Lift #1 Isolating Valve	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Actuator	300000399	No	1986	NA	Limitorque		JM036008		na	1700 RPM, 575V, .33 HP	2	2	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 100%	34	25	-9	$ 6,000	$ 8,700	4
100	Actuator Low Lift #1 Gear Box	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Actuator	300000400	Yes	1986	NA	Torkmatic		289476	59.1	Ratio		2	2	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 100%	34	25	-9	$ 6,000	$ 8,700	4
101	Valve Low Lift #1 Isolating	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000402	Yes	1986	NA	Jenkins	150B		18	in		2	2	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 100%	34	35	1	$ 10,000	$ 14,500	4
102	Valve Low Lift #1 Check	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000406	Yes	1986	NA	Jenkins	200 WOG	AB 7125 EO	10	in		2	2	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 100%	34	35	1	$ 9,000	$ 13,050	4
103	Valve Low Lift #2 Check	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000413	Yes	1986	NA	Jenkins	175WOC	AB7125EM	14	in		2	3	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	34	35	1	$ 16,000	$ 23,200	6
104	Valve Low Lift #2 Isolating	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000408	Yes	1986	NA	Jenkins	150B		18	in		2	3	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	34	35	1	$ 10,000	$ 14,500	6
105	Actuator Low Lift #2 Isolating Valve	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Actuator	300000408	No	1986	NA	Limitorque		JM036007		na	1700 RPM, 575V, .33 HP	2	3	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	34	25	-9	$ 6,000	$ 8,700	6
106	Actuator Low Lift #2 Gear Box	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Actuator	300000410	Yes	1986	NA	Torkmatic		289475	59.1	Ratio		2	3	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	34	25	-9	$ 6,000	$ 8,700	6
107	Valve Low Lift #3 Check	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000425	Yes	1986	NA	Jenkins	175WOC	AB7125EM	14	in		2	3	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	34	35	1	$ 16,000	$ 23,200	6
108	Valve Low Lift #3 Isolating	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000422	Yes	1986	NA	Jenkins	150B		18	in		2	3	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	34	35	1	$ 10,000	$ 14,500	6
109	Actuator Low Lift #3 Gear Box	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Actuator	300000421	Yes	1986	NA	Torkmatic		289477	59.1	Ratio		2	3	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	34	25	-9	$ 6,000	$ 8,700	6
110	Actuator Low Lift #3 Isolating Valve	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Actuator	300000420	No	1986	NA	Limitorque		M002006		na	1700 RPM, 575V, .33 HP	2	3	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	34	25	-9	$ 6,000	$ 8,700	6
111	Valve Low Lift #4 Check	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000441	Yes	1986	NA	Jenkins	175WOC	AB7125EM	14	in		2	3	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	34	35	1	$ 16,000	$ 23,200	6

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112	Valve Low Lift #4 Isolating	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000437	Yes	1986	NA	Jenkins	150B		18	in		2	3	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	34	35	1	$ 10,000	$ 14,500	6
113	Actuator Low Lift #4 Isolating Valve	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Actuator	300000435	No	1986	NA	Limitorque		JM036009		na	1700 RPM, 575V, .33 HP, 60HZ	2	3	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	34	25	-9	$ 6,000	$ 8,700	6
114	Actuator Low Lift #4 Gear Box	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Actuator	300000436	Yes	1986	NA	Torkmatic		290374	59.1	Ratio		2	3	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	34	25	-9	$ 6,000	$ 8,700	6
115	Energy Recovery Turbines	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Motor	Missing	Yes	2010	NA	EPACT-HPE		BTP708120400 1			1770 HP, 60 HZ, 3 Phase, 575 Volts	2	1	• Energy recovery system will not affect water production	10	20	10	$ 11,000	$ 15,950	2
116	Valve Butterfly Energy Turbine Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000752	Yes	2010	NA	Dzurik			24	in		2	1	• Energy recovery system will not affect water production	10	35	25	$ 12,000	$ 17,400	2
117	Valve Butterfly Energy Turbine Bypass	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000752	Yes	2010	NA	Dzurik		908854R017	24	in		2	1	• Energy recovery system will not affect water production	10	35	25	$ 12,000	$ 17,400	2
118	Valve Butterfly Energy Turbine Outlet	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000754	Yes	2010	NA	Dzurik		93885147R017	24	in		2	1	• Energy recovery system will not affect water production	10	35	25	$ 12,000	$ 17,400	2
119	Valve Butterfly Raw Water Well 1 Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000755	Yes	1986	NA	Jenkins	150B	AB2544K0A2	30	in		2	3	• Losing one raw water well bring the Low lift pumping redundancy to 50%	34	35	1	$ 18,500	$ 26,825	6
120	Butterfly Valve Raw Well	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000751	Yes	1986	NA	Jenkins	150B	AB2544HM	24	in		2	3	• Losing one raw water well bring the Low lift pumping redundancy to 50%	34	35	1	$ 12,000	$ 17,400	6
121	Blender Motor #1 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	No	1986	NA	Sylvania		T77U031	30	A	600V/60Hz/3ph	2	2	• Plant Firm Capacity is 40 MLD according to water permit • Mixer is installed on pump outlet and losing a mixer will take the pump offline • Redundancy is 100%	34	30	-4	$ 10,000	$ 14,500	4
122	Blender Motor #2 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	No	1986	NA	Sylvania		T77U031	30	A	600V/60Hz/3ph	2	3	• Plant Firm Capacity is 40 MLD according to water permit • Mixer is installed on pump outlet and losing a mixer will take the pump offline • Redundancy drop to 87%	34	30	-4	$ 10,000	$ 14,500	6
123	Blender Motor #3 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	No	1986	NA	Sylvania		T77U031	30	A	600V/60Hz/3ph	2	3	• Plant Firm Capacity is 40 MLD according to water permit • Mixer is installed on pump outlet and losing a mixer will take the pump offline • Redundancy drop to 87%	34	30	-4	$ 10,000	$ 14,500	6
124	Blender Motor #4 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	No	1986	NA	Sylvania		T77U031	30	A	600V/60Hz/3ph	2	3	• Plant Firm Capacity is 40 MLD according to water permit • Mixer is installed on pump outlet and losing a mixer will take the pump offline • Redundancy drop to 87%	34	30	-4	$ 10,000	$ 14,500	6
125	Low lift Motor #1 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			60	A	600V/60Hz/3ph	2	2	• Valve failure will cause LL Pump 1 Priming to fail • Redundancy is 100%	34	30	-4	$ 10,000	$ 14,500	4
126	Low lift Motor #2 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			100	A	600V/60Hz/3ph	2	3	• Valve failure will cause LL Pump 2 Priming to fail • Redundancy drop to 87%	34	30	-4	$ 13,000	$ 18,850	6
127	Low lift Motor #3 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			100	A	600V/60Hz/3ph	2	3	• Valve failure will cause LL Pump 4 Priming to fail • Redundancy drop to 87%	34	30	-4	$ 13,000	$ 18,850	6
128	Low lift Motor #4 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			100	A	600V/60Hz/3ph	2	3	• Valve failure will cause LL Pump 3 Priming to fail • Redundancy drop to 87%	34	30	-4	$ 13,000	$ 18,850	6
129	ATS	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	MCC	Missing	No	2011	2018	ASCO	J07ATS030 225R5X0	652220	225 A		600V/3ph/	2	5	• Losing the low lift PS ATS will cause the plant to stop running	2	30	28	$ 25,000	$ 36,250	10
130	Floc agitator #3 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			15	A	600V/60Hz/3ph	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	30	-4	$ 10,000	$ 14,500	8
131	Floc agitator #4 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			15	A	600V/60Hz/3ph	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	30	-4	$ 10,000	$ 14,500	8
132	Floc agitator #2 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			15	A	600V/60Hz/3ph	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	30	-4	$ 10,000	$ 14,500	8
133	Floc agitator #1 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			15	A	600V/60Hz/3ph	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	30	-4	$ 10,000	$ 14,500	8
134	Low lift #2 capacitor bank	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	No	1986	NA	ASEA			15	kVa	600V/60Hz/3ph	2	3	• Total LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Redundancy drop to 87%	34	30	-4	$ 10,000	$ 14,500	6
135	Inline Booster Pump Motor Starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	Yes	1986	NA	Sylvania	T77U031	7707	25	A		2	4	• Unique asset with similar description could not be identified in the as-built drawings. Based on PUC comment that the inline booster pump was needed to supply carrier water for the chemical system then it was increased to 4 along with associated assets	34	30	-4	$ 10,000	$ 14,500	8

Item ID	Asset Description	Level 1 – Functional Group	Level 2 – Facility Type / Location	Level 3 – Process Location	Level 4 – Asset Category	Level 5 (Asset Type)	Unique ID	Nameplate Present?	Install Year	Refurbishment Year	Manufacturer	Model	Serial Number	Size / Capacity	Unit of Measure	Operating Conditions	Condition Score (1 to 5 Scale)	CoF Score (1 to 5 Scale)	CoF Score Comments	Age	ESL	RUL	Replacement Cost (2020)	Project Cost (includes Markup)	Risk Score (1 to 25 Scale)
136	Floc agitator #1 disconnect	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Electrical	Disconnect	Missing	No	1986	NA	Westinghouse			30	A	600V/60Hz/3ph	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	25	-9	$ 1,000	$ 1,450	8
137	Floc agitator #2 disconnect	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Electrical	Disconnect	Missing	No	1986	NA	Westinghouse			30	A	600V/60Hz/3ph	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	25	-9	$ 1,000	$ 1,450	8
138	Floc agitator #3 disconnect	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Electrical	Disconnect	Missing	No	1986	NA	Westinghouse			30	A	600V/60Hz/3ph	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	25	-9	$ 1,000	$ 1,450	8
139	Floc agitator #4 disconnect	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Electrical	Disconnect	Missing	No	1986	NA	Westinghouse			30	A	600V/60Hz/3ph	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	25	-9	$ 1,000	$ 1,450	8
140	MCC E Feeder	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #1 (M)	Process Electrical	Feeder	Missing	No	1986	2011	Westinghouse			250	A	600V/60Hz/3ph	2	5	• Losing the MCC will affect the plant production	9	30	21	$ 10,000	$ 14,500	10
141	High lift #3 starter	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #2 (M)	Process Electrical	Starter	Missing	No	1986	NA	Westinghouse			540	A	600V/60Hz/3ph	3	3	• The plant has a firm capacity and each HLP is 30 MLD • The capacity is 50%	34	30	-4	$ 16,000	$ 23,200	9
142	Surface wash pump Motor #2 starter	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #1 (M)	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			60	A	600V/60Hz/3ph	2	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	30	-4	$ 10,000	$ 14,500	4
143	Surface wash pump Motor #1 starter	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #1 (M)	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			60	A	600V/60Hz/3ph	2	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	30	-4	$ 10,000	$ 14,500	4
144	Backwash pump Motor #1 starter	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #2 (M)	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			200	A	600V/60Hz/3ph	2	4	• Losing backwash will affect production and losing one pump will make redundancy 0%	34	30	-4	$ 13,000	$ 18,850	8
145	Backwash pump Motor #2 starter	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #2 (M)	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			200	A	600V/60Hz/3ph	2	4	• Losing backwash will affect production and losing one pump will make redundancy 0%	34	30	-4	$ 13,000	$ 18,850	8
146	Supernatant pump Motor #1 starter	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #2 (M)	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			9	A	600V/60Hz/3ph	2	4	• Supernatant pump is needed to discharge the decanted water to Little Carp creek • This pump has a redundancy of 0%	34	30	-4	$ 5,000	$ 7,250	8
147	Sludge pump Motor #2 starter	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #2 (M)	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			25	A	600V/60Hz/3ph	2	4	• Sludge pump is needed to discharge the sludge to sewer • This pump has a redundancy of 0%	34	30	-4	$ 10,000	$ 14,500	8
148	Soda Ash compressor breaker	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #2 (M)	Process Electrical	Breaker	Missing	No	2015	NA	Westinghouse				A	600V/60Hz/3ph	2	3	• Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; compliance point for corrosion abatement. Compressor not critical to operation, full time service not required, downtime allows addition of backup compressor. Low humidity in plant has reduced operational need for process to support Soda Ash system, can be a 2	5	20	15	$ 5,000	$ 7,250	6
149	Soda Ash makeup system breaker	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #2 (M)	Process Electrical	Breaker	Missing	No	2015	NA	Westinghouse				A	600V/60Hz/3ph	2	3	• Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; compliance point for corrosion abatement.	5	20	15	$ 5,000	$ 7,250	6
150	Soda Ash hot water heater system breaker	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #2 (M)	Process Electrical	Breaker	Missing	No	2015	NA	Westinghouse				A	600V/60Hz/3ph	2	3	• Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; compliance point for corrosion abatement.	5	20	15	$ 5,000	$ 7,250	6
151	Alum Pump No. 1	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Alum	Process Mechanical	Pump	300000812	Yes	2018	NA	Prominent		2017115631	42	L/s	120VAC/60Hz	2	3	• Alum pumps are needed to run the plant and assuming that running the plant requires at least two pumps to achieve the needed dose which is not identified in the drinking water permit • Redundancy is 33% Only 1 alum pump is needed to run at plant capacity.	2	20	18	$ 5,500	$ 7,975	6
152	Alum Pump No. 2	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Alum	Process Mechanical	Pump	300000813	Yes	2018	NA	Prominent		2016179648	42	L/s	120VAC/60Hz	2	3	• Alum pumps are needed to run the plant and assuming that running the plant requires at least two pumps to achieve the needed dose which is not identified in the drinking water permit • Redundancy is 33% Only 1 alum pump is needed to run at plant capacity.	2	20	18	$ 5,500	$ 7,975	6
153	Alum Pump No. 3	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Alum	Process Mechanical	Pump	300000814	Yes	2018	NA	ProMinent		2017115626	42	L/s	120VAC/60Hz	2	3	• Alum pumps are needed to run the plant and assuming that running the plant requires at least two pumps to achieve the needed dose which is not identified in the drinking water permit • Redundancy is 33% Only 1 alum pump is needed to run at plant capacity.	2	20	18	$ 5,500	$ 7,975	6
154	Alum Tank No. 1	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Alum	Process Structural	Tanks / Basins	300000028	No	2018	NA				11000	L		2	4	• Losing alum tank will affect production and losing one tank will make redundancy 0%	2	60	58	$ 59,700	$ 86,565	8
155	Alum Tank No. 2	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Alum	Process Structural	Tanks / Basins	300000029	No	2018	NA				11000	L		2	4	• Losing alum tank will affect production and losing one tank will make redundancy 0%	2	60	58	$ 59,700	$ 86,565	8

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156	Alum Day Tank	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Alum	Process Structural	Tanks / Basins	300000027	No	2018	NA				245	L		2	2	• Losing alum day tank will affect production but the drawings don't show it so the pumps can draw directly from the storage tanks • Alum can be drawn straight from storage tanks in an emergency.	2	60	58	$ 1,000	$ 1,450	4
157	Chlorine Vacuum Regulator	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Cl2 Gas	Process Mechanical	Regulator	300000791	No	2015	NA	Evoqua	W3T75615	BZ1460492-1				1	5	• Losing the vacuum regulator will cause chlorination to be affected and the plant will not be operated	5	20	15	$ 4,500	$ 6,525	5
158	Pre chlorine injector	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Cl2 Gas	Process Mechanical	Injector	300000788	No	2016	NA	Evoqua	W3T99146					1	3	• Pre Chlorine is not needed for regulatory purposes but needed to prevent operational problems at the plant	4	20	16	$ 3,000	$ 4,350	3
159	Standby chlorine injector	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Cl2 Gas	Process Mechanical	Injector	300000789	No	2016	NA	Evoqua	W3T99146					1	4	• Post chlorinator is needed for disinfection and has 100% redundancy	4	20	16	$ 3,000	$ 4,350	4
160	Post chlorine injector	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Cl2 Gas	Process Mechanical	Injector	300000790	No	2016	NA	Evoqua	W3T99146					1	4	• Post chlorinator is needed for disinfection and has 100% redundancy	4	20	16	$ 3,000	$ 4,350	4
161	Post chlorine injector solenoid	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Cl2 Gas	Process Mechanical	Injector	300000787	No	2016	NA	ASCO		T517554			120VAC	1	4	• Post chlorinator is needed for disinfection and has 100% redundancy	4	20	16	$ 1,400	$ 2,030	4
162	Standby chlorine injector solenoid	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Cl2 Gas	Process Mechanical	Injector	300000796	No	2016	NA	ASCO		T517554			120VAC	1	4	• Post chlorinator is needed for disinfection and has 100% redundancy	4	20	16	$ 1,400	$ 2,030	4
163	Pre chlorine injector solenoid	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Cl2 Gas	Process Mechanical	Injector	300000795	No	2016	NA	ASCO		T517554			120VAC	1	3	• Pre Chlorine is not needed for regulatory purposes but needed to prevent operational problems at the plant	4	20	16	$ 1,400	$ 2,030	3
164	Blended Phosphate Pump No. 1	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Blended Phosphate	Process Mechanical	Pump	Missing	Yes	2015	NA	ProMinent		2014247945	19.1	L/s	115VAC/60Hz	2	3	• Phosphate system is needed for corrosion control however its short term failure won't cause the production to stop Score increased from 2 to 3; regulatory requirement.	5	20	15	$ 7,500	$ 10,875	6
165	Blended Phosphate Pump No. 2	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Blended Phosphate	Process Mechanical	Pump	Missing	Yes	2015	NA	ProMinent		2014247945	19.1	L/s	115VAC/60Hz	2	3	• Phosphate system is needed for corrosion control however its short term failure won't cause the production to stop Score increased from 2 to 3; regulatory requirement.	5	20	15	$ 7,500	$ 10,875	6
166	Blended Phosphate Tank No. 1	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Blended Phosphate	Process Structural	Tanks / Basins	Missing	No	2015	NA				600	L		2	3	• Phosphate system is needed for corrosion control however its short term failure won't cause the production to stop	5	60	55	$ 1,500	$ 2,175	6
167	Blended Phosphate Tank No. 2	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Blended Phosphate	Process Structural	Tanks / Basins	Missing	No	2015	NA	Chemline	DMT135	673W	600	L		2	3	• Phosphate system is needed for corrosion control however its short term failure won't cause the production to stop Score increased from 2 to 3; regulatory requirement.	5	60	55	$ 1,500	$ 2,175	6
168	Soda Ash Hopper	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Structural	Hopper	Missing	No	2015	NA	Felxicon	75866	2014F0702-ALP63				2	3	• Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; regulatory requirement.	5	30	25	$ 65,000	$ 94,250	6
169	Soda Ash feeder	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	Missing	Yes	2015	NA	U.S. Motors						2	3	• Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; regulatory requirement.	5	20	15	$ 2,000	$ 2,900	6
170	Soda Ash mixer	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	Missing	No	2015	NA	SPX						2	3	• Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; regulatory requirement.	5	20	15	$ 2,000	$ 2,900	6
171	Soda Ash transfer pump motor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	Missing	Yes	2015	NA	E line	EM102	ELP1P3G	1.4	A		2	3	• Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; regulatory requirement.	5	20	15	$ 2,000	$ 2,900	6
172	Soda Ash Filter	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Filter	Missing	No	2015	NA	Hayward						2	3	• Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; regulatory requirement.	5	20	15	$ 2,500	$ 3,625	6
173	Soda Ash transfer pump	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	Missing	Yes	2015	NA	Goulds	3196	7040123	9	m^3/h		2	3	• Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; regulatory requirement.	5	20	15	$ 7,100	$ 10,295	6
174	Soda Ash Solution Tank	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Structural	Chemical Tanks	Missing	No	2015	NA	ACO	OT500		1100	L		2	3	• Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; regulatory requirement.	5	30	25	$ 2,000	$ 2,900	6
175	Soda Ash Tank Mixer	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	Missing	No	2015	NA	SPX						2	3	• Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; regulatory requirement.	5	20	15	$ 2,000	$ 2,900	6
176	Soda Ash dosing pump no. 1	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	Missing	Yes	2015	NA	Bredel	BREDAL 25	70771				2	3	• Soda Ash system is needed for pH stabilization however (failure of 1 pump) its in the short term failure won't cause the production to stop this score should remain at 2 as there is 100% redundancy for the dosing pumps	5	20	15	$ 21,300	$ 30,885	6
177	Soda Ash dosing pump no. 2	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	Missing	Yes	2015	NA	Bredel	BREDAL 25	70770				2	3	• Soda Ash system is needed for pH stabilization however (failure of 1 pump) its in the short term failure won't cause the production to stop this score should remain at 2 as there is 100% redundancy for the dosing pumps	5	20	15	$ 21,300	$ 30,885	6

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178	Soda Ash dosing pump no. 1 gearbox	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Gearbox	Missing	Yes	2015	NA	Bredel	CB3133 SBT					2	3	● Soda Ash system is needed for pH stabilization however (failure of 1 pump) its in the short term failure won't cause the production to stop this score should remain at 2 as there is 100% redundancy for the dosing pumps	5	20	15	Cost Included in Pump	Cost Included in Pump	6
179	Soda Ash dosing pump no. 1 motor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	Missing	Yes	2015	NA	Baldor	35J302M21 8G1		0.75	HP	575V/60HZ/3	2	3	● Soda Ash system is needed for pH stabilization however (failure of 1 pump) its in the short term failure won't cause the production to stop	5	20	15	$ 500	$ 725	6
180	Soda Ash dosing pump no. 2 gearbox	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Gearbox	Missing	Yes	2015	NA	Bredel	CB3133 SBT					2	3	● Soda Ash system is needed for pH stabilization however (failure of 1 pump) its in the short term failure won't cause the production to stop this score should remain at 2 as there is 100% redundancy for the dosing pumps	5	20	15	Cost Included in Pump	Cost Included in Pump	6
181	Soda Ash dosing pump no. 2 motor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	Missing	Yes	2015	NA	Baldor	35J302M21 8G1		0.75	HP	575V/60HZ/3	2	3	● Soda Ash system is needed for pH stabilization however (failure of 1 pump) its in the short term failure won't cause the production to stop this score should remain at 2 as there is 100% redundancy for the dosing pumps	5	20	15	$ 500	$ 725	6
182	Soda Ash Compressor Tank	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Structural	Tanks / Basins	Missing	Yes	2015	NA	Atlas Copco	Not available	Not available	80	Gallon		1	3	● Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; no backup; regulatory requirement.Compressor not critical to operation of Soda Ash system, can be a 2	5	60	55	$ 3,600	$ 5,220	3
183	Soda Ash Compressor Motor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	Missing	Yes	2015	NA	Baldor	36G548S59 4G1		5	HP	575V/60HZ/3	1	3	● Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; no backup; regulatory requirement.Compressor not critical to operation of Soda Ash system, can be a 2	5	20	15	$ 2,000	$ 2,900	3
184	Soda Ash Compressor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Compressor	Missing	Yes	2015	NA	Atlas copco	AR5V5753 P2P	9610502152				1	3	● Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; no backup; regulatory requirement.Compressor not critical to operation of Soda Ash system, can be a 2	5	20	15	$ 6,700	$ 9,715	3
185	UV System 3	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	UV Treatment	Missing	Yes	2017	NA	VIQUA	PRO20	160402463	20		120VAC/1 single	2	1	● Assuming on UV reactor per filter which is necessary for achieving the disinfection level ● Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence ● The redundancy is 0% with all 4 filters Score decreased from 4 to 1; filter for internal use; not distribution or production.	3	30	27	$ 6,900	$ 10,005	2
186	UV System 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	UV Treatment	Missing	Yes	2017	NA	VIQUA	PRO20	160402461	20		120VAC/1 single	2	1	● Assuming on UV reactor per filter which is necessary for achieving the disinfection level ● Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence ● The redundancy is 0% with all 4 filters Score decreased from 4 to 1; filter for internal use; not distribution or production.	3	30	27	$ 6,900	$ 10,005	2
187	UV System 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	UV Treatment	Missing	Yes	2017	NA	VIQUA	PRO20	160402462	20		120VAC/1 single	2	1	● Assuming on UV reactor per filter which is necessary for achieving the disinfection level ● Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence ● The redundancy is 0% with all 4 filters Score decreased from 4 to 1; filter for internal use; not distribution or production.	3	30	27	$ 6,900	$ 10,005	2
188	UV System 4	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	UV Treatment	Missing	Yes	2017	NA	VIQUA	PRO20	160402464	20		120VAC/1 single	2	1	● Assuming on UV reactor per filter which is necessary for achieving the disinfection level ● Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence ● The redundancy is 0% with all 4 filters Score decreased from 4 to 1; filter for internal use; not distribution or production.	3	30	27	$ 6,900	$ 10,005	2
189	UV System 1 Solenoid Valve	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Valve	Missing	Yes	2017	NA	VIQUA		A546863	20	in	6.9 Watts/24 VDC	2	1	● Assuming on UV reactor per filter which is necessary for achieving the disinfection level ● Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence ● The redundancy is 0% with all 4 filters Score decreased from 4 to 1; filter for internal use; not distribution or production.	3	35	32	$ 1,200	$ 1,740	2

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190	UV System 2 Solenoid Valve	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Valve	Missing	Yes	2017	NA	VIQUA		A495288	20	in	6.9 Watts/24 VDC	2	1	• Assuming on UV reactor per filter which is necessary for achieving the disinfection level • Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters Score decreased from 4 to 1; filter for internal use; not distribution or production.	3	35	32	$ 1,200	$ 1,740	2
191	UV System 3 Solenoid Valve	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Valve	Missing	Yes	2017	NA	VIQUA		A496579	20	in	6.9 Watts/24 VDC	2	1	• Assuming on UV reactor per filter which is necessary for achieving the disinfection level • Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters Score decreased from 4 to 1; filter for internal use; not distribution or production.	3	35	32	$ 1,200	$ 1,740	2
192	UV System 4 Solenoid Valve	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Valve	Missing	Yes	2017	NA	VIQUA		A546863	20	in	6.9 Watts/24 VDC	2	1	• Assuming on UV reactor per filter which is necessary for achieving the disinfection level • Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters Score decreased from 4 to 1; filter for internal use; not distribution or production.	3	35	32	$ 1,200	$ 1,740	2
193	Surface wash booster pump no. 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Pump	Missing	Yes	1986	NA	Peerless Pump		428711	277	GPM		3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	20	-14	$ 10,600	$ 15,370	6
194	Surface wash booster pump no. 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Pump	Missing	Yes	1986	NA	Peerless Pump		428711	277	GPM		3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	20	-14	$ 10,600	$ 15,370	6
195	Surface wash booster pump no. 1 motor	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Motor	Missing	Yes	1986	NA	U.S. Motors	R	M-082194328	2.5	HP	575V/60HZ/3	2	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	20	-14	$ 1,000	$ 1,450	4
196	Surface wash booster pump no. 2 motor	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Motor	Missing	Yes	1986	NA	U.S. Motors	R	M-102482728	2.5	HP	575V/60HZ/3 Ph	2	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	20	-14	$ 1,000	$ 1,450	4
197	Valve gate, surface wash line	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000695	Yes	1986	NA	Jenkins	200 WOG		4	in		3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,000	$ 1,450	6
198	valve BFP, scour system	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000378	Yes	1986	NA	Watts	909	161167	4	in		3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 2,800	$ 4,060	6
199	Valve gate, surface wash line	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000694	Yes	1986	NA	Jenkins	200 WOG		4	in		3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,000	$ 1,450	6
200	Valve, gate W surface wash pump discharge	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000693	Yes	1986	NA	Jenkins	200 WOG		4	in		3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,000	$ 1,450	6
201	Valve, gate E surface wash pump discharge	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000690	Yes	1986	NA	Jenkins	200 WOG		4	in		3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,000	$ 1,450	6
202	Valve, gate E surface wash pump inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000688	Yes	1986	NA	Jenkins	200 WOG		6	in		3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,200	$ 1,740	6
203	Valve, gate W surface wash pump supply	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000691	Yes	1986	NA	Jenkins	200 WOG		6	in		3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,200	$ 1,740	6
204	Valve Check west surface wash pump	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000692	No	1986	NA	Not available	Not available	Not available	4	in		3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 3,500	$ 5,075	6
205	Valve gate, surface wash pump bypass	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000687	Yes	1986	NA	Jenkins	200 WOG		4	in		3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,000	$ 1,450	6
206	Valve gate, plant water supply	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000685	Yes	1986	NA	Jenkins	200 WOG		6	in		3	5	• Plant water supply is needed for cooling the pumps and providing the needed potable water across the plant but is not crucial for running • No redundancy is available for the water supply system Score increased from 4 to 5; no redundancy	34	35	1	$ 1,200	$ 1,740	15
207	Valve gate, plant water supply pump bypass	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000686	Yes	1986	NA	Jenkins	200 WOG		6	in		3	5	• Plant water supply is needed for cooling the pumps and providing the needed potable water across the plant but is not crucial for running • No redundancy is available for the water supply system Score increased from 4 to 5; no redundancy	34	35	1	$ 1,200	$ 1,740	15
208	Valve gate, plant water meter bypass	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000684	Yes	1986	NA	Jenkins	200 WOG		6	in		3	5	• Plant water supply is needed for cooling the pumps and providing the needed potable water across the plant but is not crucial for running • No redundancy is available for the water supply system Score increased from 4 to 5; no redundancy	34	35	1	$ 1,200	$ 1,740	15
209	Valve gate, plant water supply	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000683	Yes	1986	NA	Jenkins	200 WOG		6	in		3	5	• Plant water supply is needed for cooling the pumps and providing the needed potable water across the plant but is not crucial for running • No redundancy is available for the water supply system Score increased from 4 to 5; no redundancy	34	35	1	$ 1,200	$ 1,740	15

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210	Strainer, plant water supply	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	Missing	No	1986	NA	Rockwell	Not available	Not available	4	in		3	5	• Plant water supply is needed for cooling the pumps and providing the needed potable water across the plant but is not crucial for running • No redundancy is available for the water supply system Score increased from 4 to 5; no redundancy	34	35	1	$ 3,900	$ 5,655	15
211	Valve Check east surface wash pump	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000689	No	1986	NA	Not available	Not available	Not available	4	in		3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 3,500	$ 5,075	6
212	surface wash pump no. 1 disconnect	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Disconnect	Missing	Yes	1986	NA	Westinghouse		NU362	60	A	600V/3Ph	2	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	25	-9	$ 1,000	$ 1,450	4
213	surface wash pump no. 2 disconnect	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Disconnect	Missing	Yes	1986	NA	Westinghouse		NU362	60	A	600V/3Ph	2	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	25	-9	$ 1,000	$ 1,450	4
214	DP-ED step down transformer for panel	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Transformer	Missing	Yes	1986	NA	Polygon	5H1-15CR-3C	5688-20 844	10	kV	600V/3Ph	2	5	• The transformers are needed to run the plant	34	25	-9	$ 1,500	$ 2,175	10
215	DP-EB step down transformer for panel	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Transformer	Missing	Yes	1986	NA	Polygon	5H1-25CR-3C	5803-10	25	kVa	600V/3Ph	2	5	• The transformers are needed to run the plant	34	25	-9	$ 2,800	$ 4,060	10
216	Valve gate inline booster pump	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000699	No	1986	NA	Jenkins	200 WOG		4	in		3	4	Unique asset with similar description could not be identified in the as-built drawings. Based on PUC comment that the inline booster pump was needed to supply carrier water for the chemical system then it was increased to 4 along with associated assets	34	35	1	$ 1,000	$ 1,450	12
217	Valve gate inline booster pump	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000698	No	1986	NA	Jenkins	200 WOG		4	in		3	4	Unique asset with similar description could not be identified in the as-built drawings. Based on PUC comment that the inline booster pump was needed to supply carrier water for the chemical system then it was increased to 4 along with associated assets	34	35	1	$ 1,000	$ 1,450	12
218	Valve butterfly inline booster pump	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000700	No	1986	NA	Not available	Not available		4	in		3	4	Unique asset with similar description could not be identified in the as-built drawings. Based on PUC comment that the inline booster pump was needed to supply carrier water for the chemical system then it was increased to 4 along with associated assets	34	35	1	$ 1,125	$ 1,631	12
219	Valve butterfly inline booster bypass	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000702	No	1986	NA	Not available	Not available		4	in		3	4	Unique asset with similar description could not be identified in the as-built drawings. Based on PUC comment that the inline booster pump was needed to supply carrier water for the chemical system then it was increased to 4 along with associated assets	34	35	1	$ 1,125	$ 1,631	12
220	Valve check inline booster bypass	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000701	No	1986	NA	Not available	Not available		4	in		3	4	Unique asset with similar description could not be identified in the as-built drawings. Based on PUC comment that the inline booster pump was needed to supply carrier water for the chemical system then it was increased to 4 along with associated assets	34	35	1	$ 3,500	$ 5,075	12
221	Valve gate inline booster pump	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Pump	300000593	Yes	2015	NA	Peerless pump	2X2X10 PV	2687368				2	4	Unique asset with similar description could not be identified in the as-built drawings. Based on PUC comment that the inline booster pump was needed to supply carrier water for the chemical system then it was increased to 4 along with associated assets	5	20	15	$ 1,700	$ 2,465	8
222	Valve gate inline booster pump motor	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Motor	300000593	Yes	2015	NA	WEG		JM010504W	10	HP	600V/3Ph	2	4	Unique asset with similar description could not be identified in the as-built drawings. Based on PUC comment that the inline booster pump was needed to supply carrier water for the chemical system then it was increased to 4 along with associated assets	5	20	15	$ 4,000	$ 5,800	8
223	Valve gate inline booster pump disconnect	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Disconnect	Missing	Yes	1986	NA	Westinghouse	NU361		30	A	600V/3Ph	2	4	Unique asset with similar description could not be identified in the as-built drawings. Based on PUC comment that the inline booster pump was needed to supply carrier water for the chemical system then it was increased to 4 along with associated assets	34	25	-9	$ 1,000	$ 1,450	8
224	Valve pressure control inline booster pump	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000594	No	2018	NA	Singer						1	4	Unique asset with similar description could not be identified in the as-built drawings. Based on PUC comment that the inline booster pump was needed to supply carrier water for the chemical system then it was increased to 4 along with associated assets	2	35	33	$ 675	$ 979	4
225	DP-EC step down transformer for panel	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Alum	Process Electrical	Transformer	Missing	Yes	1986	NA	Polygon	5H1-25CR-3C	5803-5	25	kVa	600V/3Ph	2	5	• The transformers are needed to run the plant	34	25	-9	$ 2,800	$ 4,060	10
226	Valve filter #1 filtrate	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000236	No	1986	NA	JENKINS	AB 2544 EM		14	in		3	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 3,000	$ 4,350	12
227	Valve actuator filter #1 filtrate	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Actuator	300000236	Yes	1986	NA	Limitorque	4		0.4	HP	120 VAC	3	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	25	-9	$ 6,000	$ 8,700	12
228	Valve actuator filter #2 filtrate	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Actuator	300000237	Yes	1986	NA	Limitorque	4		0.4	HP	120 VAC	3	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	25	-9	$ 6,000	$ 8,700	12

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229	Valve filter #2 filtrate	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000237	No	1986	NA	JENKINS	AB 2544 EM		14	in		3	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 3,000	$ 4,350	12
230	Valve filter #3 filtrate	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000238	No	1986	NA	JENKINS	AB 2544 EM		14	in		3	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 3,000	$ 4,350	12
231	Valve actuator filter #3 filtrate	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Actuator	300000238	Yes	1986	NA	Limitorque	4		0.4	HP	120 VAC	3	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	25	-9	$ 6,000	$ 8,700	12
232	Valve actuator filter #4 filtrate	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Actuator	300000239	Yes	1986	NA	Limitorque	4		0.4	HP	120 VAC	3	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	25	-9	$ 6,000	$ 8,700	12
233	Valve filter #4 filtrate	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000239	No	1986	NA	JENKINS	AB 2544 EM		14	in		3	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 3,000	$ 4,350	12
234	Valve Butterfly BW waste header isolation	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000680	No	1986	NA	JENKINS	AAB 2544 HM		24	in		3	5	• This valve is needed to allow filter backwash which is necessary to run the plant	34	35	1	$ 12,000	$ 17,400	15
235	Valve Butterfly BW tank 1 inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000681	No	1986	NA	JENKINS	AAB 2544 HM		24	in		3	4	• The backwash tanks has a full redundancy and losing one tank will reduce the redundancy	34	35	1	$ 12,000	$ 17,400	12
236	Valve Butterfly BW tank 2 inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000682	No	1986	NA	JENKINS	AAB 2544 HM		24	in		3	4	• The backwash tanks has a full redundancy and losing one tank will reduce the redundancy	34	35	1	$ 12,000	$ 17,400	12
237	Valve plug, suction sludge pump BW Tank No. 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000188	No	1986	NA	Dezurik			4	in		4	3	• The sludge valves will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,000	$ 1,450	12
238	Valve actuator plug, suction sludge pump, BW tank No. 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000188	Yes	1986	NA	Keystone Valve	150-952-270-777-002	02728-75222-02	1.1	A	110V/single phase/60 Hz	2	3	• The sludge valves will be needed during BW tank operation but the tank can still be used	34	35	1	$ 5,000	$ 7,250	6
239	Valve plug, suction sludge pump BW Tank No. 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	Missing	No	1986	NA	Dezurik			4	in		4	3	• The sludge valves will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,000	$ 1,450	12
240	Valve actuator plug, suction sludge pump, BW tank No. 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	Missing	Yes	1986	NA	Keystone Valve	150-952-270-777-002	02563-72491-01	1.1	A	110V/single phase/60 Hz	2	3	• The sludge valves will be needed during BW tank operation but the tank can still be used	34	35	1	$ 5,000	$ 7,250	6
241	Valve plug, BW tank sludge pump 1 suction	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000671	Yes	1986	NA	Dezurik	EJ4	907059	4	in		2	3	• The sludge valves will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,000	$ 1,450	6
242	Valve plug, BW tank sludge pump 2 suction	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000675	Yes	1986	NA	Dezurik	EJ4	907059	4	in		2	3	• The sludge valves will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,000	$ 1,450	6
243	Valve plug, sludge pump 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000677	No	1986	NA	Dezurik	EJ4	907059	4	in		2	3	• The sludge valves will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,000	$ 1,450	6
244	Valve plug, sludge pump 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000673	No	1986	NA	Dezurik	EJ4	907059	4	in		2	3	• The sludge valves will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,000	$ 1,450	6
245	Valve plug, sludge pump 1 (to truck)	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000674	No	1986	NA	Dezurik	EJ4	907059	4	in		2	3	• The sludge valves will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,000	$ 1,450	6
246	Valve plug, sludge pump 2 (to truck)	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000678	No	1986	NA	Dezurik	EJ4	907059	4	in		2	3	• The sludge valves will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,000	$ 1,450	6
247	Valve Butterfly Raw Water Well 2 Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000756	Yes	1986	NA	Jenkins	150B	AB2544K0A2	30	in		2	3	• Losing one raw water well bring the Low lift pumping redundancy to 50%	34	35	1	$ 18,500	$ 26,825	6
248	Valve low lift Water Level Control	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000240	Yes	1986	NA	Power Plant Supply Company		1502843683	30	in		2	3	Assuming that this is the LIT needed to triger low level alarms for the LLPs operation then this can cause operational problems over the long run if not functioning properly so it is assumed to be a critical asset.	34	35	1	$ 10,000	$ 14,500	6
249	Valve Butterfly Filter 1 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000715	Yes	1986	NA	Jenkins	2242 EL		4	in	200 PSIG	3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,125	$ 1,631	6
250	Valve Butterfly Filter 1 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000717	Yes	1986	NA	Jenkins	2242 EL		4	in	200 PSIG	3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,125	$ 1,631	6
251	Valve Butterfly Filter 1 Backwash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000718	Yes	1986	NA	Jenkins			20	in	1700 RPM, 575 Volts, .33 HP	2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 10,000	$ 14,500	8
252	Actuator Valve Butterfly Filter 1 Backwash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000718	Yes	1986	NA	Limitorque			20	in	1700 RPM, 575 Volts, .33 HP	2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	25	-9	$ 6,000	$ 8,700	8
253	Actuator Valve Butterfly Filter 1 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000714	Yes	1986	NA	Limitorque		39321	24	in	NA	2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	25	-9	$ 6,000	$ 8,700	8
254	Valve Butterfly Filter 1 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000714	No	1986	NA	Jenkins	-	-	24	in		4	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 12,000	$ 17,400	16
255	Valve Piston Filter 1 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000716	No	1986	NA	Jenkins	2242 EL		4	in	200 PSIG	3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 4,700	$ 6,815	6

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256	Valve Butterfly Filter 1 Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000713	Yes	1986	NA	Jenkins		M030814	24	in	1700 RPM, 575 Volts, 1 HP	2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 12,000	$ 17,400	8
257	Valve Plug Floc Tank 2 Drain Valve	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000739	No	1986	NA	DEZURIK			6	in		2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 1,200	$ 1,740	8
258	Valve Plug Floc Tank 1 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000740	No	1986	NA	DEZURIK			6	in		2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 1,200	$ 1,740	8
259	Valve Butterfly Filter 2 Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000719	Yes	1986	NA	Limitorque		J039332	24	in	NOCONP	3	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 12,000	$ 17,400	12
260	Valve Butterfly Filter 2 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000720	Yes	1986	NA	Jenkins		290356	24	in		4	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 12,000	$ 17,400	16
261	Actuator Valve Butterfly Filter 2 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000720	Yes	1986	NA	Limitorque			24	in		2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	25	-9	$ 6,000	$ 8,700	8
262	Valve Butterfly Filter 2 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000721	Yes	1986	NA	Jenkins			4	in	200 PSIG	3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,125	$ 1,631	6
263	Valve Piston Filter 2 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000722	No	1986	NA	-	-	-	4	in		2	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 4,700	$ 6,815	4
264	Valve Butterfly Filter 2 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000723	Yes	1986	NA	Jenkins		223ZEL	4	in	200 PSIG	2	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,125	$ 1,631	4
265	Valve Butterfly Filter 2 Backwash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000724	Yes	1986	NA	Jenkins			20	in		2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 10,000	$ 14,500	8
266	Actuator Valve Butterfly Filter 2 Backwash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000724	Yes	1986	NA	Limitorque			20	in	1700 RPM, 575 Volts, .33 HP	2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	25	-9	$ 6,000	$ 8,700	8
267	Valve Butterfly Filter 3 Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000725	Yes	1986	NA	Jenkins		J039332	24	in		2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 12,000	$ 17,400	8
268	Actuator Valve Butterfly Filter 3 Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000725	Yes	1986	NA	Limitorque		J039325	24	in	NOCONP	2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	25	-9	$ 6,000	$ 8,700	8
269	Valve Butterfly Filter 3 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000726	Yes	1986	NA	Jenkins			24	in		2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 12,000	$ 17,400	8
270	Actuator Valve Butterfly Filter 3 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000726	Yes	1986	NA	Limitorque						2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 5,000	$ 7,250	8
271	Valve Butterfly Filter 3 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000727	No	2008	NA	-	-	-	4	in		3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	12	35	23	$ 1,125	$ 1,631	6
272	Valve Butterfly Filter 3 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000729	Yes	1986	NA	Jenkins		2232EL	4	in	200 PSIG	3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,125	$ 1,631	6
273	Valve Piston Filter 3 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000728	No	1986	NA	-	-	-	4	in		2	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 4,700	$ 6,815	4
274	Valve Butterfly Filter 3 Backwash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000730	Yes	1986	NA	Jenkins			20	in		2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 10,000	$ 14,500	8
275	Actuator Valve Butterfly Filter 3 Backwash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000730	Yes	1986	NA	Limitorque					1700 RPM, 575 Volts	2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	25	-9	$ 6,000	$ 8,700	8
276	Valve Butterfly Filter 4 Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000731	Yes	1986	NA	Jenkins			24	in		2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 12,000	$ 17,400	8
277	Actuator Valve Butterfly Filter 4 Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000731	Yes	1986	NA	Limitorque		J039324	24	in	NOCONP	2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	25	-9	$ 6,000	$ 8,700	8
278	Valve Butterfly Filter 4 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000732	Yes	1986	NA	Jenkins			24	in		2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 12,000	$ 17,400	8
279	Actuator Valve Butterfly Filter 4 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000732	Yes	1986	NA	Limitorque					NV	2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	25	-9	$ 6,000	$ 8,700	8

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280	Valve Butterfly Filter 4 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000733	Yes	1986	NA	Jenkins			4	in	200 PSIG	2	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,125	$ 1,631	4
281	Valve Butterfly Filter 4 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000735	Yes	1986	NA	Jenkins			4	in		4	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,125	$ 1,631	8
282	Valve Piston Filter 4 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000734	No	1986	NA	-	-	-	4	in		2	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 4,700	$ 6,815	4
283	Valve Butterfly Filter 4 Backwash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000736	Yes	1986	NA	Jenkins			20	in		2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 10,000	$ 14,500	8
284	Actuator Valve Butterfly Filter 4 Backwash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000736	Yes	1986	NA	Limitorque					1700 RPM, 575 Volts	2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	25	-9	$ 6,000	$ 8,700	8
285	Valve Plug Floc Tank 4 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000737	No	1986	NA	DEZURIK			6	in		2	1	• Floc Tank drain is needed only for tank cleaning so not a critical asset	34	35	1	$ 1,200	$ 1,740	2
286	Valve Plug Floc Tank 3 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000738	No	1986	NA	DEZURIK			6	in		2	1	• Floc Tank drain is needed only for tank cleaning so not a critical asset	34	35	1	$ 1,200	$ 1,740	2
287	Mixer #1 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Mechanical	Mixer	300000193	Yes	1986	NA	Lightnin	XLEVM-1-5	480154			NA	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	40	6	$ 36,300	$ 52,635	8
288	Motor #1 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Electrical	Motor	300000194	Yes	1986	NA	Eurodrive	DF22DT90 L	12.43425.4/1			1.5 HP, 300 - 1500 RPM, 575V,60 HZ	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	20	-14	$ 800	$ 1,160	8
289	Sluice Gate # N-1 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Mechanical	Gate	Missing	No	1986	NA	-	-	-	24x24	in		2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	20	-14	$ 13,700	$ 19,865	8
290	Mixer #2 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Mechanical	Mixer	Missing	Yes	1986	NA	Lightnin	XLEVM-1-5	480156			NA	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	40	6	$ 36,300	$ 52,635	8
291	Motor #2 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Electrical	Motor	Missing	Yes	1986	NA	SEW-Eurodrive	DF22DT90 L	12.43425.4/1			1.5 HP, 300 - 1500 RPM, 575V,60 HZ	3	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	20	-14	$ 800	$ 1,160	12
292	Sluice Gate # S-2 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Mechanical	Gate	Missing	No	1986	NA	-	-	-	24x24	in		2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	20	-14	$ 13,700	$ 19,865	8
293	Mixer #3 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Mechanical	Mixer	Missing	Yes	1986	NA	Lightnin	XLEVM-1-5	480155			NA	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	40	6	$ 36,300	$ 52,635	8
294	Motor #3 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Electrical	Motor	Missing	Yes	1986	NA	SEW-Eurodrive	DF22DT90 L6	12.43425.4/3			1.5 HP, 300 - 1500 RPM,330 - 575V,60 HZ	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	20	-14	$ 800	$ 1,160	8
295	Sluice Gate # N-3 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Mechanical	Gate	Missing	No	1986	NA	-	-	-	24x24	in		2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	20	-14	$ 13,700	$ 19,865	8
296	Sluice Gate # N-4 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Mechanical	Gate	Missing	No	1986	NA	-	-	-	24x24	in		2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	20	-14	$ 13,700	$ 19,865	8
297	Mixer #4 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Mechanical	Mixer	Missing	Yes	1986	NA	Lightnin	XLEVM-1-5	480153			NA	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	40	6	$ 36,300	$ 52,635	8
298	Motor #4 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Electrical	Motor	Missing	Yes	1986	NA	SEW-Eurodrive	DF22DT90 L6	12.43425.4/2			1.5 HP, 300 - 1500 RPM,330 - 575V,60 HZ	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	20	-14	$ 800	$ 1,160	8
299	Sluice Gate # S-1 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Mechanical	Gate	Missing	No	1986	NA	-	-	-	24x24	in		2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	20	-14	$ 13,700	$ 19,865	8

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300	Sluice Gate # N-2 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Mechanical	Gate	Missing	No	1986	NA	-	-	-	24x24	in		2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	20	-14	$ 13,700	$ 19,865	8
301	Sluice Gate # S-3 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Mechanical	Gate	Missing	No	1986	NA	-	-	-	24x24	in		2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	20	-14	$ 13,700	$ 19,865	8
302	Sluice Gate # S-4 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Mechanical	Gate	Missing	No	1986	NA	-	-	-	24x24	in		2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	20	-14	$ 13,700	$ 19,865	8
303	Mixer Chamber #4	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Structural	Tanks / Basins	Missing	No	1986	NA	-	-	-				2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	60	26	$ 53,920	$ 78,185	8
304	Mixer Chamber #3	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Structural	Tanks / Basins	Missing	No	1986	NA	-	-	-				2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	60	26	$ 53,920	$ 78,185	8
305	Mixer Chamber #2	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Structural	Tanks / Basins	Missing	No	1986	NA	-	-	-				2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	60	26	$ 53,920	$ 78,185	8
306	Mixer Chamber #1	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Structural	Tanks / Basins	Missing	No	1986	NA	-	-	-				2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	60	26	$ 53,920	$ 78,185	8
307	Filter Chamber #1	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Structural	Tanks / Basins	Missing	No	1986	NA	-	-	-				2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	60	26	$ 65,886	$ 95,534	8
308	Filter Chamber #2	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Structural	Tanks / Basins	Missing	No	1986	NA	-	-	-				2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	60	26	$ 65,886	$ 95,534	8
309	Filter Chamber #3	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Structural	Tanks / Basins	Missing	No	1986	NA	-	-	-				2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	60	26	$ 65,886	$ 95,534	8
310	Filter Chamber #4	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Structural	Tanks / Basins	Missing	No	1986	NA	-	-	-				2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	60	26	$ 65,886	$ 95,534	8
311	Valve Backwash #2 Suction	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000180	Yes	1986	NA	Jenkins	Jenkins		24	in		2	5	• Losing backwash will affect production but one pump should be sufficient to backwash any of the filters (100% redundancy) Score increased from 4 to 5. This could be reduced as there is 100% redundancy. According to design documents, 2 backwash pumps need to operate under some temperature conditions to achieve rated plant capacity. For day to day operations at present demand, 1 pump is sufficient, but won't meet capacity rating at all conditions.	34	35	1	$ 8,000	$ 11,600	10
312	Pump Backwash #2	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000179	Yes	1986	NA	Warren Pumps Houdaille		82104-2	16-DLB-20		7530 GPM, 710 RPM	2	5	• Losing backwash will affect production but one pump should be sufficient to backwash any of the filters (100% redundancy) Score increased from 4 to 5. This could be reduced as there is 100% redundancy. According to design documents, 2 backwash pumps need to operate under some temperature conditions to achieve rated plant capacity. For day to day operations at present demand, 1 pump is sufficient, but won't meet capacity rating at all conditions.	34	20	-14	$ 61,000	$ 88,450	10
313	Valve Backwash Pump #2 Check	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000177	Yes	1986	NA	Jenkins			16	in		2	5	• Losing backwash will affect production but one pump should be sufficient to backwash any of the filters (100% redundancy) Score increased from 4 to 5. This could be reduced as there is 100% redundancy. According to design documents, 2 backwash pumps need to operate under some temperature conditions to achieve rated plant capacity. For day to day operations at present demand, 1 pump is sufficient, but won't meet capacity rating at all conditions.	34	35	1	$ 20,000	$ 29,000	10

Item ID	Asset Description	Level 1 – Functional Group	Level 2 – Facility Type / Location	Level 3 – Process Location	Level 4 – Asset Category	Level 5 (Asset Type)	Unique ID	Nameplate Present?	Install Year	Refurbishment Year	Manufacturer	Model	Serial Number	Size / Capacity	Unit of Measure	Operating Conditions	Condition Score (1 to 5 Scale)	CoF Score (1 to 5 Scale)	CoF Score Comments	Age	ESL	RUL	Replacement Cost (2020)	Project Cost (includes Markup)	Risk Score (1 to 25 Scale)
314	Valve Backwash #2 Discharge	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000178	Yes	1986	NA	Jenkins			16	in		2	5	• Losing backwash will affect production but one pump should be sufficient to backwash any of the filters (100% redundancy) Score increased from 4 to 5. This could be reduced as there is 100% redundancy. According to design documents, 2 backwash pumps need to operate under some temperature conditions to achieve rated plant capacity. For day to day operations at present demand, 1 pump is sufficient, but won't meet capacity rating at all conditions.	34	35	1	$ 4,000	$ 5,800	10
315	Motor Backwash Pump #2 Discharge Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000176	Yes	1986	NA	Limitorque		JM036122			1700 RPM, .33 HP, 575 Volts	2	5	• Losing backwash will affect production but one pump should be sufficient to backwash any of the filters (100% redundancy) Score increased from 4 to 5. This could be reduced as there is 100% redundancy. According to design documents, 2 backwash pumps need to operate under some temperature conditions to achieve rated plant capacity. For day to day operations at present demand, 1 pump is sufficient, but won't meet capacity rating at all conditions.	34	20	-14	$ 11,000	$ 15,950	10
316	Motor Backwash Pump #2	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000174	Yes	1986	NA	Canadian General Electric	148379	GX1170			100 HO, 719 RPM, 575 Volts, phase 3, 60 Hz	2	5	• Losing backwash will affect production but one pump should be sufficient to backwash any of the filters (100% redundancy) Score increased from 4 to 5. This could be reduced as there is 100% redundancy. According to design documents, 2 backwash pumps need to operate under some temperature conditions to achieve rated plant capacity. For day to day operations at present demand, 1 pump is sufficient, but won't meet capacity rating at all conditions.	34	20	-14	$ 11,000	$ 15,950	10
317	Valve Backwash #1 Suction	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000181	Yes	1986	NA	Jenkins			24	in		2	5	• Losing backwash will affect production but one pump should be sufficient to backwash any of the filters (100% redundancy) Score increased from 4 to 5. This could be reduced as there is 100% redundancy. According to design documents, 2 backwash pumps need to operate under some temperature conditions to achieve rated plant capacity. For day to day operations at present demand, 1 pump is sufficient, but won't meet capacity rating at all conditions.	34	35	1	$ 8,000	$ 11,600	10
318	Pump Backwash #1	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000173	Yes	1986	NA	Warren Pumps Houdaille		82104-1			7530 GPM, 710 RPM, Imp Dia 173/4	2	5	• Losing backwash will affect production but one pump should be sufficient to backwash any of the filters (100% redundancy) Score increased from 4 to 5. This could be reduced as there is 100% redundancy. According to design documents, 2 backwash pumps need to operate under some temperature conditions to achieve rated plant capacity. For day to day operations at present demand, 1 pump is sufficient, but won't meet capacity rating at all conditions.	34	20	-14	$ 61,000	$ 88,450	10
319	Valve Check - Backwash Pump #2	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000171	Yes	1986	NA	Jenkins			16	in		2	5	• Losing backwash will affect production but one pump should be sufficient to backwash any of the filters (100% redundancy) Score increased from 4 to 5. This could be reduced as there is 100% redundancy. According to design documents, 2 backwash pumps need to operate under some temperature conditions to achieve rated plant capacity. For day to day operations at present demand, 1 pump is sufficient, but won't meet capacity rating at all conditions.	34	35	1	$ 20,000	$ 29,000	10
320	Valve Backwash Pump #1 Discharge	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000170	Yes	1986	NA	Jenkins			16	in		2	5	• Losing backwash will affect production but one pump should be sufficient to backwash any of the filters (100% redundancy) Score increased from 4 to 5. This could be reduced as there is 100% redundancy. According to design documents, 2 backwash pumps need to operate under some temperature conditions to achieve rated plant capacity. For day to day operations at present demand, 1 pump is sufficient, but won't meet capacity rating at all conditions.	34	35	1	$ 4,000	$ 5,800	10
321	Motor Backwash Pump #1 Discharge Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000169	Yes	1986	NA	Limitorque		JM036121			1700 RPM, .33 HP, 575 Volts	2	5	• Losing backwash will affect production but one pump should be sufficient to backwash any of the filters (100% redundancy) Score increased from 4 to 5. This could be reduced as there is 100% redundancy. According to design documents, 2 backwash pumps need to operate under some temperature conditions to achieve rated plant capacity. For day to day operations at present demand, 1 pump is sufficient, but won't meet capacity rating at all conditions.	34	20	-14	$ 11,000	$ 15,950	10

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322	Motor Backwash Pump #1	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000172	Yes	1986	NA	Canadian General Electric	148379	GX1170			100 HP, 710 RPM, 575 Volts, phase 3, 60 Hz	2	5	• Losing backwash will affect production but one pump should be sufficient to backwash any of the filters (100% redundancy) Score increased from 4 to 5. This could be reduced as there is 100% redundancy. According to design documents, 2 backwash pumps need to operate under some temperature conditions to achieve rated plant capacity. For day to day operations at present demand, 1 pump is sufficient, but won't meet capacity rating at all conditions.	34	20	-14	$ 15,000	$ 21,750	10
323	Surge Tank #2	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pressure Vessel	300000158	Yes	1986	NA	DTE Industries Limited					NA	2	2	• Two surge tanks for the high lift PS so a redundancy of 100% Is present	34	20	-14	$ 55,000	$ 79,750	4
324	Surge Tank #1	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pressure Vessel	300000149	Yes	1986	NA	DTE Industries Limited					NA	2	2	• Two surge tanks for the high lift PS so a redundancy of 100% Is present	34	20	-14	$ 55,000	$ 79,750	4
325	Valve Surge Tank #2 Isolation	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000157	Yes	1986	NA	Jenkins			16	in		2	2	• Two surge tanks for the high lift PS so a redundancy of 100% Is present	34	35	1	$ 4,300	$ 6,235	4
326	Valve Surge Tank #1 Isolation	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000150	Yes	1986	NA	Jenkins			16	in		2	2	• Two surge tanks for the high lift PS so a redundancy of 100% Is present	34	35	1	$ 4,300	$ 6,235	4
327	Motor Surge Tank #1 Compressor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000153	Yes	1986	NA	Baldor	M3311T-5				7 1/2 HP, 575 Volts, 1725 RPM, 60 HZ, Phase 3	2	2	• Two surge tanks for the high lift PS so a redundancy of 100% Is present	34	20	-14	$ 3,500	$ 5,075	4
328	Motor Surge Tank #2 Compressor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000154	Yes	1986	NA	Baldor	M3311T-5				7 1/2 HP, 575 Volts, 1725 RPM, 60 HZ, Phase 3	2	2	• Two surge tanks for the high lift PS so a redundancy of 100% Is present	34	20	-14	$ 3,500	$ 5,075	4
329	Disconnect Surge Tank #1 Compressor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Disconnect	300000151	Yes	1986	NA	Nova Line					NA	2	2	• Two surge tanks for the high lift PS so a redundancy of 100% Is present	34	25	-9	$ 1,000	$ 1,450	4
330	Disconnect Surge Tank #2 Compressor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Disconnect	300000152	Yes	1986	NA	Nova Line					NA	2	2	• Two surge tanks for the high lift PS so a redundancy of 100% Is present	34	25	-9	$ 1,000	$ 1,450	4
331	Suction Header Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000524	Not Accessible	1986	NA	-	-	-				3	1	• The valve is needed to isolate the future pump but can be replaced by a blind flange temporarily	34	20	-14	$ 40,500	$ 58,725	3
332	Suction Header Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000522	Not Accessible	1986	NA	-	-	-				3	3	• The plant has a firm capacity and each HLP is 30 MLD • The capacity is 50%	34	20	-14	$ 40,500	$ 58,725	9
333	Suction Header Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000523	Not Accessible	1986	NA	-	-	-				3	3	• The plant has a firm capacity and each HLP is 30 MLD • The capacity is 50%	34	20	-14	$ 40,500	$ 58,725	9
334	Suction Header Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000525	Not Accessible	1986	NA	-	-	-				3	3	• The plant has a firm capacity and each HLP is 30 MLD • The capacity is 50%	34	20	-14	$ 40,500	$ 58,725	9
335	Valve check, sludge pump 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000672	No	1986	NA	Hilllens BBK	2016	3574B	4	in		2	2	• The sludge pumps will be needed during BW tank operation but the tank can still be used	34	35	1	$ 3,500	$ 5,075	4
336	Valve check, sludge pump 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000676	No	1986	NA	Hilllens BBK	2016	3574B	4	in		2	2	• The sludge pumps will be needed during BW tank operation but the tank can still be used	34	35	1	$ 3,500	$ 5,075	4
337	Pump, sludge pump 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Pump	Missing	Yes	1986	NA	Moyno	AM14451-3 ZL	2F036G1 CDQ3 AAA				3	2	• The sludge pumps will be needed during BW tank operation but the tank can still be used	34	20	-14	$ 4,000	$ 5,800	6
338	Pump Motor, sludge pump 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Motor	Missing	Yes	1986	NA	Brook Crompton Parkinson Ltd	DP	2315011-57	10	HP	575V/60HZ/3, 12 or 9 Amp	3	2	• The sludge pumps will be needed during BW tank operation but the tank can still be used	34	20	-14	Cost Included in Pump	Cost Included in Pump	6
339	Pump, sludge pump 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Pump	Missing	Yes	1986	NA	Moyno	AM194130 3-2 FG	2F036G1 CDQ3 AAA				5	2	• The sludge pumps will be needed during BW tank operation but the tank can still be used	34	20	-14	$ 4,000	$ 5,800	10
340	Pump Motor, sludge pump 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Motor	Missing	Yes	1986	NA	Brook Crompton Parkinson Ltd	DP	2315011-57	10	HP	575V/60HZ/3, 12 or 9 Amp	3	2	• The sludge pumps will be needed during BW tank operation but the tank can still be used	34	20	-14	Cost Included in Pump	Cost Included in Pump	6
341	Valve plug, sludge to emergency tank truck	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000679	No	1986	NA	Dezurik	EJ4	907059	4	in		2	2	• The sludge pumps will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,000	$ 1,450	4
342	Valve plug, BW tank 2 bottom level	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000661	No	1986	NA	Dezurik			8	in		2	1	• The valve is needed to determine the decant level of the tank	34	35	1	$ 1,500	$ 2,175	2
343	Valve plug, BW tank 2 middle level	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000660	No	1986	NA	Dezurik			8	in		2	1	• The valve is needed to determine the decant level of the tank	34	35	1	$ 1,500	$ 2,175	2
344	Valve plug, BW tank 2 top level	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000661	No	1986	NA	Dezurik			8	in		2	1	• The valve is needed to determine the decant level of the tank	34	35	1	$ 1,500	$ 2,175	2
345	Valve plug, BW tank 1 bottom level	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000658	No	1986	NA	Dezurik			8	in		2	1	• The valve is needed to determine the decant level of the tank	34	35	1	$ 1,500	$ 2,175	2
346	Valve plug, BW tank 1 middle level	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000657	No	1986	NA	Dezurik			8	in		2	1	• The valve is needed to determine the decant level of the tank	34	35	1	$ 1,500	$ 2,175	2
347	Valve plug, BW tank 1 top level discharge	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000656	No	1986	NA	Dezurik			8	in		2	1	• The valve is needed to determine the decant level of the tank	34	35	1	$ 1,500	$ 2,175	2
348	Disconnect, sludge pump 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Disconnect	Missing	Yes	1986	NA	D	81641	T1	30	Amp	600V/3Ph/60hz	2	2	• The sludge pumps will be needed during BW tank operation but the tank can still be used	34	25	-9	$ 1,000	$ 1,450	4

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349	Disconnect, sludge pump 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Disconnect	Missing	Yes	1986	NA	D	81641	T1	30	Amp	600V/3Ph/60hz	2	2	• The sludge pumps will be needed during BW tank operation but the tank can still be used	34	25	-9	$ 1,000	$ 1,450	4
350	Valve plug, supernatant pump 2 suction	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000665	No	1986	NA	Dezurik			8	in		2	2	• The supernatant pumps will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,500	$ 2,175	4
351	Valve plug, supernatant pump 2 discharge	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000667	No	1986	NA	Dezurik			8	in		2	2	• The supernatant pumps will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,500	$ 2,175	4
352	Valve check, supernatant pump 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000666	No	1986	NA	Hilllens BBK	TJPE 2016		6	in		3	2	• The supernatant pumps will be needed during BW tank operation but the tank can still be used	34	35	1	$ 6,500	$ 9,425	6
353	Pump, supernatant no. 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Pump	Missing	Yes	1986	2011	Fairbanks Morse		2229529				2	2	• The supernatant pumps will be needed during BW tank operation but the tank can still be used	9	20	11	$ 16,400	$ 23,780	4
354	Pump Motor, supernatant no. 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Motor	Missing	Yes	1986	2011	Brook Corporation Parkinson	A132258	231531001	7.5	HP	575V/60HZ/3	2	2	• The supernatant pumps will be needed during BW tank operation but the tank can still be used	9	20	11	$ 3,500	$ 5,075	4
355	Pump, supernatant no. 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Pump	Missing	Yes	1986	2011	Fairbanks Morse		1794070				2	2	• The supernatant pumps will be needed during BW tank operation but the tank can still be used	9	20	11	$ 16,400	$ 23,780	4
356	Pump Motor, supernatant no. 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Motor	Missing	Yes	1986	2011	Brook Corporation Parkinson	A132258	231531001	7.5	HP	575V/60HZ/3	2	2	• The supernatant pumps will be needed during BW tank operation but the tank can still be used	9	20	11	$ 3,500	$ 5,075	4
357	Valve plug, supernatant pump 1 discharge	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000664	No	1986	NA	Dezurik			8	in		2	2	• The supernatant pumps will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,500	$ 2,175	4
358	Valve plug, supernatant pump 1 suction	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000662	No	1986	NA	Dezurik			8	in		2	2	• The supernatant pumps will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,500	$ 2,175	4
359	Valve check, supernatant pump 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000663	No	1986	NA	Hilllens BBK	TJPE 2016		6	in		3	2	• The supernatant pumps will be needed during BW tank operation but the tank can still be used	34	35	1	$ 6,500	$ 9,425	6
360	Valve plug, BW tanks to supernatant line	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000668	No	1986	NA	Dezurik			8	in		2	2	• The supernatant pumps will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,500	$ 2,175	4
361	Disconnect, supernatant pump #1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Disconnect	Missing	Yes	1986	NA	Westinghouse Canada Inc.	NU361		30	HP	600V/3Ph/60hz	2	2	• The supernatant pumps will be needed during BW tank operation but the tank can still be used	34	25	-9	$ 1,000	$ 1,450	4
362	Disconnect, supernatant pump #2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Disconnect	Missing	Yes	1986	NA	Westinghouse Canada Inc.	NU361		30	HP	600V/3Ph/60hz	2	2	• The supernatant pumps will be needed during BW tank operation but the tank can still be used	34	25	-9	$ 1,000	$ 1,450	4
363	Valve plug, decant to pond valve	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000669	No	1986	NA	Dezurik			8	in		2	2	• The supernatant valve can be directed in two direction so the redundancy is 100%	34	35	1	$ 1,500	$ 2,175	4
364	Valve plug, decant to overflow	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000670	No	1986	NA	Dezurik			8	in		2	2	• The supernatant valve can be directed in two direction so the redundancy is 100%	34	35	1	$ 1,500	$ 2,175	4
365	Valve, BFP	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000810	No	2018	NA	Watts	Not available	Not available	2	in		1	4	This a BFP for the belnded phosphate so assigning a score of 4 based on PUC's requirement.	2	35	33	$ 620	$ 899	4
366	Valve, BFP Alum	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000783	No	2018	NA	Watts	Not available	Not available	2	in		1	4	• This BFP is needed to run the alum system necessary for coagulation	2	35	33	$ 620	$ 899	4
367	Valve, BFP Chlorine	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Cl2 Gas	Process Mechanical	Valve	300000784	No	2018	NA	Watts	Not available	Not available	2	in		1	4	• This BFP is needed to run the chlorine system necessary for disinfection	2	35	33	$ 620	$ 899	4
368	Valve, butterfly backwash flow control	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000186	No	1986	NA	Jenkins			20	in		3	4	• This valve is needed to control the backwash flow necessary to run the filters	34	35	1	$ 10,000	$ 14,500	12
369	Valve Actuator Motor, butterfly backwash flow control	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000185	Yes	2011	NA	Rotork	IQS 12	D141910101	0.34	kW	120V/single phase	2	4	• This valve is needed to control the backwash flow necessary to run the filters	9	35	26	$ 5,000	$ 7,250	8
370	Valve Actuator Gearbox, butterfly backwash flow control	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000185	Yes	2011	NA	Rotork	IW5/IR1	T1912501-001				2	4	• This valve is needed to control the backwash flow necessary to run the filters	9	35	26	$ 5,000	$ 7,250	8
371	Valve, butterfly backwash flow control, filter tank	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000747	No	1986	NA	Jenkins			24	in		3	4	• This valve is needed to control the backwash flow necessary to run the filters	34	35	1	$ 8,000	$ 11,600	12
372	Valve Actuator Motor, butterfly backwash flow control filter tanks	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000747	Yes	1986	NA	Limitorque	SMC 03	M041779	0.4	HP	120V/single phase	3	4	• This valve is needed to control the backwash flow necessary to run the filters	34	35	1	$ 5,000	$ 7,250	12
373	Valve Actuator Gearbox, butterfly level control filter tanks	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000747	Yes	1986	NA	Torque matic		290358	250			3	4	• The valve is needed to control the level inside the filters	34	35	1	$ 5,000	$ 7,250	12
374	Valve HL #3 Suction	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000129	Yes	1986	NA	Jenkins			20	in		2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	34	35	1	$ 6,500	$ 9,425	6
375	Pump HL #3	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000128	Yes	1986	NA	Patterson Pump Division		84BT-8093-A12	4360	m3	RPM - 1160, Head - 170	2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	34	20	-14	$ 40,000	$ 58,000	6
376	Motor HL #3	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000127	Yes	1986	NA	Westinghouse Canada Inc.	HSA	3-17S7410			300 HP, 575 Volts, 3 Phase, 60 HZ, 1186 RPM	2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	34	20	-14	$ 25,500	$ 36,975	6
377	Valve HL#3 Check	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000126	No	2013	NA	Jenkins			12	in		2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	7	35	28	$ 12,500	$ 18,125	6
378	Valve HL#3 Discharge	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000125	No	2013	NA	Dezurik		20141126D	16	in		2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	7	35	28	$ 4,000	$ 5,800	6

Item ID	Asset Description	Level 1 – Functional Group	Level 2 – Facility Type / Location	Level 3 – Process Location	Level 4 – Asset Category	Level 5 (Asset Type)	Unique ID	Nameplate Present?	Install Year	Refurbishment Year	Manufacturer	Model	Serial Number	Size / Capacity	Unit of Measure	Operating Conditions	Condition Score (1 to 5 Scale)	CoF Score (1 to 5 Scale)	CoF Score Comments	Age	ESL	RUL	Replacement Cost (2020)	Project Cost (includes Markup)	Risk Score (1 to 25 Scale)
379	Motor HL#3 Discharge Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000124	Yes	2013	NA	Limitorque	152469-001	L110179			Rated Torque - 1500ft/lb and 2034 Nm, 515-600 V, 60 HZ, 0.26 Hp,	2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	7	20	13	$ 5,000	$ 7,250	6
380	Valve HL #2 Suction	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000123	Yes	1986	NA	Jenkins			20	in		2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	34	35	1	$ 6,500	$ 9,425	6
381	Pump HL #2	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000122	Yes	1986	NA	Patterson Pump Division		84BT-8092-A12	4360	m3	RPM - 1160, Head - 170	2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	34	20	-14	$ 40,000	$ 58,000	6
382	Motor HL #2	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000121	Yes	1986	NA	Westinghouse Canada Inc.	HSA	2-17S7410			300 HP, 575 Volts, 3 Phase, 60 HZ, 1186 RPM	2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	34	20	-14	$ 25,500	$ 36,975	6
383	Valve HL#2 Check	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000786	No	2012	NA	Schlumburg			12	in		2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	8	35	27	$ 12,500	$ 18,125	6
384	Valve HL#2 Discharge	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000785	No	2012	NA	Dezurik		20130320D	16	in		2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	8	35	27	$ 4,000	$ 5,800	6
385	Motor HL#2 Discharge Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000801	Yes	2012	NA	Limitorque		L1055083			Rated Torque - 1500ft/lb and 2034 Nm, 515-600 V, 60 HZ, 0.26 Hp,	2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	8	20	12	$ 5,000	$ 7,250	6
386	Motor Future High Lift Discharge Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000133	No	1986	NA	Limitorque						2	1	• The valve is needed to isolate the future pump but can be replaced by a blind flange temporarily	34	20	-14	$ 5,000	$ 7,250	2
387	Valve Future High Lift Discharge	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000134	Yes	1986	NA	Jenkins			20	in		2	1	• The valve is needed to isolate the future pump but can be replaced by a blind flange temporarily	34	35	1	$ 6,500	$ 9,425	2
388	Valve Pipe Leading to Surface Wash Pumps	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000130	Yes	1986	NA	Jenkins			6	in		2	5	• Losing surface wash will affect filter performance on the long-term but won't affect production valve is used to supply water for the chemical systems	34	35	1	$ 1,200	$ 1,740	10
389	Valve HL #1 Suction	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000117	Yes	1986	NA	Jenkins			20	in		2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	34	35	1	$ 6,500	$ 9,425	6
390	Pump HL #1	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000116	Yes	2011	NA	Patterson Pump Division		84BT-8094-A12	4360	m3	RPM - 1160, Head - 170	2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	9	20	11	$ 40,000	$ 58,000	6
391	Motor HL #1	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000115	Yes	1986	NA	Westinghouse Canada Inc.	HSA	1-17S7410			300 HP, 575 Volts, 3 Phase, 60 HZ, 1186 RPM	2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	34	20	-14	$ 25,500	$ 36,975	6
392	Valve HL#1 Check	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000114	No	2011	NA	Schlumburg			12	in		2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	9	35	26	$ 12,500	$ 18,125	6
393	Valve HL#1 Discharge	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000113	No	2011	NA	Dezurik		20120424D	16	in		2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	9	35	26	$ 4,000	$ 5,800	6
394	Motor HL#1 Discharge Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000112	Yes	2011	NA	Limitorque		L971486			Rated Torque - 1500ft/lb and 2034 Nm, 515-600 V, 60 HZ, 0.26 Hp,	2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	9	20	11	$ 5,000	$ 7,250	6
395	Generator Backup Pump	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000142	Yes	1986	NA	Cotta Transmission Co.	SR12E	164348			NA	2	2	• Emergency power supply for HLP1 but the system already have a backup generator for all pumps so this would be a minor failure We believe that the score for the diesel motor for HLP1 shouldn't be increased as this would assume a power failure and a backup generator failure which would be a double Failure.	34	20	-14	$120,000	$ 174,000	4
396	Pump Engine Diesel (WWT)	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Engine	300000140	Yes	1986	NA	John Deere		RG6619AD522 16			NA	2	2	• Emergency power supply for HLP1 but the system already have a backup generator for all pumps so this would be a minor failure We believe that the score for the diesel motor for HLP1 shouldn't be increased as this would assume a power failure and a backup generator failure which would be a double Failure.	34	20	-14	$ 30,000	$ 43,500	4
397	Valve Backflow Preventor Chlorine	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000782	Yes	1986	NA	Watts		7732	2	in	175 PSI	2	4	• This BFP is needed to run the chlorine system necessary for disinfection	34	35	1	$ 1,600	$ 2,320	8
398	Valve Top Valve After Discharge Surge	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000108	No	1986	NA	Jenkins			12	in		2	5	• Isolation valve on the single discharge line from the HLPs with 0% redundancy	34	35	1	$ 4,000	$ 5,800	10
399	Valve Lower Valve Before Discharge Surge	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000109	No	1986	NA	Jenkins			12	in		2	5	• Isolation valve on the single discharge line from the HLPs with 0% redundancy	34	35	1	$ 4,000	$ 5,800	10
400	Motor Treated Water Isolating	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000110	No	1986	NA	Limitorque					.94 HP, 60 HZ, 575 V, 60 HZ, ph 3	2	4	• This valve is needed to isolate the HLPs for repairs	34	20	-14	$ 5,000	$ 7,250	8
401	Valve Treated Water Isolating	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000111	No	1986	NA	Willamette Valve Inc.		84013	24	in		2	4	• This valve is needed to isolate the HLPs for repairs	34	35	1	$ 15,500	$ 22,475	8

Item ID	Asset Description	Level 1 – Functional Group	Level 2 – Facility Type / Location	Level 3 – Process Location	Level 4 – Asset Category	Level 5 (Asset Type)	Unique ID	Nameplate Present?	Install Year	Refurbishment Year	Manufacturer	Model	Serial Number	Size / Capacity	Unit of Measure	Operating Conditions	Condition Score (1 to 5 Scale)	CoF Score (1 to 5 Scale)	CoF Score Comments	Age	ESL	RUL	Replacement Cost (2020)	Project Cost (includes Markup)	Risk Score (1 to 25 Scale)
402	Generator Backup Power	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Generator	300000139	Yes	1986	NA	Leroy Somer		A2510L7			160 kwh, 200 kva, 1800 RPM, 600 - 347v, 3 pH, 60 HZ,	2	5	● Emergency power is not necessary for production Score increased from 1 to 5; Llpump #4 should be more critical since it runs on generator; disaster recover	34	35	1	$120,000	$ 174,000	10
403	Backflow Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000809	Yes	1986	NA	Watts		7168	1	in		2	5	Based on PUC's requirement, the asset score to match the generator backup power since LLP#4 runs on this generator which is critical. This valve supplies cooling water to the engine. Should be serviceable in order to operate the backup diesel. This valve supplies cooling water to the engine. Should be serviceable in order to operate the backup diesel.	34	35	1	$ 1,600	$ 2,320	10
404	Tank Emergency Power Fuel #1	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Structural	Tanks / Basins	300000164	No	1986	NA	-	-	-				2	5	● Emergency power is not necessary for production Score increased from 1 to 5; Llpump #4 should be more critical since it runs on generator; disaster recovery	34	60	26	$ 3,400	$ 4,930	10
405	Tank Emergency Power Fuel #2	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Structural	Tanks / Basins	300000165	No	1986	NA	-	-	-				2	5	● Emergency power is not necessary for production Score increased from 1 to 5; Llpump #4 should be more critical since it runs on generator; disaster recovery	34	60	26	$ 3,400	$ 4,930	10
406	Tank Emergency Power Fuel #3	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Structural	Tanks / Basins	300000166	No	1986	NA	-	-	-				2	5	● Emergency power is not necessary for production Score increased from 1 to 5; Llpump #4 should be more critical since it runs on generator; disaster recovery	34	60	26	$ 3,400	$ 4,930	10
407	Valve butterfly pressure reducing	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000749	Yes	1986	NA	Jenkins			24	in		2	2	● The valve is needed for the pressure relief system isolation	34	35	1	$ 8,000	$ 11,600	4
408	Actuator Valve butterfly pressure reducing	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000749	Yes	1986	NA	Master gear co	MFF36S3	A6145				2	2	● The valve is needed for the pressure relief system isolation	34	35	1	$ 5,000	$ 7,250	4
409	Valve butterfly, level bypass	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000757	No	1986	NA	Jenkins			24	in		3	3	● This valve is needed to protect the raw water supply	34	35	1	$ 8,000	$ 11,600	9
410	Treated Water Surge Relief Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	Missing	No	1986	NA	Jenkins			12	in		2	4	● The valve is needed for the protecting the discharge header of the HLPS	34	35	1	$ 15,500	$ 22,475	8

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Appendix TM3A

Appendix B

Surface Water Treatment Facilities Condition Assessment Report

- B1: Fulcrum Condition Assessment Data Exports (provided via file transfer)

AECOM Imagine it. Delivered.

Public Utility Commission

Drinking Water System Asset Management Plan

Condition Assessment of Surface Water Treatment Facilities

Prepared by:

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Date: August, 2020

Project #: 60596267

Distribution List

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Revision History

Rev #	Date	Revised By:	Revision Description
0	Nov 11, 2019	SS, HV	Draft for internal review
1	January 16, 2020	MS	Internal review and draft submission
2	August 6, 2020	MS	Final Submission

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August 6, 2020

Andrew Hallett
Project Manager
PUC Services Inc.
500 Second Line E,
Sault Ste. Marie, ON P6A 6P2

Project #
60596267

Dear Mr. Andrew Hallet:

Subject: Drinking Water System Asset Management Plan
Condition Assessment of Surface Water Treatment Facilities

Please find enclosed our report on Condition Assessment exercise performed at the Surface Water Treatment facilities on July 16 – 18, 2019. This report shall be included as an **Appendix B** to *TM#3 – State of Infrastructure*.

Sincerely,
AECOM Canada Ltd.

Michele Samuels, M. Eng., MBA, P.Eng.
Senior Asset Management Consultant
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Statement of Qualifications and Limitations

The attached Report (the "Report") has been prepared by AECOM Canada Ltd. ("AECOM") for the benefit of the Client ("Client") in accordance with the agreement between AECOM and Client, including the scope of work detailed therein (the "Agreement").

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AECOM: 2015-04-13

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Table of Contents

List of Figures

List of Tables

Appendices

1. This Report

This report is developed to summarize the approach and findings of the inventory and visual condition assessment exercise performed at Sault Ste. Marie's surface water treatment facilities. This report shall be included as an addendum to *Technical Memo # 3 – State of the Infrastructure* which will utilize the inventory and visual condition data collected to develop risk profiles and identify further condition assessment activities for large assets.

2. Inventory and Condition Assessment Methodology

The scope of work for inventory and condition assessment of the PUC's facility assets included:

1. Inventory and visual, non-destructive, physical condition assessment (ICA) of critical large process equipment, process structural, and process electrical assets at the Water Treatment Plant (2059 Second Line West) and Gross Cap Raw Water Pumping Station.

   Note: An external walkaround of Marshall Drive Tanks was performed, and condition data was recorded for assets based on feedback provided by PUC staff. However, none of the assets were easily accessible and thus were not visually assessed.
2. Assignment of each asset to a specific asset hierarchy as defined in **Section 2.2.1**.
3. Determining the current condition grade of each asset using the condition rating scale provided in **Section 2.2.3**.
4. Confirming the installation year (i.e. age) of each asset. The age of each asset was field-verified to the extent possible (e.g. equipment label verification) or it was assumed based on discussion with PUC staff.

2.1 Inventory and Condition Assessment (ICA) of Facilities

Two (2) AECOM staff performed the ICA of the Water Treatment Plant (2059 Second Line West) and Gross Cap Raw Water Pumping Station. The ICA was limited to accessible and large key assets which belong to the following asset categories:

1. Process Mechanical Equipment;
2. Process Electrical Equipment; and
3. Process Structural;

To ensure the tasks are completed efficiently and cost effectively, two (2) PUC plant personnel accompanied each AECOM employee during the entire duration of the ICA to:

1. Assist in locating assets within the scope of this task; and
2. Provide comments on operation & maintenance issues, historical anecdotes, and/or condition of assets.

2.1.1 Existing Asset Inventory

An asset inventory list was provided by PUC for each surface water treatment facility with asset description and unique asset ID. However, it was conveyed that the asset inventory list was prepared approximately 10 years back and was not consistently updated over the years. Therefore, the list was not conclusive and additional assets not included on the inventory list was to be anticipated.

AECOM reviewed the existing asset inventory list and assigned an asset category based only on the asset description/name to identify the assets that will be captured for this study to better understand the level of effort required for completion of the ICA exercise. **Table 1** provides a summary of the number of assets based on asset category and facility location.

Table 1: Number of Assets Organized by Asset Category at WTP and Gros Cap Facility

Asset Category	Number of Assets	
	Gros Cap Raw Water Pumping Station	WTP
Process Mechanical	75	300
Process Electrical	17	53
Process Structural	1	3
Total Count of Assets Included in Proposed ICA Scope	**93**	**356**
Other Assets (Building Mechanical, Health & Safety)	*5*	*59*
Other Assets (Process Instrumentation, Building Electrical, Lab Equipment)	*36*	*178*

During the ICA site walkthrough, PUC staff guided AECOM staff to locate the assets present in the asset inventory list and directed them to assets which were more recently installed and not included in the existing asset inventory list.

2.2 Asset Attributes Captured

Table 2 outlines the asset attributes collected by AECOM during the ICA. The information collected within the application was exported in a useable format such as Microsoft Excel Spreadsheet and PDF reports (**Included as Appendix with *TM#3 – State of the Infrastructure***) to complete the project deliverables.

Table 2: Overview of Data Entry Fields in the Inventory and Condition Assessment Template

Asset Information	Field Name	Field Description
Asset Hierarchy	*Level 1 (Functional Group)*	Pre-defined field (*Surface Water Facilities*). The hierarchy level recognizes assets based on the functional group defined by PUC, i.e. Surface Water Facilities, Groundwater Facilities, Storage Facilities.
	Level 2 (Facility Type / Location)	Select the name of the facility (e.g. "Gros Cap Raw Water Pumping Station" or "Water Treatment Plant").
	Level 3 (Process)	The General process location of the site; e.g. “Raw Water”, “Flocculation”, etc.
	Level 4 (Asset Category)	Asset categories included within scope of this project; i.e. Process Equipment, Process Structural and Process Electrical
	Level 5 (Asset Type)	A specific asset type, based on the “asset category” selected (i.e. "Pump" under Process Equipment, "Tank" under Process Structural).

Asset Information	Field Name	Field Description
	Unique ID	If an Asset Tag is available with a Unique Asset I.D., enter the asset I.D. If not, type "Not Available."
	Asset Description	A general description of the asset (e.g. Raw Water Pump #1)
Operational Information	*Nameplate Available*	"Yes" or "No". This shall indicate if information recorded was collected from the nameplate or was provided by plant staff.
	Installation Year (YYYY)	Year which the asset was installed based on nameplate. If missing, a best estimate shall be made based on PUC staff feedback.
	Refurbishment Year (YYYY)	Year which the asset was repaired or refurbished. If no records immediately available, a best estimate shall be made based on PUC staff feedback.
	Manufacturer	Name of the manufacturer.
	Model	Model number.
	Serial Number	Serial number.
	Status (Active / Inactive)	Specify whether the asset was operating at the time of inspection.
	Size / Capacity	The general capacity or size of an asset. E.g. Pump capacity, pipe diameter, etc. If not applicable, enter "NA".
	Unit of Measure	Unit of Size/Capacity data; e.g. L/s, HP, mm, inches, feet etc.
	Operating Conditions (HP/RPM/Electrical Requirements)	If not applicable, write "NA"
	Level of Redundancy	If the process has redundancy, enter the percentage of redundancy. If not, enter "NA".
	General Notes	Record any other relevant additional asset information.
Condition Data	*Condition Rating*	Rated between 1 and 5 based on physical condition criteria.
	Data Collection System (Visual/Anecdotal)	If the asset was inaccessible for visual inspection and the condition rating was completed based on the feedback from PUC staff, then enter "Anecdotal."
	Comments	Add notes related to condition score based on visual observation or staff comments.

AECOM staff was responsible for ensuring information under Asset Hierarchy and Condition Data type was complete for all assets, however completion of Operational Information was dependent on availability and accessibility during inspection (such as presence of nameplate on equipment or feedback from PUC staff; nameplate being easily accessible etc.). For instances where the information specified above could not be easily accessed or collected, the field was left blank or listed as "Missing".

Asset attribute information collected is discussed in detail from **Sections 2.2.1 to 2.2.3**

2.2.1 Asset Hierarchy

Assets captured were broken down into five (5) levels of asset hierarchy listed below:

1. Level 1 – Functional Group
2. Level 2 – Facility Type / Location
3. Level 3 – Process Location

4. Level 4 – Asset Category
5. Level 5 – Asset Type

Table 3 provides a breakdown of the two (2) facilities that were inspected as a part of the ICA task and the existing processes at each facility.

Table 3: Asset Hierarchy Data – Facility Type / Location & Process

Level 1 – Functional Group	Level 2 - Facility Type / Location	Level 3 – Process Location
Surface Water Facilities	Gross Cap Raw Water Pumping Station	Pump Room
	Surface Water Treatment Plant	Pressure Reducing Station (Basement) Low Lift Pumping Station (Main) Flocculation & Filter Chamber (FF) High Lift Pumping Station (B) Motor Control Centre #1 (M) Motor Control Centre #2 (M) Chemical Facilities (M) - Cl_2 Gas Chemical Facilities (M) - Alum Chemical Facilities (M) - Blended Phosphate Pipe Gallery (Main Floor) Pipe Gallery (Basement)

Table 4 provides a breakdown of the three (3) asset categories which were inspected as a part of the ICA task and some of the asset types belonging within each category.

Table 4: Asset Hierarchy Data – Asset Category & Type

Level 4 - Asset Category	Level 5 - Asset Type		
Process Mechanical	Pump Valve Compressor Pressure Vessel Screen Mixer	Regulator Injector Filter Gearbox Gate	
Process Structural	Tanks Chemical Tanks		
Process Electrical	Actuator Disconnect Motor Breaker	Motor Control Centres (MCC's) Generator Starter Transformer	Variable Frequency Drive (VFD) Control Panel Feeder Engine

Unique I.D. – AECOM staff recorded the Unique I.D. tagged on the assets during the ICA. For instances where a Unique ID was not available, AECOM staff recorded "Not Available" under the Unique I.D. field.

Asset Description – AECOM staff continued using the asset description format provided by PUC which consisted of the asset type information and associated process or major equipment type, a numbering system for multiple assets within a single process and/or its functionality to describe the assets.

2.2.2 Operational Information

Installation Year – Was collected from the equipment name plate, if/when available. Where missing, the information was requested from the PUC staff accompanying the ICA team. For instances where the installation year is unknown, "Unknown" was entered. For Process Structural assets, the year of building construction was assumed as the Year of Installation.

The ICA team inquired with accompanying plant staff regarding refurbishments performed on the assets which would contribute to an adjustment in estimated life expectancy. If refurbishment was performed, the *year of refurbishment* was entered. If no refurbishment was performed, the accompanying field remained blank.

In addition to installation year, the name plate was also used to collect *manufacturer, model, serial number, size / capacity, units*, and *operating requirements* information. If this information was not labeled on the asset, the ICA team inquired with accompanying PUC staff. If no information is available or provided, the field shall be left blank.

Status (Active / Inactive) – The ICA team entered if the asset was in operation at the time of inspection.

2.2.3 Condition Assessment Methodology

Physical Condition Rating & Comment – The physical condition assessment consisted of a non-destructive, visual assessment of each asset where accessible. The condition assessment was limited to visual observations only and no physical testing was conducted. High-level performance observations in terms of capacity, suitability, quality, quantity, and cost or energy efficiency was not performed during the site inspection visit.

Each asset's condition was graded in accordance with AECOM's 5-point condition rating scale (**Table 5**). Where an asset is not easily accessible, a score of "NA" is assigned.

All the description scenarios do not need to be fulfilled to assign the corresponding ratings.

Table 5: Condition Rating Scale

Grade	Condition	Description
1	Very Good	New equipment or structure, no visible deficiencies or defects. Operable and well-maintained. Only normal scheduled maintenance required.
2	Good	Well-maintained with minor repairs needed. Operates at optimal conditions.
3	Fair	Functionally sound, but appearance significantly affected by deterioration. More minor repairs and infrequent major repairs required, or structure is marginal in its capacity to prevent leakage.
4	Poor	Deterioration has a significant effect on performance of asset due to leakage or other structural problems. Equipment is operating but defects are beginning to affect its performance. Significant repairs or likely replacement required within 2 years.
5	Very Poor	Major repair or replacement required in short-term. Equipment is no longer functioning or is a safety hazard. Unit needs a large overhaul repair or entire replacement to operate at ideal and safe conditions.
NA	Not Observed	Asset exists but was not able to be inspected.

Any comments from accompanying PUC plant staff regarding major defects, failures, or items in need of constant repair (typically for assets with a score between 3 and 5) were included in the Condition Comments field.

Data Collection System (Visual / Anecdotal) – For instances where an asset is not easily accessible, but a score could be assigned based on anecdotal information, the information was specified in this field. Examples of anecdotal information included feedback from PUC plant staff regarding O&M or age-based condition grade (remaining useful life).

2.3 Electronic Forms

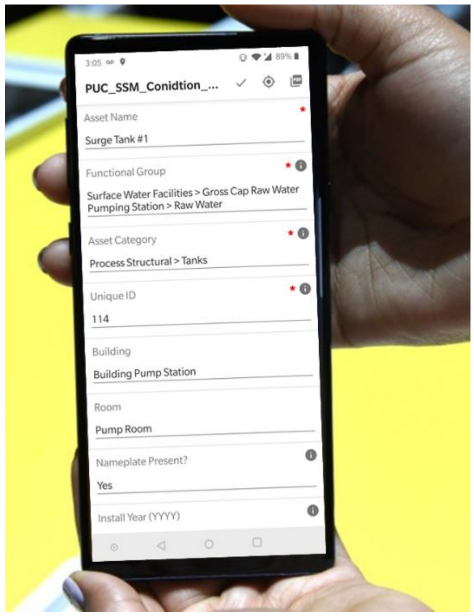


Figure 1: Mobile Device with Electronic Form Application

The ICA teams collected inventory data on-site in an application called Fulcrum using handheld mobile devices (mobile phones and/or tablets; **Figure 1**). To ensure a consistent approach to the ICA, AECOM developed a standard electronic form template to capture the asset attributes highlighted in **Table 2**. The application also enabled users to capture photographs and generated PDF reports of the asset information along with photographs for each asset.

The outputs generated by the Fulcrum application have been included in **Appendix A**.

3. Summary of Condition Assessment Task

A total of 410 assets were recorded during the asset inventory and condition assessment exercise. Please refer **Appendix A** for a complete registry of assets recorded. Asset inventory in spreadsheet format was included as an appendix with *TM#3 – State of the Infrastructure*.

3.1 Asset Hierarchy Level

Table 6 provides a detailed breakdown of the assets recorded based on Asset Hierarchy Level 2 (Facility Location) and Level 3 (Process location). From the table it can be observed that 85% of the assets recorded were located at the Surface Water Treatment Plant. In the surface water treatment plant, the greatest number of assets (99) were recorded at the Pipe Gallery (Basement) followed by High Lift Pumping Station (75).

Table 6: Breakdown of Assets Based on Level 2 (Facility Location) & Level 3 (Process Location) Asset Hierarchy Levels

Level 2 & Level 3 Asset Hierarchy Levels	Count
Gros Cap Raw Water Pumping Station	**68**
▪ Pump Room	68
Surface Water Treatment Plant	**342**
▪ Motor Control Centre #1 (M)	3
▪ Chemical Facilities (M) - Blended Phosphate	4
▪ Chemical Facilities (M) - Alum	7
▪ Chemical Facilities (M) - Cl2 Gas	8
▪ Motor Control Centre #2 (M)	8
▪ Pressure Reducing Station	19
▪ Flocculation & Filter Chambers	28
▪ Pipe Gallery (Main Floor)	38
▪ Low Lift Pumping Station	53
▪ High Lift Pumping Station	75
▪ Pipe Gallery (Basement)	99
Grand Total	**410**

Figure 2 provides a detailed breakdown of the assets recorded based on Asset Hierarchy Level 2 (Facility Location) and Level 4 (Asset Category). From the figure it can be observed that ~62% of assets belonged to the Process Mechanical category followed by Process Electrical at ~34%.

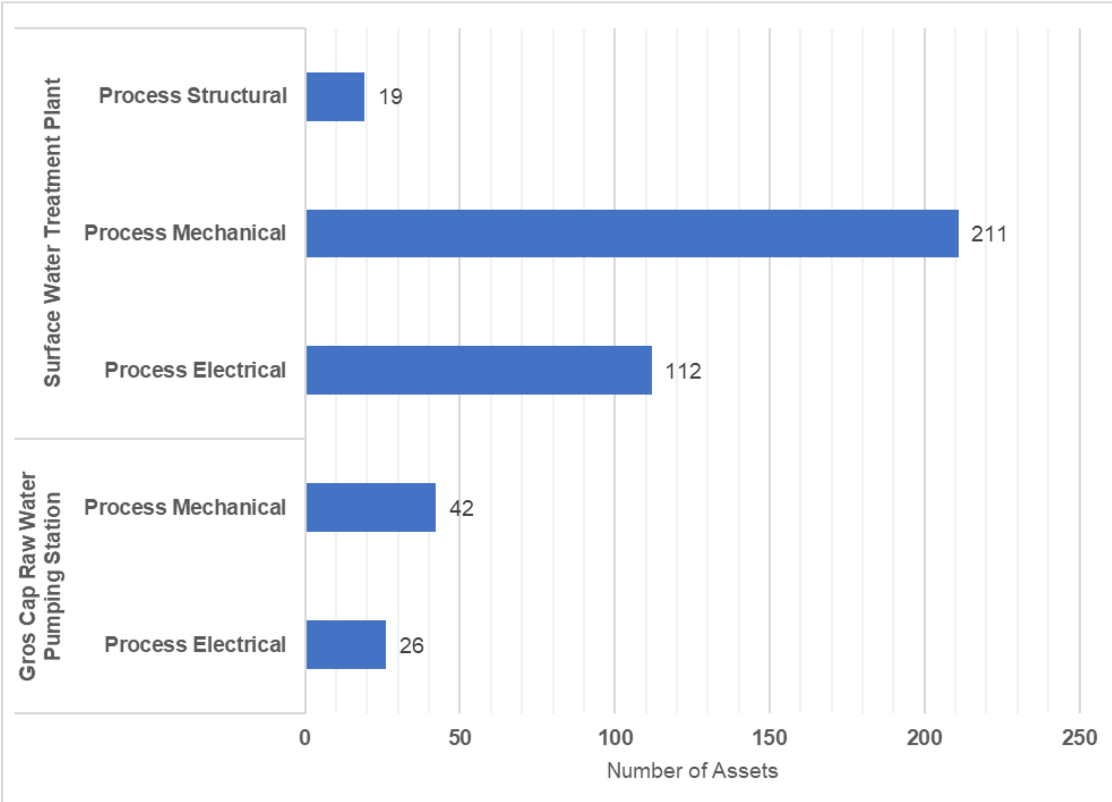


Figure 2: Breakdown of Assets Based on Level 2 (Facility Location) & Level 4 (Asset Category) Hierarchy Levels

Table 7 provides a breakdown of assets recorded based on Asset Hierarchy Level 5 (Asset Type). From the table it can be observed that 71% of the Process Mechanical assets were Valves, 35% of Process Electrical assets were Motors and 90% of Process Structural assets were Tanks / Basins.

Table 7: Breakdown of Assets Recorded Based on Level 4 (Asset Category) & Level 5 (Asset Type) Hierarchy Levels

Level 4 & Level 5 Asset Hierarchy	Count	Level 4 & Level 5 Asset Hierarchy	Count
Process Mechanical	**253**	**Process Electrical**	**139**
Compressor	3	Actuator	28
Filter	1	Breaker	3
Gate	8	Control Panel	2
Gearbox	2	Disconnect	18
Injector	6	Engine	1
Mixer	8	Feeder	1
Pressure Vessel	6	Generator	1
Pump	37	MCC	1
Regulator	1	Motor	48
Screen	2	Starter	25
Valve	178	Transformer	3
		UV Treatment	4

Level 4 & Level 5 Asset Hierarchy	Count	Level 4 & Level 5 Asset Hierarchy	Count
		Valve	4
		Process Structural	**19**
		Chemical Tanks	1
		Hopper	1
		Tanks / Basins	17

3.2 Installation Year

Figure 3 provides a breakdown of assets based on Installation Year. As demonstrated in the figure, most of the assets were installed in 1986 at Surface Water Treatment Plan (80%) and 1983 at Gros Cap Raw Water Pumping Station (98%) which mimics the timeline of when both facilities were commissioned.

Few assets were recorded with an installation year later than 1983 at Gros Cap. At surface water treatment plant, 20% of assets recorded were installed after 1986. Of these, most assets were installed in 2015 (27) followed by 10 assets installed in 2018.

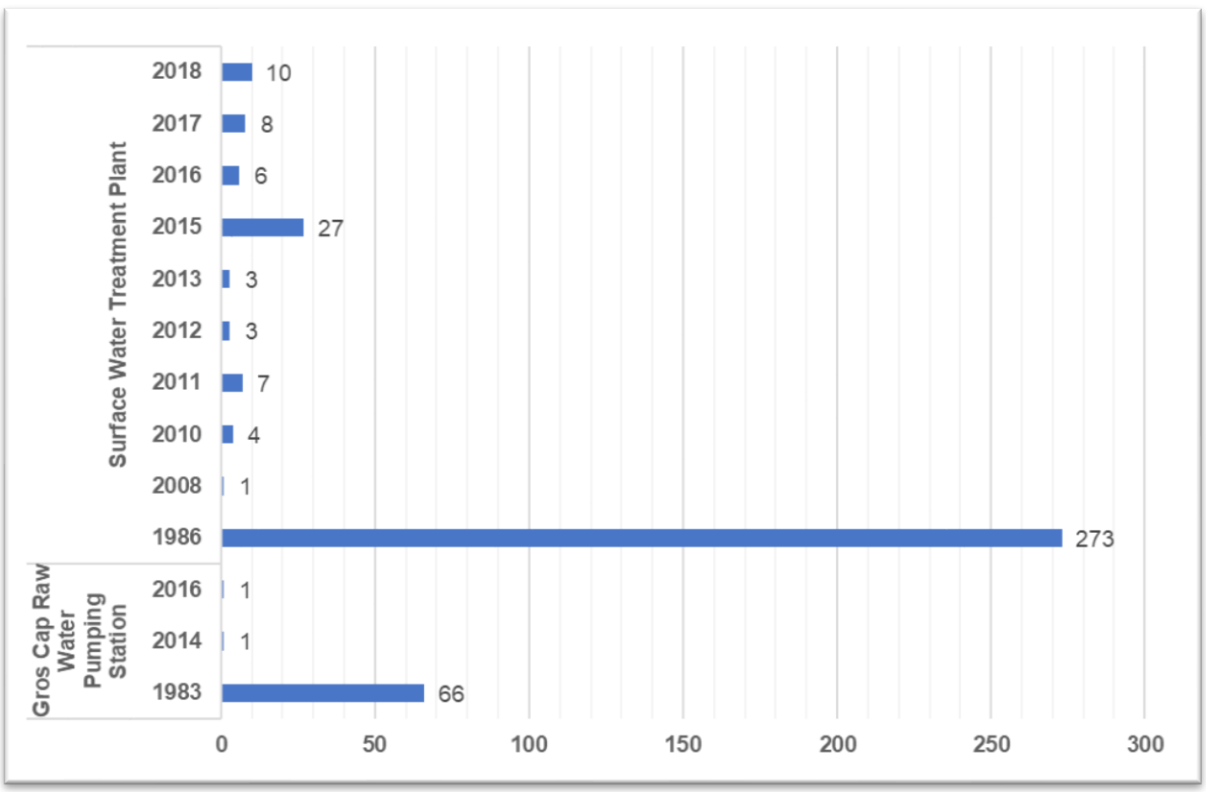


Figure 3: Breakdown of Assets based on Install Year

3.3 Visual Condition Assessment Results

Of the 410 assets recorded at both the facilities during the ICA exercise, 71% of the assets were observed to be in *2-Good* condition followed by 18% which were observed to be in *3-Fair* condition. Only 5 assets were observed to be in *4-Poor* condition and 1 asset in *5-Very Poor* condition (refer to **Table 9**).

Figure 4 provides a breakdown of assets based on facility. It can be observed that all assets at Gros Cap Raw Water Pumping Station had a score of *3-Fair* or lower with most of the assets with a score of *2-Good*. None of the assets at Gros Cap were observed to be in *4-Poor* or *5-Very Poor* condition. The only assets with a score of *4-Poor* or worse were observed at Surface Water Treatment Plant.

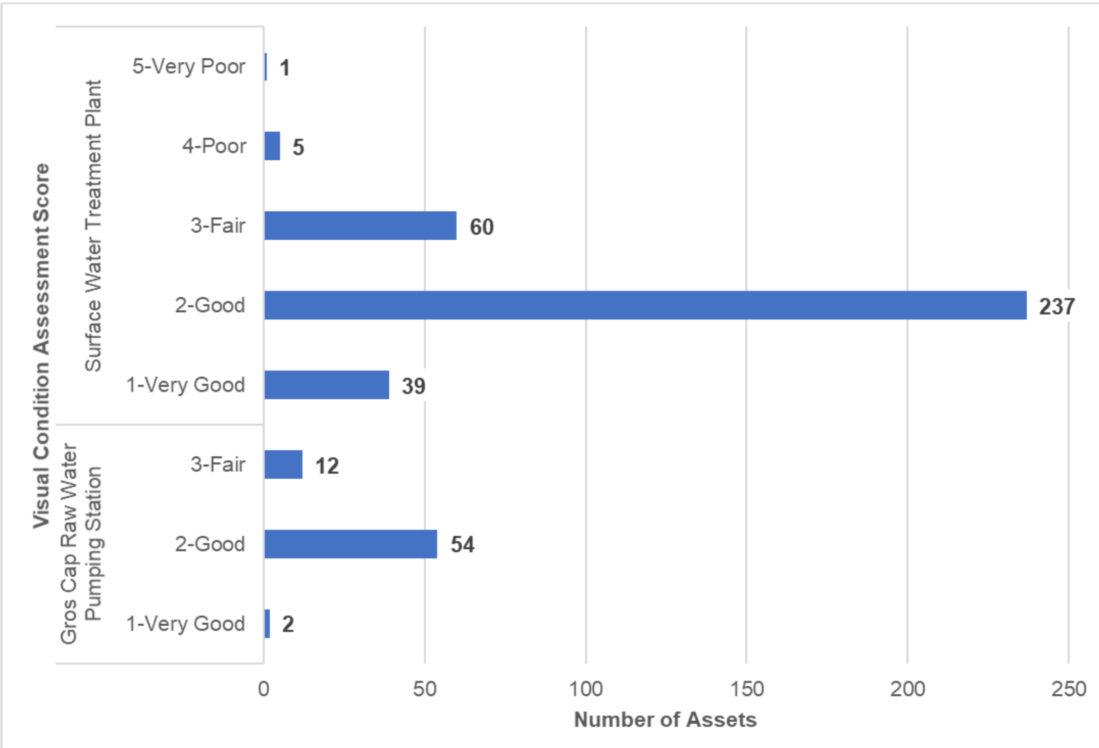


Figure 4: Breakdown of Visual Condition Assessment Score

From **Table 8**, it can be observed that all assets with a score of *4-Poor* and *5-Very Poor* are original construction (circa 1986). Most assets installed in the past decade (2008 and later) were observed to be in *1-Very Good* to *2-Good* condition.

Table 8: Breakdown of Visual Condition Assessment Scores Based on Install Year

Install Year	1-Very Good	2-Good	3-Fair	4-Poor	5-Very Poor	Grand Total
1983	2	52	12	-	-	**66**
1986	19	189	59	5	1	**273**
2008	-	-	1	-	-	**1**
2010	-	4	-	-	-	**4**
2011	1	6	-	-	-	**7**
2012	3	-	-	-	-	**3**
2013	2	1	-	-	-	**3**
2014	-	1	-	-	-	**1**
2015	4	23	-	-	-	**27**
2016	6	1	-	-	-	**7**
2017	-	8	-	-	-	**8**

Install Year	1-Very Good	2-Good	3-Fair	4-Poor	5-Very Poor	Grand Total
2018	4	6	-	-	-	**10**
Grand Total	**41**	**288**	**75**	**5**	**1**	**410**

From **Table 9** the following can be observed:

1. Of the 5 assets in *4-Poor* condition, 3 were in Pipe Gallery (Main Floor) and 2 in Pipe Gallery (Basement). The only asset with a score of *5-Very Poor* was in Pipe Gallery (Basement).
2. All assets with a condition score of *4-Poor* or more were Process Mechanical.
3. All 5 assets with a score of *4-Poor* are Valves and the asset with a score of *5-Very Poor* is a Pump.
4. The asset types observed to be *3-Fair* included actuators, mixers, motors, pump, starter and valve. Most of these assets (65%) were valves which formed 26% of the total valves captured.

Assets with a score of *4-Poor* and *5-Very Poor* are discussed in detail in **Section 3.3.1.**

Table 9: Breakdown of Assets Based on Asset Hierarchy

Asset Hierarchy				Visual Condition Score					
Level 2 – Facility Type / Location	Level 3 – Process Location	Level 4 – Asset Category	Level 5 (Asset Type)	1- Very Good	2- Good	3- Fair	4- Poor	5- Very Poor	Grand Total
Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Actuator	-	6	-	-	-	6
			Control Panel	-	2	-	-	-	2
			Disconnect	-	5	-	-	-	5
			Motor	2	6	2	-	-	10
			Starter	-	1	3	-	-	4
		Process Electrical Total		**2**	**20**	**5**	**-**	**-**	**27**
		Process Mechanical	Compressor	-	2	-	-	-	2
			Pressure Vessel	-	4	-	-	-	4
			Pump	-	2	2	-	-	4
			Screen	-	2	-	-	-	2
			Valve	-	24	5	-	-	29
		Process Mechanical Total		**-**	**34**	**7**	**-**	**-**	**41**
	Pump Room Total			**2**	**54**	**12**	**-**	**-**	**68**
Gros Cap Raw Water Pumping Station Total				**2**	**54**	**12**	**-**	**-**	**68**
Surface Water Treatment Plant	Chemical Facilities (M) - Alum	Process Electrical	Transformer	-	1	-	-	-	1
		Process Electrical Total		**-**	**1**	**-**	**-**	**-**	**1**
		Process Mechanical	Pump	-	3	-	-	-	3
		Process Mechanical Total		**-**	**3**	**-**	**-**	**-**	**3**
		Process Structural	Tanks / Basins	-	3	-	-	-	3
		Process Structural Total		**-**	**3**	**-**	**-**	**-**	**3**
	Chemical Facilities (M) - Alum Total			**-**	**7**	**-**	**-**	**-**	**7**
	Chemical Facilities (M) - Blended Phosphate	Process Mechanical	Pump	-	2	-	-	-	2
		Process Mechanical Total		**-**	**2**	**-**	**-**	**-**	**2**
		Process Structural	Tanks / Basins	-	2	-	-	-	2
		Process Structural Total		**-**	**2**	**-**	**-**	**-**	**2**
	Chemical Facilities (M) - Blended Phosphate Total			**-**	**4**	**-**	**-**	**-**	**4**
	Chemical Facilities (M) - Cl2 Gas	Process Mechanical	Injector	6	-	-	-	-	6
			Regulator	1	-	-	-	-	1
			Valve	1	-	-	-	-	1
		Process Mechanical Total		**8**	**-**	**-**	**-**	**-**	**8**
	Chemical Facilities (M) - Cl2 Gas Total			**8**	**-**	**-**	**-**	**-**	**8**
		Process Electrical	Disconnect	-	4	-	-	-	4
			Motor	-	3	1	-	-	4

Level 2 – Facility Type / Location	Level 3 – Process Location	Level 4 – Asset Category	Level 5 (Asset Type)	1- Very Good	2- Good	3- Fair	4- Poor	5- Very Poor	Grand Total
		Process Electrical Total		**-**	**7**	**1**	**-**	**-**	**8**
	Flocculation & Filter Chambers	Process Mechanical	Gate	-	8	-	-	-	8
			Mixer	-	4	-	-	-	4
		Process Mechanical Total		**-**	**12**	**-**	**-**	**-**	**12**
		Process Structural	Tanks / Basins	-	8	-	-	-	8
		Process Structural Total		**-**	**8**	**-**	**-**	**-**	**8**
	Flocculation & Filter Chambers Total			**-**	**27**	**1**	**-**	**-**	**28**
	High Lift Pumping Station	Process Electrical	Disconnect	-	2	-	-	-	2
			Engine	-	1	-	-	-	1
			Generator	-	1	-	-	-	1
			Motor	4	17	-	-	-	21
		Process Electrical Total		**4**	**21**	**-**	**-**	**-**	**25**
			Compressor	1	-	-	-	-	1
			Filter	-	1	-	-	-	1
			Gearbox	-	2	-	-	-	2
			Pressure Vessel	-	2	-	-	-	2
			Pump	-	9	4	-	-	13
			Valve	3	22	-	-	-	25
		Process Mechanical Total		**4**	**36**	**4**	**-**	**-**	**44**
		Process Structural	Chemical Tanks	-	**1**	-	-	-	**1**
			Hopper	-	1	-	-	-	1
			Tanks	1	3	-	-	-	4
		Process Structural Total		**1**	**5**	**-**	**-**	**-**	**6**
	High Lift Pumping Station Total			**9**	**62**	**4**	**-**	**-**	**75**
	Low Lift Pumping Station	Process Electrical	Actuator	-	8	-	-	-	8
			MCC	-	1	-	-	-	1
			Motor	-	5	-	-	-	5
			Starter	-	14	-	-	-	14
		Process Electrical Total		**-**	**28**	**-**	**-**	**-**	**28**
		Process Mechanical	Mixer	-	1	3	-	-	4
			Pump	8	-	-	-	-	8
			Valve	4	8	1	-	-	13
		Process Mechanical Total		**12**	**9**	**4**	**-**	**-**	**25**
	Low Lift Pumping Station Total			**12**	**37**	**4**	**-**	**-**	**53**
		Process Electrical	Feeder	-	1	-	-	-	1

Asset Hierarchy				Visual Condition Score					
Level 2 – Facility Type / Location	**Level 3 – Process Location**	**Level 4 – Asset Category**	**Level 5 (Asset Type)**	**1- Very Good**	**2- Good**	**3- Fair**	**4- Poor**	**5- Very Poor**	**Grand Total**
	Motor Control Centre #1 (M)		Starter	-	2	-	-	-	2
		Process Electrical Total		-	**3**	-	-	-	**3**
	Motor Control Centre #1 (M) Total			-	**3**	-	-	-	**3**
	Motor Control Centre #2 (M)	Process Electrical	Breaker	-	3	-	-	-	3
			Starter	-	4	1	-	-	5
		Process Electrical Total		-	**7**	1	-	-	**8**
	Motor Control Centre #2 (M) Total			-	**7**	1	-	-	**8**
	Pipe Gallery (Basement)	Process Electrical	Actuator	-	-	4	-	-	4
			Disconnect	-	7	-	-	-	7
			Motor	-	5	2	-	-	7
			Transformer	-	2	-	-	-	2
			UV Treatment	-	4	-	-	-	4
			Valve	-	4	-	-	-	4
		Process Electrical Total		-	**22**	**6**	-	-	**28**
		Process Mechanical	Pump	-	3	3	-	1	7
			Valve	3	26	33	2	-	64
		Process Mechanical Total		**3**	**29**	**36**	**2**	**1**	**71**
	Pipe Gallery (Basement) Total			**3**	**51**	**42**	**2**	**1**	**99**
	Pipe Gallery (Main Floor)	Process Electrical	Actuator	-	9	-	-	-	9
		Process Electrical Total		-	9	-	-	-	9
		Process Mechanical	Valve	-	19	7	3	-	29
		Process Mechanical Total		-	19	7	3	-	29
	Pipe Gallery (Main Floor) Total			-	**28**	**7**	**3**	-	**38**
	Pressure Reducing Station	Process Electrical	Actuator	1	-	-	-	-	1
			Motor	1	-	-	-	-	1
		Process Electrical Total		2	-	-	-	-	2
		Process Mechanical	Valve	5	11	1	-	-	17
		Process Mechanical Total		5	11	1	-	-	17
	Pressure Reducing Station Total			**7**	**11**	**1**	-	-	**19**
Surface Water Treatment Plant Total				**39**	**237**	**60**	**5**	**1**	**342**
Grand Total				**41**	**291**	**72**	**5**	**1**	**410**

3.3.1 Summary of Inspector Comments on Asset Condition

Table 10 and **Table 11** provide a list of assets with a Score of *4-Poor* and *5-Very Poor* at the Surface Water Treatment Plant with comments about visual observations made by the inspectors. In addition, comments provided by PUC maintenance staff are also summarized in the tables. **Figure 5** shows some photographs of assets with a Score of *4-Poor* and *5-Very Poor.*

As highlighted in the condition comments, the Valves were assigned a score of *4-Poor* due to severe corrosion accompanied with surface delamination / severe flaking. There were signs of leakage noticed which can be indicative of sealing issues. This was further confirmed by PUC maintenance staff comments regarding issues with sealing the valves. All the valves listed in **Table 10** are original installation (1986) and are thus either near or past the useful service life.

Table 10: List of Assets with a Condition Score of 4-Poor at the Surface Water Treatment Plant

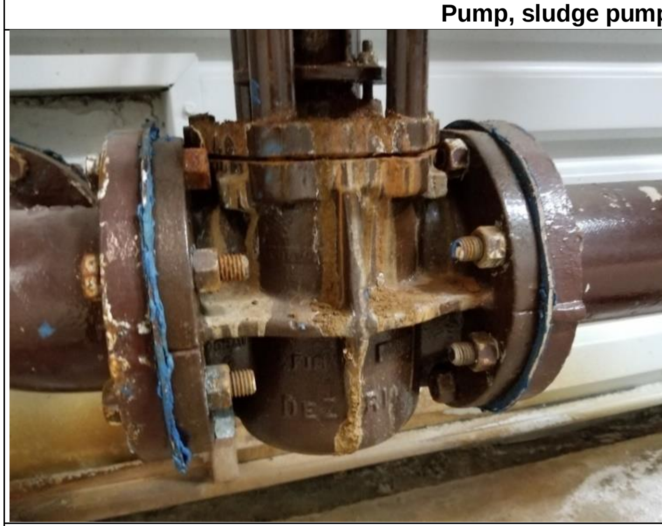
Unique ID	Asset Description	Level 3 – Process Location	Level 4 – Asset Category	Level 5 (Asset Type)	Install Year	Condition Comments	PUC Staff Comments Summary
300000188	Valve plug, suction sludge pump BW Tank No. 2	Pipe Gallery (Basement)	Process Mechanical	Valve	1986	Severe corrosion and wear all over body, flange, and bolt evident by leak.	Valve and actuator are not performing per original design and need replacement
Missing	Valve plug, suction sludge pump BW Tank No. 1	Pipe Gallery (Basement)	Process Mechanical	Valve	1986	Severe corrosion and wear all over body, flange, and bolt evident by leak	Valve and actuator are not performing per original design and need replacement
300000714	Valve Butterfly Filter 1 Drain	Pipe Gallery (Main Floor)	Process Mechanical	Valve	1986	Severe corrosion and coating loss; leakage stains	Valve does not properly seal and reaching end of service life.
300000720	Valve Butterfly Filter 2 Drain	Pipe Gallery (Main Floor)	Process Mechanical	Valve	1986	Severe corrosion and coating loss; leakage stains	Major maintenance issues with valves and actuators and their components (sealing issues). Jenkins (manufacturer) does not manufacturer these specific valves anymore.
300000735	Valve Butterfly Filter 4 Surface Wash	Pipe Gallery (Main Floor)	Process Mechanical	Valve	1986	Severe corrosion of the valve operator whose failure can significantly impact the valve.	Cannot get them sealed, when trying to isolate. There is leakage, reaching end of service life.

The Sludge Pump 1 was assigned a score of *5-Very Poor* due to the excessive leakage resulting water pooling on the floor and the over evident deterioration of the asset. PUC maintenance staff also stated that the pump was not working at the designed flow rate. All pump is original installation (1986) and is thus either near or past the useful service life.

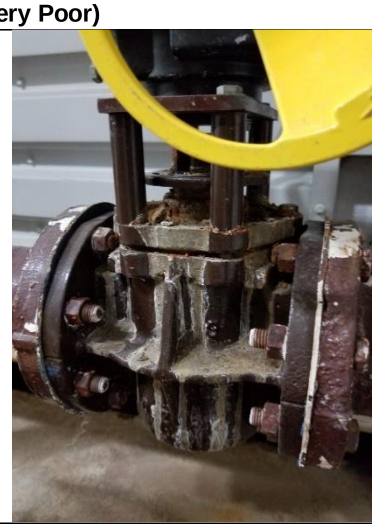
Table 11: List of Assets with a Condition Score of 5-Very Poor at the Surface Water Treatment Plant

Unique ID	Asset Description	Level 3 – Process Location	Level 4 – Asset Category	Level 5 (Asset Type)	Install Year	Condition Comments	PUC Staff Comments Summary
300000188	Pump, sludge pump 1	Pipe Gallery (Basement)	Process Mechanical	Pump	1986	Seal is worn and causes leaking evident on pump base and water pooling on floor. Deterioration evident.	Not performing at designed flow rate.

Pump, sludge pump 1 (Score: 5-Very Poor)



Valve plug, suction sludge pump BW Tank No. 2 (Score: 4-Poor)



Valve plug, suction sludge pump BW Tank No. 1 (Score: 4-Poor)

	
Valve Butterfly Filter 1 Drain (Score: 4-Poor)	**Valve Butterfly Filter 2 Drain (Score: 4-Poor)**
	
Valve Butterfly Filter 4 Surface Wash (Score: 4-Poor)	

Figure 5: Photographs of Assets Scored 4-Poor and 5-Very Poor

3.3.2 Summary of Operator Comments Regarding Asset Condition

Comments provided by the plant operator and maintenance staff regarding the condition of assets at each process location have been summarized below. These comments were an overview of the condition of assets at the process location and thus have been summarized in most instances according to asset type. The condition comments could not be verified by AECOM personnel and in most instances contradicted the visual observations recorded. Thus, the final visual condition scores assigned to each asset were independent of the comments provided by the PUC plant staff. However, a summary of these comments has been presented below.

Pressure Reducing Station (Basement)

1. Valve Inlet Surge Relief - Functional but does not close tight. Seat is worn out.
2. Valve low lift Water Level Control - Has been rebuilt twice and needs to be rebuilt again. Doesn’t seal

Low Lift Pumping Station (Main)

1. Inlet Blender Mixers - Many of the mixers are not sized correctly and don’t last long.
2. Low lift Motor #4 starter - Copper wire creates a spark - arc in the contact every time the pump starts. Become pitted and weld together or can cause flash. All relays need to be replaced, at end of life.

Flocculation & Filter Chamber (FF)

1. Motors - Spare parts are not available which makes it difficult to repair quickly. New parts need to be made-to-order which impacts the operation of other components of the asset. The motor cannot be run at the optimum speed which affects operation.
2. Sluice Gates - Haven't been exercised, not sure if okay or properly operating, original construction so may need major repair or rehab.
3. Filter Chamber - Some of the Chambers' coating seems to be flaking or chipping off which was noticed when tanks are drained for maintenance.

High Lift Pumping Station (B)

1. Actuators – Backwash Valve (Check, Suction, Discharge): Random failures with actuators. Not functioning 100 percent as they are intended to.
2. Backwash Pumps - Issues with finding spare parts; lead time for parts is long; not readily available which are very imp to system, so downtime is an issue. Not functioning as intended. No major rehab or repair performed other than greasing. Very critical to the system.
3. Motors – Backwash Pump: Past their useful service life. Maintenance issues expected along with issues with spare parts. Due for a major service or repair. Has not be serviced regularly.
4. Surge Tanks - The tanks are due for an internal inspection which hasn't been performed for a long time. The air Relief Valve on the top is close to end of life and requires a replacement.
5. Suction Header Valve - Have not been inspected or operated in a long time. Assumed to be inoperable and requiring repair or maintenance.
6. High Lift Pump - Long lead time for parts, needs a major check of its internal components, only regular maintenance performed i.e. greasing, currently operates well with no major issues.
7. High Lift Pump Motor - Are functional but are due for a major re-built.
8. Motor Treated Water Isolating Valve - Ongoing issues with actuator cannot be fully closed. Cannot use actuator to take it of seat. Not functioning as intended.

Motor Control Centre #2 (M)

1. High Lift #3 Starter - Periodic maintenance; continuous failure in primary contractors and control relays. Copper contacts have welded shut.

Pipe Gallery (Basement)

1. Valves (Multiple Types) – Does not seal properly. Needs to be manually adjusted or system must be shut-off when doing maintenance. Not performing as per original design.
2. Strainer – Plant Water Supply - Cannot remove screen due to corrosion so cleaned in place
3. Valves Actuator Filter - Has failed and does not feedback to SCADA.
4. Sludge Pumps and Motors - Not performing at designed flow rate. Seal is worn and causes leaking.

Pipe Gallery (Main Floor)

1. Valves (Filter Surface wash and Back wash) - Cannot get them sealed, when trying to isolate there is leakage. Some of the valves are not produced by the manufacturers anymore.
2. Actuators (Filter Inlet, Drain, Backwash) – Components randomly fail (shafts, electrical, etc.)

3.4 Marshall Drive Tank Condition Assessment

Assets at the Marshall Drive Tank station were not easily accessible at the time of asset inventory and condition assessment exercise. However, a temporary condition score was assigned to some of the process mechanical assets (valves) to record their condition. The condition scores and comments were provided by the maintenance staff (Refer **Table 12**). However, the actual condition of the assets could not be confirmed visually by AECOM.

Table 12: List of Assets with Condition Score & Comments at the Marshall Drive Tank

Unique ID	Asset Description	Level 3 – Process Location	Level 4 – Asset Category	Level 5 (Asset Type)	Install Year	Condition Score	PUC Staff Comments Summary
200000007	Valve Butterfly 600 (24") - #1	Tank Station	Process Mechanical	Valve	1984	3-Moderate to 4-poor	Never been cycled, original 1984.
200000008	Valve Butterfly 600 (24") - #2	Tank Station	Process Mechanical	Valve	1984	3-Moderate to 4-poor	Never been cycled, original 1984.
200000009	Valve Butterfly 600 (24") - #3	Tank Station	Process Mechanical	Valve	1984	3-Moderate to 4-poor	Never been cycled, original 1984.
200000010	Valve Butterfly 600 (24") - #4	Tank Station	Process Mechanical	Valve	1984	3-Moderate to 4-poor	Never been cycled, original 1984.
200000011	Valve Butterfly 600 (24") - #5	Tank Station	Process Mechanical	Valve	1984	3-Moderate to 4-poor	Never been cycled, original 1984.
200000012	Valve Butterfly 600 (24") - #6	Tank Station	Process Mechanical	Valve	1984	3-Moderate to 4-poor	Never been cycled, original 1984.
200000013	Valve Deflector 600 - #7	Tank Station	Process Mechanical	Valve	1984	Unknown	Difficult to assess due to location of valve, could be opened but may not ever fully close.
200000014	Valve Deflector 600 - #8	Tank Station	Process Mechanical	Valve	1984	Unknown	Difficult to assess due to location of valve, could be opened but may not ever fully close.
200000015	Tank	Tank Station	Process Structural	Tank	1984	3-Moderate to 4-poor	Never been inspected. Outer tank base concrete is deteriorating.
200000016	Screens VentMD	Tank Station	Process Mechanical	Screens	1984	Unknown	Currently functional but uncertain of condition.

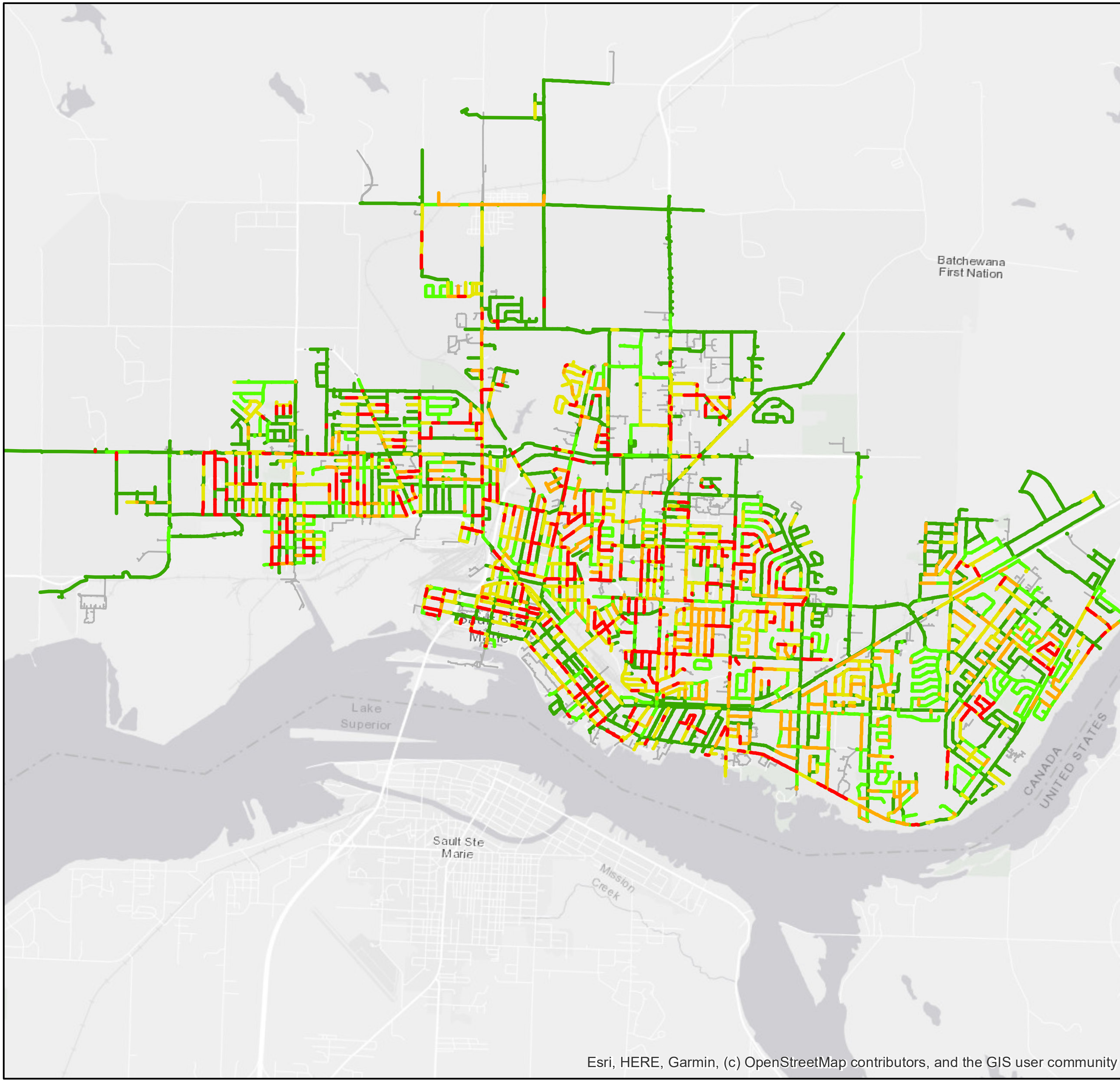
4. Next Steps

The asset inventory and condition data will be used to develop ***Technical Memo #3 – State of Infrastructure.***

Appendix TM3A

Appendix C

Linear Distribution Likelihood of Failure Maps



PUC

N

LoF

- Very Poor
- Poor
- Fair
- Good
- Very Good
- Others

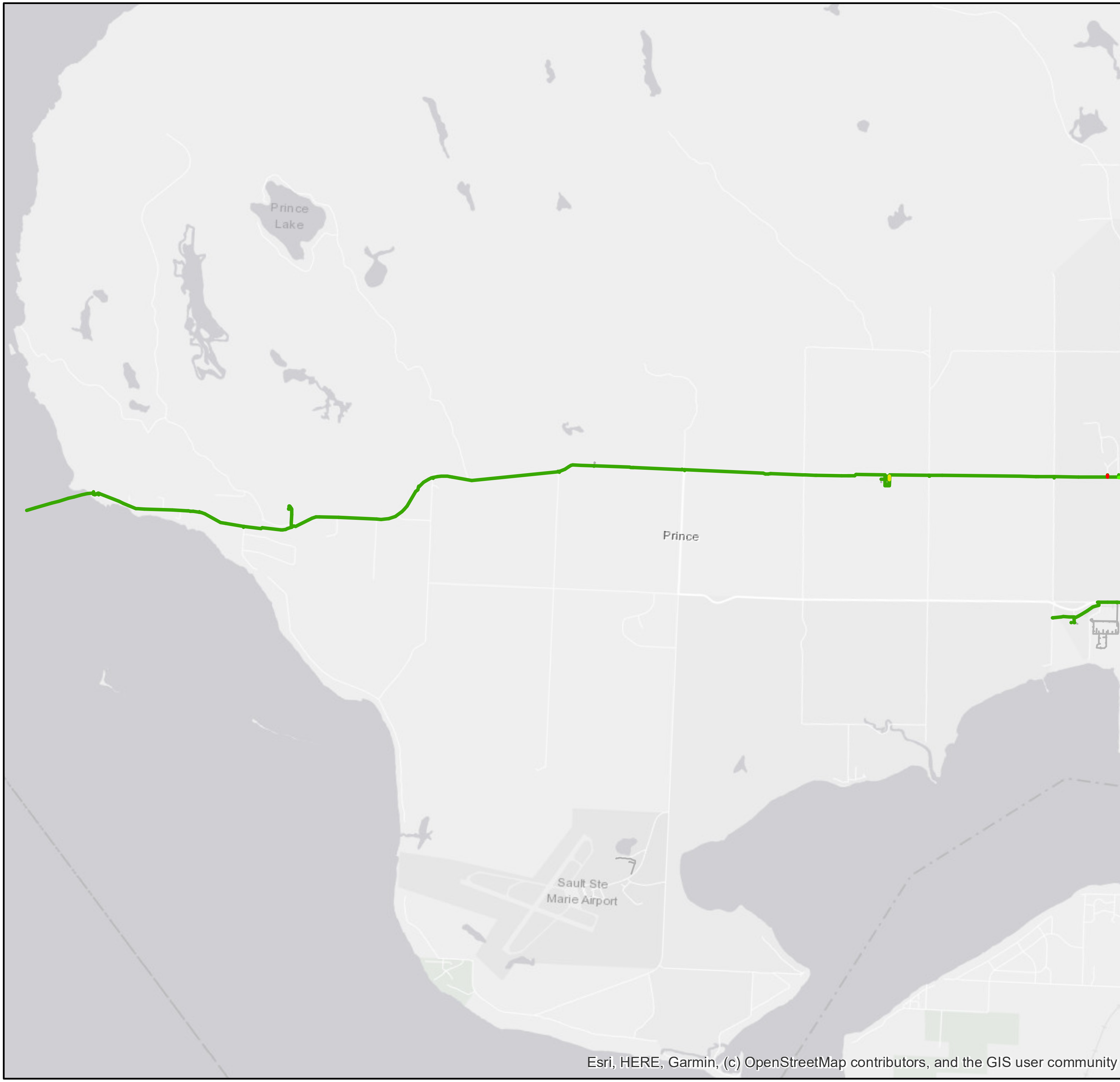
0 400 800 1,600 2,400
Meters

Drinking Water
Asset Management Plan

6/8/2020	1:65,998	Datum - UTM 1983 Z16 Source - GCS NA 1983
P#:	V#:	**LoF Map**

AECOM

Map location: C:\PUC Calibration Session\Figures - Map Template.mxd
Date Saved: 6/8/2020 3:23:09 PM



N

LoF

- Very Poor
- Fair
- Good
- Very Good
- Others

0 400 800 1,600 2,400
Meters

Drinking Water
Asset Management Plan

6/8/2020	1:65,998	Datum - UTM 1983 Z16 Source - GCS NA 1983
P#:	V#:	**LoF Map**
AECOM		

Map location: C:\PUC Calibration Session\Figures - Map Template.mxd
Date Saved: 6/8/2020 3:23:09 PM

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Public Utilities Commission of the City of Sault Ste. Marie

Drinking Water System Asset Management Plan

Technical Memo #3B – State of the Infrastructure: Risk and Criticality

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Date: July 2023

Project #: 60596267

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Revision History

Rev #	Date	Revised By:	Revision Description
1	December 15, 2019	SS, KK, MS	Initial Draft
2	January 15, 2020	MS	Internal review and draft submission
3	August 7, 2020	SS, KK, MS	Final submission
4	June 12, 2023	KK	Final submission

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July 04, 2023

Project #
60596267

Dear Orlan:

Subject: Drinking Water System Asset Management Plan
Technical Memo #3B – State of the Infrastructure: Risk and Criticality

Please find enclosed our final submission of *TM#3B – State of the Infrastructure: Risk and Criticality* for the drinking water system at Sault Ste. Marie. This document has incorporated your comments and edits from draft submission.

We trust the enclosed meets your approval. Should you have any questions or require further information about our submission, please do not hesitate to contact us.

Sincerely,
AECOM Canada Ltd.

Khalid Kaddoura, PhD, PMP P.Eng
Project Manager/ Senior Asset Management Consultant
khalid.kaddoura@aecom.com

Encl.
cc:

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AECOM: 2015-04-13

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Table of Contents

List of Figures

List of Tables

Appendices

1. Project Overview

PUC Services Inc. ("PUC") is a multi-utility services company who is solely owned by the Corporation of the City of Sault Ste. Marie. PUC provides drinking water systems and an electrical distribution system under service contracts between PUC and its clients. The City of Sault Ste. Marie (herein referred to as "the City") has a population of 73,368 and is projected to experience an increase in population of 9,900 by 2036 (as reported to Council in 2019). To service this population, PUC maintains a drinking water system dating back to 1916. Today, PUC supplies drinking water from both surface water and groundwater using a combination of surface water intakes and pumps, a surface water treatment plant, 6 wells, two reservoirs, and 445 kilometers of watermains.

PUC is charged with maintaining and renewing a diverse portfolio of mixed vintage infrastructure within the bounds of available funding levels. With a variety of water sources, PUC desires to align its future investments in drinking water sources, storage, and treatment facilities with growth projections while ensuring that a high quality of drinking water is provided. As well, PUC recognizes the challenges in drinking water distribution. Unlike wastewater and/or stormwater collection systems, pressurized watermains are often operationally and cost prohibitive to inspect, resulting in many municipalities possessing limited condition information, and in many cases managing them in a reactive fashion.

With the inception of *Ontario Regulation 588/17*, PUC faces an upcoming series of regulatory requirements for asset management systems that align with ongoing PUC and City initiatives to update the Financial Plan, develop a Drinking Water Master Plan, and update the City's Official Plan. Recognizing the alignment of these goals with asset management, PUC has engaged AECOM to develop a Drinking Water System Asset Management Plan. The project deliverables will provide PUC with a roadmap for establishing its asset management system and include:

1. A review of asset data and data management practices to evaluate requirements for the proposed asset management system.
2. The creation of an Asset Management Policy to serve as the top-down guidance document that defines the components of the asset management system.
3. An analysis of the State of the Infrastructure using a combination of desktop and field assessments to develop risk profiles and identify further condition assessment activities for large assets.
4. Development of PUC's current and proposed Levels of Service.
5. The consolidation of plans and projects required to achieve the objectives of the asset management system into an Asset Management Strategy.
6. The development of a Financial Strategy to evaluate the requirements for sustainably funding the asset management system, to propose funding models for meeting the needs of the system, and to support the update of PUC's Financial Plan.

1.1 This Report

Defining the State of the Infrastructure can be an exhaustive process when done for the first time. It involves quantifying the assets owned by PUC, examining their age, replacement value, and characteristics such as material type. The characteristics of PUC's asset portfolio will have implications for how assets are maintained, the upcoming cycles of replacement that may be required, and the potential risk exposure of the assets as it relates to these observations.

Accomplishing these objectives for a treatment and distribution system will produce a significant amount of documentation. As such, the decision was made to separate *Technical Memo #3* into two documents. The State of the Infrastructure was organized as follows (**Table 1**):

Table 1 – Report Structure

Report Name	Objectives
Technical Memo #3A – State of the Infrastructure	▪ Define asset quantities, age, and replacement value. ▪ Examine condition where information is available.
Technical Memo #3B – State of the Infrastructure: Risk and Criticality **(This Report)**	▪ Introduce concepts of risk assessment and risk management. ▪ Conduct consequence of failure and risk assessments ▪ Present the results of the assessments.

2. Risk Management

2.1 Overview

In analysing risk for infrastructure assets, the first step is to identify assets that are most critical to the business. Critical assets are those that will potentially have the greatest impact on service delivery and performance objectives should they fail. The fundamental principle of consequence (or criticality) models is that they evaluate the relative importance of assets based on select criteria. The approach to risk analysis within this project is aligned with industry best practices such as:

- The American Water Works Association (AWWA) J100:10 – Risk and Resilience Management of Water and Wastewater Systems (RAMCAP) (AWWA, 2010)
- The International Organization for Standardization (ISO) 31000:2009 Risk Management – Principles and guidelines (ISO31000, 2009)
- The Canadian Guidance for Managing Drinking-Water Systems: A Risk Assessment/Risk Management Approach (Canadian Water and Wastewater Association, 2005)

Many of these standards and best practices utilize a triple-bottom-line assessment approach containing the following four (4) criticality pillars:

- Economic – influence of the asset's failure on monetary resources;
- Operational – influence of the asset's failure on operational ability;
- Social – influence of the asset's failure on society; and
- Environmental – influence of the asset's failure on the environment

By applying specific indices, the risk assessment framework generates a risk (or priority) score for each asset. The risk score is a rating of the asset based on the detailed assessment of the likelihood and consequence of failure based on a number of key parameters. All parameters are then equated using equation **[1]**.

$$Risk = Likelihood\ of\ Failure \times Consequence\ of\ Failure \quad [1]$$

Based on this principle, the risk associated with a given asset's failure can be managed by limiting the likelihood of this occurring, or the impact realized, should it occur. In *Technical Memorandum #3A*, AECOM discussed the calculation of the Likelihood of Failure (LoF) for both linear and non-linear assets based on historical data, environmental exposure, age and operating conditions.

Consequence of Failure (CoF) reflects the relative "impact" of a given asset's failure. While traditionally these have been looked at as purely economic terms (i.e. repair cost, loss of revenue, etc.), the truth is that investment decisions can often be driven by non-economic factors. Understanding both the economic and non-economic impacts associated with loss or limitation of service help in categorizing an asset's "criticality" and justifying infrastructure decisions in a consistent, defensible manner. Even without understanding when failure will occur, categorizing assets based on "criticality" or "failure consequence" allows municipalities to effectively target management strategies aimed at mitigating risk.

Table 2 demonstrates how "consequence" related data can be combined in shaping our approach to managing an individual asset based on a three-point scale (minor, moderate, and major).

Table 2: Influence of Asset Criticality on Management Strategy

Criticality Rating	Minor	Moderate	Major
Service Implication	Negligible impact to service delivery	Noticeable to significant impact to service	Catastrophic impact to service and/or public safety
Operational Impact	Failure can be addressed through normal operations	Failure can be accommodated but strains operations	Failure cannot be handled in an effective manner
Management Strategy	Run-to-Failure	Manage failure	Avoid failure

"Failure" reflects an asset's ability to provide its required level of service (LoS). While this is often interpreted in a physical sense, as a measure of deterioration of an asset's structure, loss of service can occur on several fronts. Some of the common failures' consequence against the four pillars are as follows:

- Structural – Leak/break
- Economic – Cost of maintenance exceeds renewal
- Operational – Insufficient capacity
- Regulatory – Maintenance requirements and MOE compliance

Understanding which failure types are most prevalent to a given type of asset, and how potential "failure modes" will develop over an asset's lifecycle, provides valuable insight when developing management strategies. The type and amount of effort (and investment) placed on diagnosing and tracking factors contributing to loss of service should reflect the ultimate value of the information collected in supporting staff in making planning and management decisions; **Table 3** expands on **Table 2** to highlight factors influencing this decision.

Table 3: Influence of Asset Criticality on Assessment Strategy

Criticality Rating	Minor	Moderate	Major
Service Impact	Negligible/Low	Noticeable/ Significant	Major/Catastrophic
Operational Impact	Failure can be addressed through normal operations	Failure can be accommodated but strains operations	Failure cannot be handled in an effective manner
Management Strategy	Run-to-Failure	Failure Management	Failure Avoidance
Assessment Priorities	Monitoring and forecasting	Assessment and planning	Proactive maintenance and rehabilitation
Accuracy Requirements	High tolerance for performance uncertainty	Low tolerance for performance uncertainty	No tolerance for performance uncertainty

Because of the limited impact of failure in low criticality assets, taking a reactive approach to data collection and asset renewal will not pose significant risk and liability in the future. While adopting a 'run-to-failure' policy can be politically unpalatable, using lifecycle costing and hard economics to drive system inspection/renewal/rehabilitation can provide a consistent, defensible framework for planning and decision-making. A data collection strategy based on asset monitoring and forecasting will provide effective results. PUC may:

- Focus on low-cost / high-coverage inspection techniques to monitor asset performance and identify assets requiring short-term attention; and
- Use failure pattern and/or statistical modelling, and observations of past performance, to forecast medium and long-range needs.

Inspection and planning programs for moderate/high priority assets – those whose failure will produce noticeable to significant impact to service – should be optimized based on criticality or levels of service parameters. PUC needs to:

- Increase the frequency of assessment as condition deteriorates and the rate of degradation increases on an unanticipated manner; and
- Ramp-up tools and techniques to increase certainty of data collected as condition deteriorates and the need for accurate understanding of condition grows.

2.2 Consequence of Failure (CoF)

2.2.1 Methodology for Non-Linear Assets

For the purpose of this study, CoF was defined for vertical assets in terms of the five-point rating scale presented in **Table 4**. This criticality rating scale recognises that poor asset performance or asset failure could have impacts in terms of environmental, public safety, worker safety, equipment and process aspects, with severity of the criticality ranging from “Very Low” to “Very High”.

The consequence of failure (CoF) was completed by AECOM in consultation with PUC water treatment plant operators and maintenance staff following the reception of the consequence rating scale and preliminary CoF scores from AECOM.

Table 4: Consequence of Failure Rating Scale – Vertical Assets

Grade	Level	Definition
1	Very Low	▪ Loss of equipment does not impact service or has minimal impact ▪ Process running below design capacity and 100% redundancy available ▪ Regulatory objectives and requirements met ▪ No Injuries
2	Low	▪ Loss of equipment causes localized disruption of non-essential service ▪ 100% redundancy available ▪ Regulatory objectives and requirements met ▪ Minor injuries, no medical attention required
3	Moderate	▪ Loss of equipment causes localized disruption of essential service ▪ Between 99% and 25% redundancy available ▪ Regulatory objectives not met but requirements met ▪ Minor injuries, medical attention required or temporary disability
4	High	▪ Loss of equipment causes widespread short disruption or long-term localization of disruption of essential service ▪ Reduced Capacity or <25% Redundancy available ▪ Regulatory objectives and requirements not met ▪ Multiple serious injuries or permanent partial disability
5	Very High	▪ Loss of equipment causes widespread short disruption or long-term localization of disruption of essential service ▪ Equipment currently running over design capacity with no redundancy ▪ Regulatory objectives and requirements not met ▪ One or more fatalities or permanent total disability

Workshop #2 – Linear Risk Framework conducted on October 08, 2019 was used as an opportunity to introduce the consequence of rating scale and discuss the preliminary CoF scores that were developed by AECOM based on review of drawings and relevant asset information available. **Appendix A** provides a detailed breakdown of non-linear asset inventory along with the CoF scores and discussions regarding scoring justifications.

2.2.2 Methodology for Linear Assets

Successful implementation of risk-based planning and decision-making requires the identification of critical infrastructure to determine the CoF component of the risk equation. This is typically performed within a computerized work process or model that is based on a rating system of various failure consequence parameters. Parameters use a system of multi-variant weightings to derive a final overall value (Refer to **Figure 1**). The CoF parameter is a semi-quantitative and is developed to reflect an organization's policy and goals, as closely as possible.

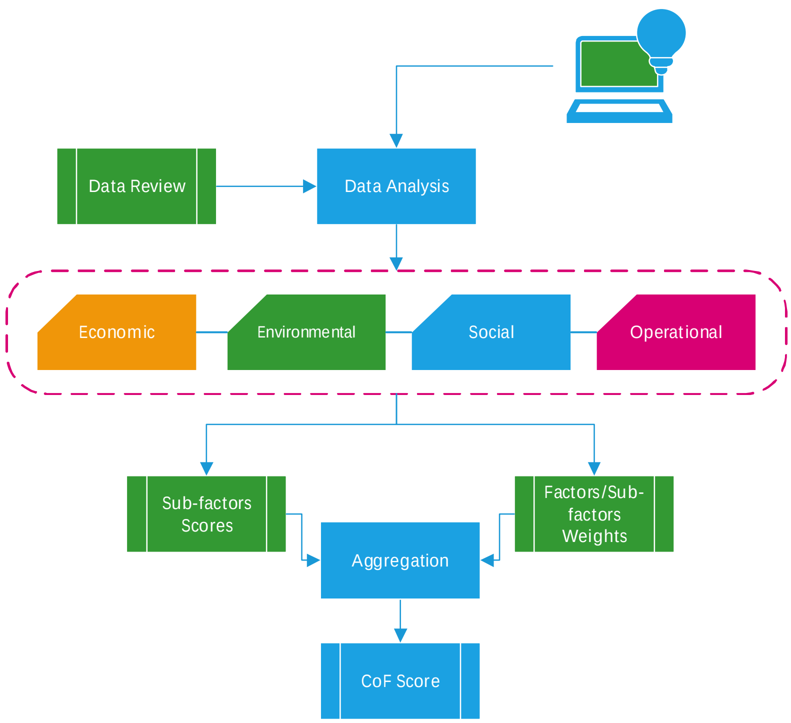


Figure 1: CoF Overall Methodology

Piped infrastructure is geographically dispersed over a wide area with many external influences; therefore, the consequence model is typically generated from a spatial data analysis (GIS) that could be automated and repeated, with little user intervention to minimize long-term data maintenance cost. Current industry best-practices for risk-based infrastructure management identify a consequence model as considering the following impacts of failure:

- **Economic:**
  Reflects potential impacts in terms of direct and indirect capital costs of pipe failure. It generally considers direct cost of repairing the pipe and remediation, and the potential collateral damage to neighboring properties and structures. For example, it will be more expensive to repair a failed pipeline in a highly traveled area where traffic management costs are high. The scoring ranges for the economic risk model indices are typically proportional to the sum of the direct and indirect cost of repair.

- **Environmental:**
  Reflects potential impact to the environment in the event of a pipe failure that is directly or indirectly related. These could be related to the loss of treated water, loss of energy, disturbance to the surrounding terrain and areas, contamination of spilled water with the surroundings that may degrade the quality of water, etc.

- **Social:**
  Reflects potential impact to the public in the event of pipe failure. It generally considers the magnitude of the spill and potential disruption to nearby roadway traffic, commercial activity, and/or public health and safety.

- **Operational:**
  Reflects potential impact to the system's operations in the event of pipe failure. Generally, it considers both organizational impact and the system impact in terms of whether there is enough redundancy within the system to circumvent the failed asset for an extended period. In addition, the operational criteria considers the urgency and complexity of remediation of a failure and the safety of work crews.

Weights are applied to each impact's category and are dependent on a balance of science and the perspective of the stakeholders. The weightings are intended to form a balance among different stakeholder requirements in an environment where operators may weigh the operational category higher than a water customer who may weigh the social impact higher. The weightings can be altered in the future as stakeholder views and overall organizational drivers change over time. The ultimate weight given to each category is qualitative but is also a reflection of the PUC's overall goals and stakeholder priorities. There is a practical consideration of weighting determinations, and the ultimate rating system should reasonably delineate the assets in broad categories to differentiate priorities clearly.

2.2.2.1 Index Weightings

To develop the CoF model for the linear system, individual factors are considered and rationalized . Each factor is weighted on a scale from 0% to 100%, with the total of all required to equal 100%. Each factor consists of sub-factors that when combined, represent the overall consequence score. Each of these sub-factors consists of a 1 to 100 score (attribute values) such that 1 would indicate insignificant/minimal consequence while 100 would indicate the highest consequence. Sub-factors are also weighted against each other on a scale from 0% to 100%, with the total of all being required to equal 100%.

Based on the factors considered for PUC, **Table 5** summarizes the weights ofthe four factors and related sub-factors. According to the table, the highest factor in the CoF model is related tooperations with a weight of 40%, while the least weight among the factors is the environmental category. Withregards to the sub-factors, the highest aggregated weighted factor is the diameter with a total contribution of 40%compared to the other global weights. As the pipe size is a dominant subfactor, the CoF index is significantly drivenby this attribute.

Table 5: Weighting of Factors and Sub-factors

Factor	Local Weight	Subfactor	Local Weight
Economic	**20%**	Pipe Size	30%
		Pipe Material	15%
		Accessibility	15%
		Households/ km	10%
		Land Use	15%
		Pipeline Depth to Ground Water Table (GWT)	15%
Operational	**40%**	Pipe Size	60%
		Pipe Material	40%
Social	**25%**	Pipe Size	25%
		Road Class	15%
		Critical Customers	35%
		Households/ km	20%
		Land Use	5%
Environmental	**15%**	Pipe Size	25%
		Water Body	15%
		Soil Type	25%
		Slope	35%

PUC staff indicated that contact mains (large pipelines) exist where failure may not impose significant impact to the distribution network. These instances occur at Gaulais, Lorna, Shannon, and Steelton wells and all but Goulais can be isolated from the transmission system to mitigate any failure impacts. Each well contributes about 10% of total available supply, so there may also be minor impacts to capacity should any one well suffer a failure. Therefore, before proceeding with calculating the CoF index for each asset, the Watermain ID of these segments were filtered and assigned as "contact mains" with a score of 1 (**Table 6**) .

In addition, due to the automated nature of the model, some pipe criticalities were revisited to ensure that they scored in the moderate and major categories as they service critical customers. These pipes are summarized in **Appendix B**.

Table 6: Watermain ID of Contact Mains

Watermain ID	Well	Watermain ID	Well	Watermain ID	Well
4864	Lorna Well	**13508**	Steelton Well	**102362**	Goulais Well
4850	Lorna Well	**13515**	Steelton Well	**102349**	Goulais Well
4845	Lorna Well	**15221**	Steelton Well	**102347**	Goulais Well
4860	Lorna Well	**15222**	Steelton Well	**102343**	Goulais Well
4862	Lorna Well	**15223**	Steelton Well	**102350**	Goulais Well
5614	Lorna Well	**15224**	Steelton Well	**102361**	Goulais Well
6175	Shannon Well	**16136**	Steelton Well	**102360**	Goulais Well
5411	Shannon Well	**16137**	Steelton Well	**102358**	Goulais Well
5650	Shannon Well	**16138**	Steelton Well	**102359**	Goulais Well
7146	Shannon Well	**16139**	Steelton Well	**102344**	Goulais Well
103142	Shannon Well	**16317**	Steelton Well	**102363**	Goulais Well
5630	Shannon Well	**16318**	Steelton Well	**102348**	Goulais Well
120430	Shannon Well	**16319**	Steelton Well	**102342**	Goulais Well
120431	Shannon Well	**16320**	Steelton Well	**102351**	Goulais Well
120432	Shannon Well	**16321**	Steelton Well	**102364**	Goulais Well
120433	Shannon Well	**16322**	Steelton Well	**102353**	Goulais Well
120429	Shannon Well	**16323**	Steelton Well	**102345**	Goulais Well
120434	Shannon Well	**16324**	Steelton Well	**102346**	Goulais Well
576	Steelton Well	**16325**	Steelton Well		
644	Steelton Well	**16326**	Steelton Well		
2491	Steelton Well	**16327**	Steelton Well		
2955	Steelton Well	**16328**	Steelton Well		
3444	Steelton Well	**16329**	Steelton Well		
3449	Steelton Well	**14689**	Goulais Well		
4328	Steelton Well	**14696**	Goulais Well		
6508	Steelton Well	**14710**	Goulais Well		
7281	Steelton Well	**14604**	Goulais Well		
11696	Steelton Well	**14590**	Goulais Well		
11711	Steelton Well	**13930**	Goulais Well		
15837	Steelton Well	**102352**	Goulais Well		

2.2.2.2 Attribute Hierarchies

Figure 2 graphically summarizes the hierarchy of the attributes and weights for the CoF framework.

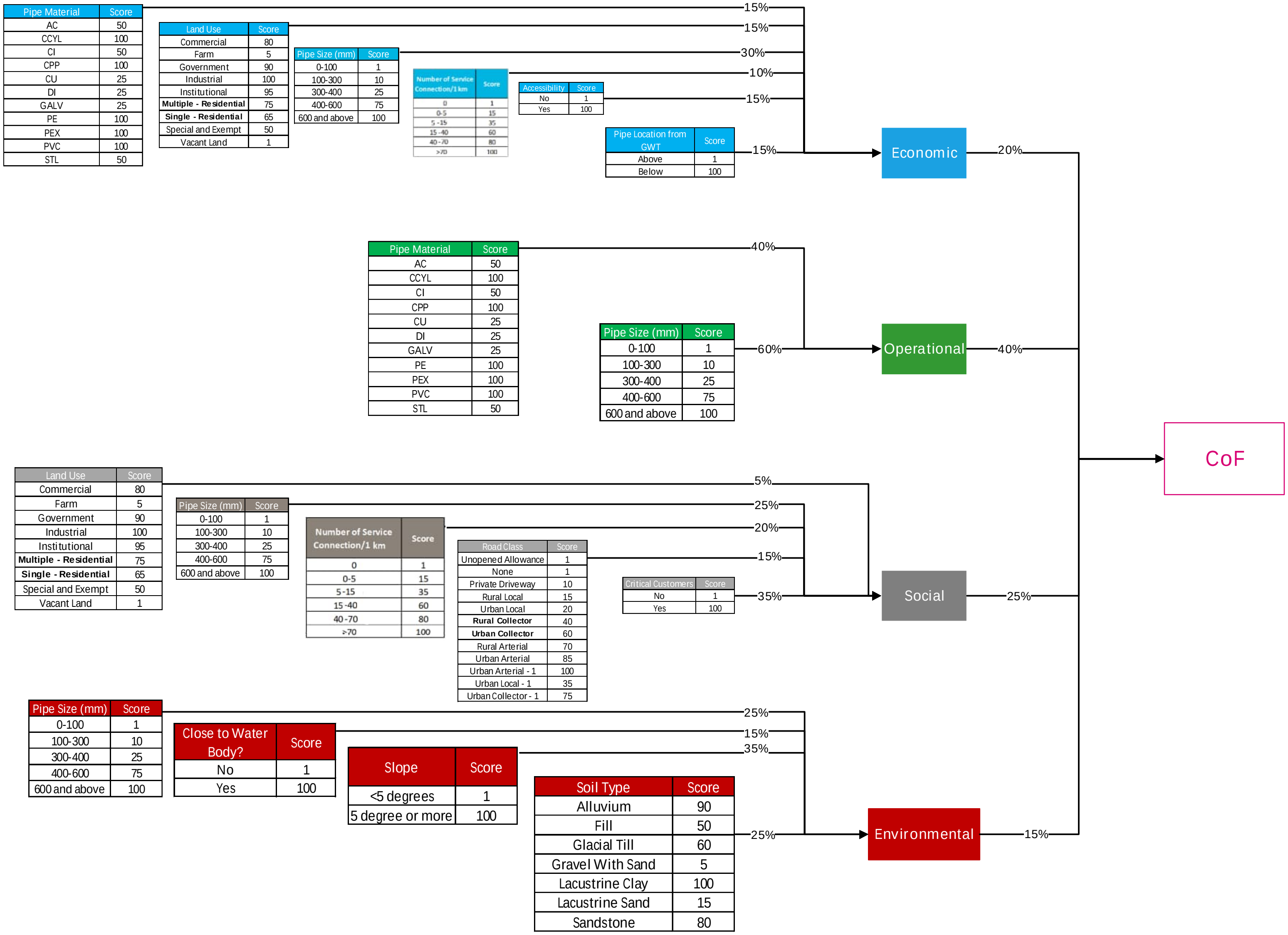


Figure 2: CoF Attributes and Weights

In **Figure 2,** each parameter was assigned a score from 1 to 100, in which an attribute that has significant failure consequences was assigned a higher score when compared to moderate to negligible consequences.

1. **Pipe size** – medium to large pipes may have more failure consequences than smaller pipelines.
2. **Pipe material** –failure mechanisms of concrete pressure pipes, metallic pipes, and thermoplastic pipes vary considerably. Based on literature (Clair and Sinha, 2014)[1], thermoplastic pipes may cause significant failure consequences once they fail as opposed to some metallic pipelines (assuming all other factors are the same – pipe size, depth, etc.). Concrete pressure pipe failures are drastically catastrophic as they are mostly attributed to broken wires. Within each pipeline category, some scores varied depending on the expected mode of failure and were assigned based on common risk management practices in the Greater Toronto Area.
3. **Accessibility** – pipes that are inaccessible were given a higher score to prioritize maintenance activities.
4. **Households** (normalized) – a higher score was assigned to pipes that are connected to a larger number of households.
5. **Land use** – higher scores were assigned to pipes located in dense areas and other critical locations as opposed to vacant lands.
6. **Pipeline depth to groundwater table** – pipelines located below the groundwater table may require additional dewatering and could result in higher costs.
7. **Road class** – higher scores were assigned to pipes in roads where the average daily traffic is expected to be high.
8. **Critical customer** – this factor was specifically added to consider critical customers including hospitals, retirement homes, heavy manufacturing, steel mill, and other health care facilities.
9. **Water body** – higher scores were assigned to pipes that are in close proximity to water bodies.
10. **Soil type** – relatively impervious soils may increase the probability of flooding scenarios. Soil types that would tend to hold water and have smaller grains were assigned a higher score.
11. **Slope** – pipes located within steeper gradients were assigned a higher score.

2.2.2.3 Data Requirements

Input data is required to calculate the CoF score. This data is collected from information acquired from the Geographic Information System (GIS) supplied by PUC. **Table 7** provides the sub-factors used in the model with its data sources, format, and field(s).

[1] *St. Clair, A. M., & Sinha, S. (2014). Development of a standard data structure for predicting the remaining physical life and consequence of failure of water pipes.* Journal of Performance of Constructed Facilities*, 28(1), 191-203.*

Table 7: CoF Model Data Requirements

Parameter	Data Source(s)	Format	Attribute Field	Geoprocessing
Slope	LND_CONTOUR	Polyline Feature Class	ELEVATION	1. Raster Calculation: Topography to Raster 2. Raster Calculation: Slope, Degrees (0 – 90) 3. Feature Vertices to Point (WAT_Watermain, Midpoint) 4. Extract Values to Points (Slope)
Soil Type	SSM_GeoTechnical Survey_1977	Polygon Feature Class	SOILTYPE	Spatial join with WAT_Watermain.
Pipe Size	WAT_Watermain	Polyline Feature Class	PipeDiameter	n/a
Material	WAT_Watermain	Polyline Feature Class	Material	n/a
Land Use	ParcelPropertyCode	Polygon Feature Class	CODE_CLASS	Iterative spatial join process using definition queries and WAT_Watermain. Pipes were assigned land use values in order of priority; such that higher priority land uses overwrite lower priority land uses.
Accessibility	RD_RailwayCentreLine WAT_RMS	Polyline Feature Class Polygon Feature Class	n/a	Near Analysis (25-meter tolerance) Watermains converted to midpoints. Midpoints that did not intersect the utility corridor polygon were flagged as not having a dedicated utility corridor/easement.
Pipe Type	WAT_Watermain	Polyline Feature Class	PipeDiameter	n/a
Road Class	STREETS	Polyline Feature Class	OFFICIALPLAN STREETDESIGNATION	Iterative spatial join process using definition queries and WAT_Watermain. Pipes were assigned road class values in order of road class priority; such that higher priority road classes overwrite lower priority road class at road intersections.
Water Body	OHN_WATERBODY OHN_WATERCOURSE	Shapefile (Ministry of the Environment/ Land Information Ontario)	n/a	Near Analysis (25-meter tolerance)
Number of Service Connections	WAT_ServiceLead	Polyline Feature Class	n/a	Spatial Join used to count service connection features by watermain and utility corridor.
Special Areas	SSM_GeoTechnical Survey_1977 LND_CONTOUR WWIS_Out (Wells, Ministry of the Environment)	Polygon Feature Class Polyline Feature Class Point Shapefile	ELEVATION SOIL TYPE STATIC_LEV	1. Pipes in clay units were isolated. Slope values within clay units were then examined in Excel. 2. Point groundwater measurements from Ministry of the Environment extrapolated using Inverse Distance Weighting. Values assigned to WAT_Watermain using Extract Values to Points
Critical Customers	ParcelPropertyCode	Polygon Feature Class	CODE_CLASS	High priority land use designations identified within Excel.

2.2.2.4 Consequence of Failure Multi-Criteria Rating

Using the Multi Criteria Rating Technique, a pipe's CoF score can be calculated as per equation **[2].** The asset's CoF can be assessed based on the tabulation of index values using the Weighted Average approach. The Weighted Average approach uses the weights of all four categories (economic, operational, social, and environmental). Each category (*i*) contributes to the overall asset's criticality according to its respective weight to establish a blended value.

$$CoF_{i=(eco.,opr.,soc.,env.)} = W_i \sum_{j=1}^{n} W_{ij} S_{ij} \qquad [2]$$

where:

CoF_i Consequence of failure score for each factor *i* (economic, operational, social, and environmental)

S_{ij} Factor (*j*) score from 1 to 100 in each category *i*

W_{ij} Subfactor weight as a percentage

2.2.2.5 Defining the Consequence of Failure Rating

A qualitative grading system is used to relate scoring to PUC's ability to respond to asset failure, should it occur. **Table 8** describes typical characteristics of assets within each CoF category ranked as either, minor, moderate, or major. The description of the rating system can provide a general understanding of each category. It should be noted that not all metrics were assessed within the criticality model based on available data, and the nature of multi-criteria assessments means that each asset will be assessed by a combination of CoF drivers.

Table 8: CoF Ranking Definition

Minor	Insignificant to limited impact on the four pillars (environment, social, economy, and operations); limited disruption to surroundings and the natural environment; The CoF score is low and the cost of failure is negligible to low. Negligible to minor injuries due to failure.
Moderate	Moderate impact on the four pillars (environment, social, economy, and operations); society experiences minor impacts and the cost of failure is moderate; Moderate injuries but not serious.
Major	Major impact on the four pillars (environment, social, economy, and operations); Major consequence for large population, serious risk of losing water supply, no redundancy of failed pipe segments, significant costs of failure are incurred, etc.; Serious injuries due to failures.

2.2.2.6 Consequence of Failure Rating Breakpoints

Using the Multi-Criteria Rating System, an absolute aggregated number (1,100) is calculated to describe an asset CoF using the scoring scheme described in **Table 5** . When CoF is computed for the system, the percentile method is applied to determine where individual points lie in the CoF distribution. To better conceptualize the rating system, percentile breakpoints are assigned through the CoF distribution to categorize an asset's calculated score as minor, moderate, and major.

Breakpoints are set dynamically to ensure they are reflective of a dynamic risk portfolio. This method of setting breakpoints proves a useful and consistent method to conceptualize CoF scores that combines benchmarked conceptions of failure consequence, statistical interpretation, and graphical interpretation. Any classification of a score using breakpoints will be subjective to the given tolerance for risk and may be adjusted by the user to reflect their specific level of tolerance. Furthermore, assets can vary in their scores within a given scoring category (for example, two assets with a score of 45 and 60, respectively, could both be classified as moderate), meaning that in the context of asset prioritization, absolute scores will prove most useful in identifying priorities within a cohort of assets. Assigning breakpoints and classification provides a reasonable way to conceptualize CoF on a system wide level in a user-friendly manner. **Table 9** displays the CoF breakpoint ratings for the system based on the current CoF distribution.

Table 9: CoF Breakpoints

Rank	Lower	Upper
Minor	1	42
Moderate	42	61
Major	61	100

2.2.2.7 Workshop Calibration

The weights and scores of factors affecting the CoF calculation were reviewed with PUC *Workshop #2 – Linear Risk Framework* on October 08, 2019. This workshop was used as an opportunity to introduce the CoF approach, index weightings and hierarchies, and the multi-criteria rating.. Upon discussion, AECOM calibrated the weights and some attribute values of factors to incorporate PUC's comments. The latest results were discussed and shared with PUC on December 09, 2019.

2.3 Risk Score

Understanding the overall risk exposure of an asset is critical for decision making. The risk scores rely on the results of the two risk parameters, namely the LoF and CoF.

For linear assets, the LoF computations, scorings, and ratings were demonstrated in *TM#3A*. Each asset has unique CoF and LoF scores, which are used to calculate the corresponding risk score by applying equation **[1]**. The risk assessment calculations often require a calibration process such that the output is comparable with real-world situations. Once equation **[1]** is assessed, the asset risk score can be visualized to understand its risk exposure.

For non-linear assets, the visual condition assessment scores (also discussed in *TM#3A*) were used as a proxy for LoF and the risk score was calculated using equation **[1].**

2.3.1 Risk Score Rating Breakpoints

For linear assets, the product of the CoF and LoF was normalized so that the risk score would range between 1 and 100. This number must be categorized using a three-point scale. The three categories were taken similar to the CoF categories as minor, moderate, and major. **Table 10** displays the risk score breakpoint ratings for the system based on the current Risk score distribution.

Table 10: Risk Score Breakpoints

Rank	Lower	Upper
Minor	1	26
Moderate	26	37
Major	37	100

3. Results

3.1 Linear Assets

3.1.1 Consequence of Failure

The distribution of the CoF scores was based on the breakpoints determined for each category. The overall histogram of the scores is shown in **Figure 3**. Additional statistics are demonstrated in **Figure 4**, **Figure 5** and **Figure 6**. According to **Figure 4**, approximately 319 km (72%) of total length is in the minor category; approximately 74 km (17%) of total length in the moderate category; and approximately 49 km (11%) of total length is in the major category.

Further, **Figure 5** shows the CoF distribution by length and diameter. The major category is dominated by large diameter pipelines. Large diameters ranging from 450 mm and above are categorized in the moderate and major groups except for contact mains; these pipes are in the minor category. Some of the small to medium size pipelines (100 to 400 mm) are categorized in the moderate category (roughly 74 km; 19% of small to medium pipes total length).

Figure 6 shows the CoF scores based on material types. Approximately 5 km of thermoplastic pipes and 3 km of ferrous pipes and are in the major category. Roughly, 38 km (97%) of concrete pressure pipes (CPP and CCYL) are in the major category.

Appendix C includes a GIS map of the CoF results.

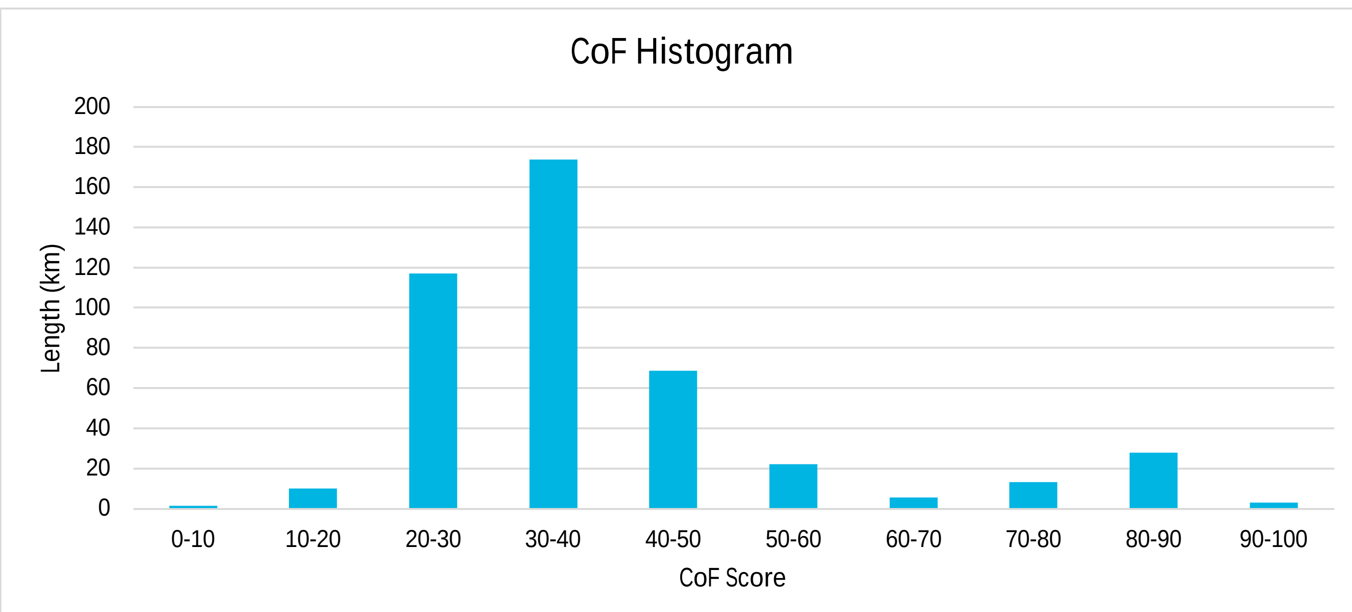


Figure 3: CoF Histogram

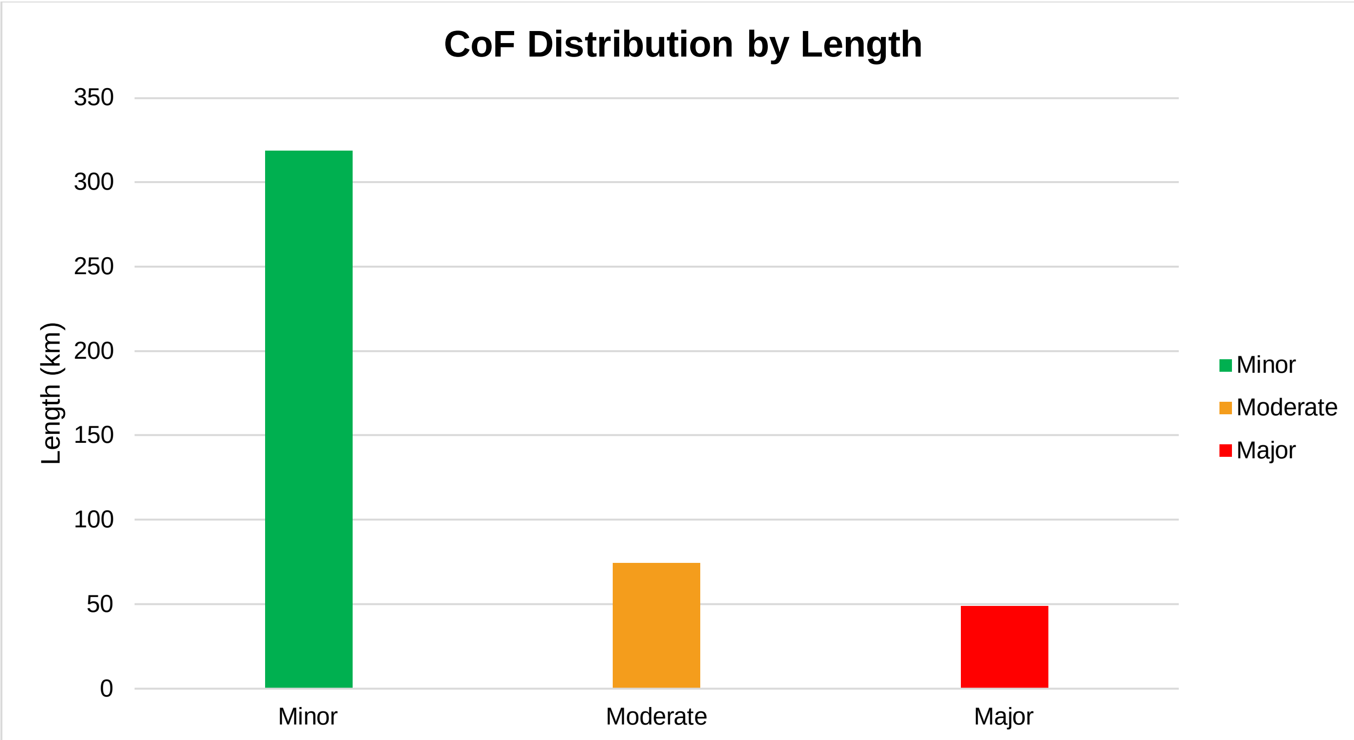


Figure 4: CoF Distribution by Length

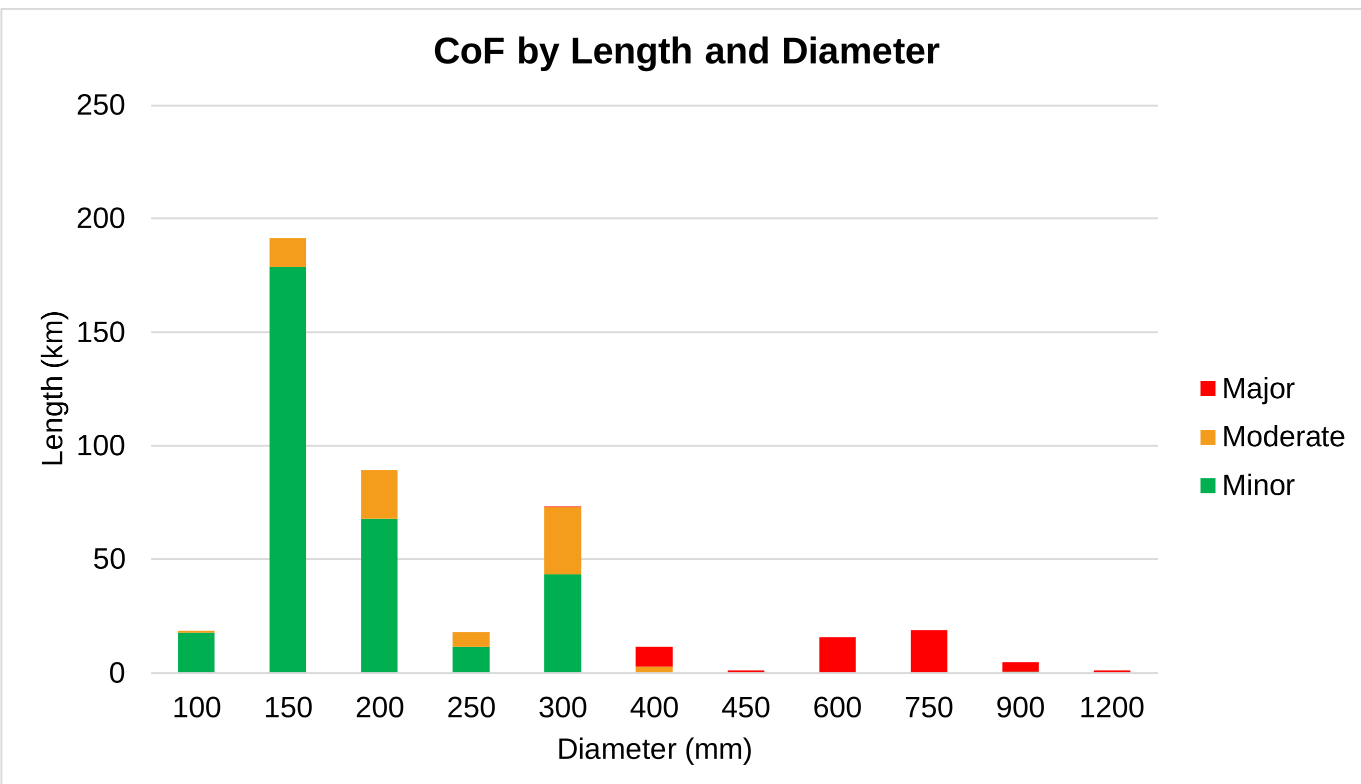


Figure 5: CoF by Length and Diameter

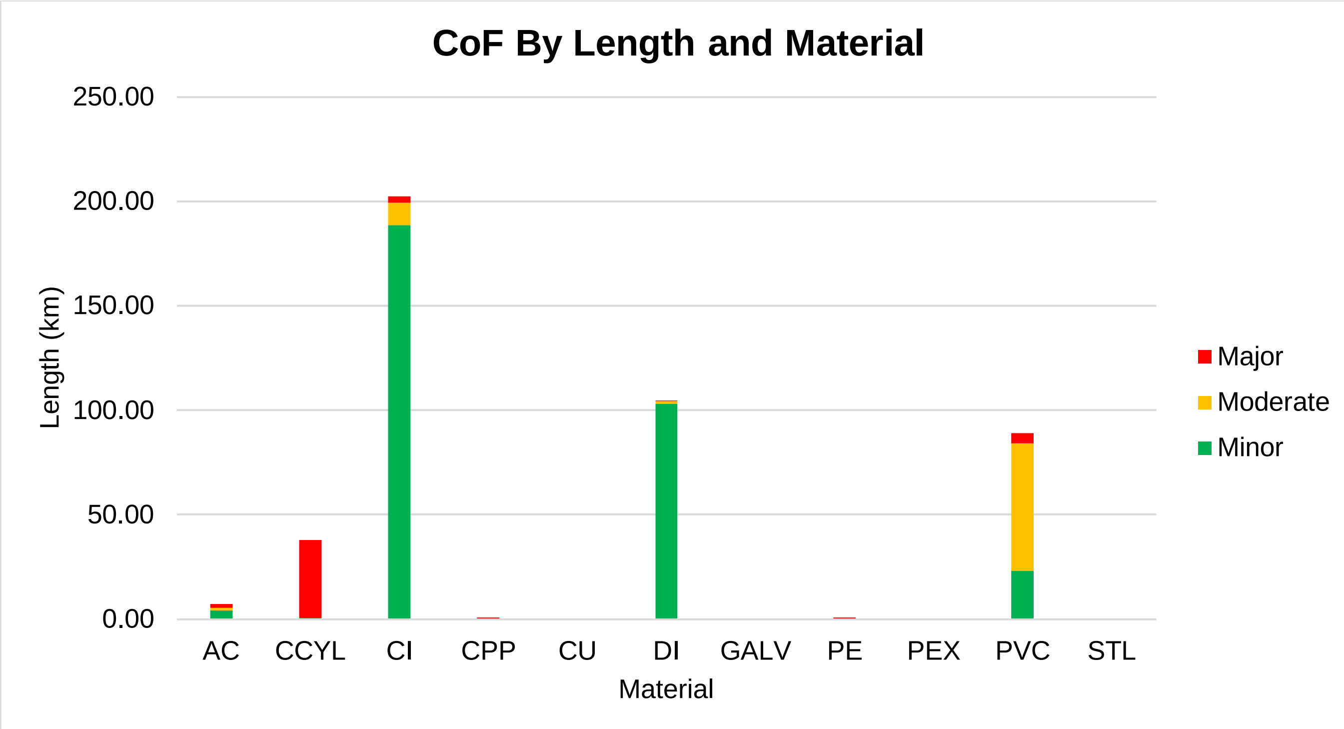


Figure 6: CoF by Length and Material

3.1.2 Risk Score

The distribution of the risk scores was based on the breakpoints determined for each category. The overall histogram of the scores is shown in **Figure 7**. Additional statistics are demonstrated in **Figure 8**, **Figure 9** and **Figure 10**. According to **Figure 8**, approximately 337 km (76%) of total length is in the minor category; about 61 km (14%) of total length in the moderate category; and approximately, 44 km (10%) of total length is in the major category.

Further, **Figure 9** shows the risk distribution by length and diameter. The major category is dominated by 150 mm size with a total length of 24 km (55% of total length in the major category). Approximately, 40 km (99%) of the 450 to 1200 mm pipelines' total length is in the minor risk score.

Figure 10 shows risk scores based on the material types. Approximately, 43 km (14%) of ferrous pipeline total length is in the major category. In specific, 41 km of the total major category is observed in CI pipelines.

A scatter plot that displays the distribution of the CoF and LoF parameters based on the risk score is shown in **Figure 11**. **Appendix D** includes the GIS map of the risk results.

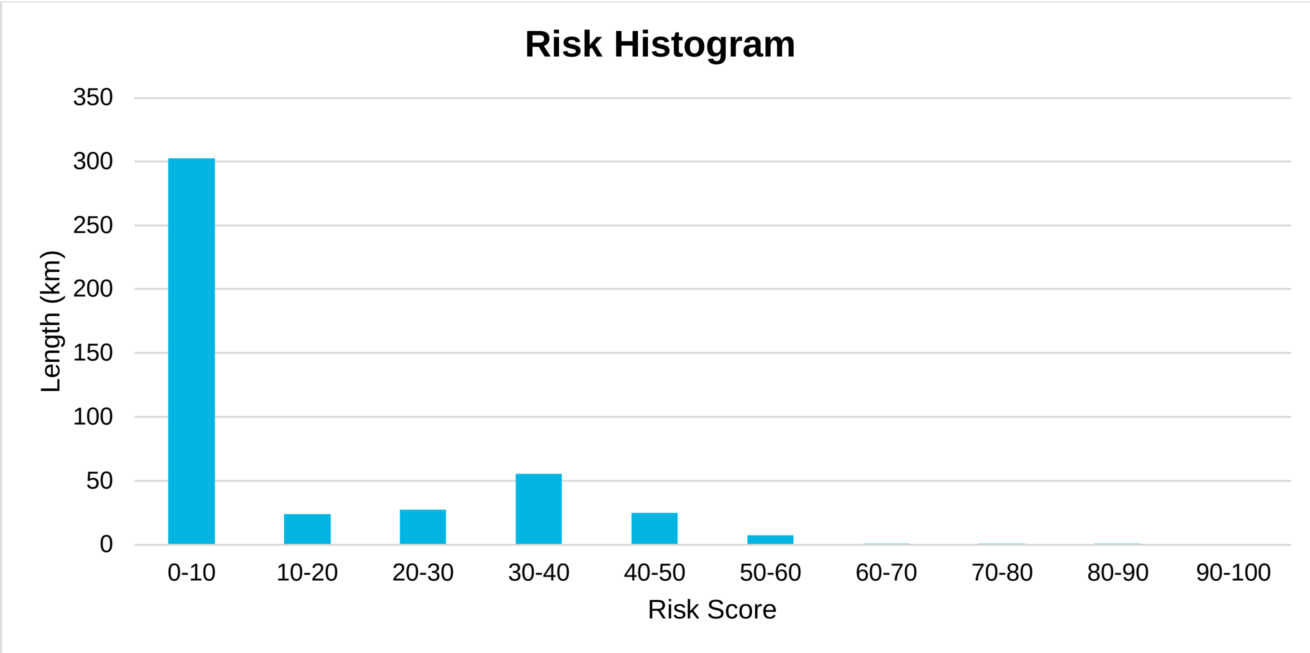


Figure 7: Risk Score Histogram

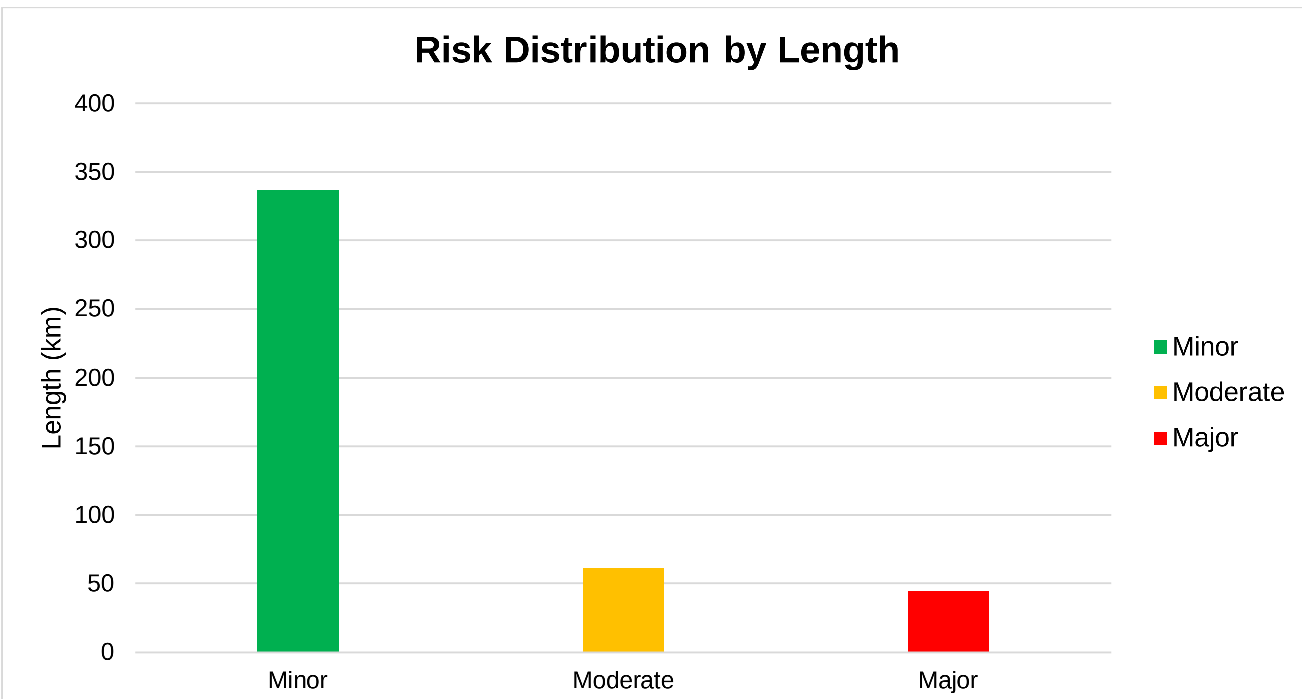


Figure 8: Risk Score by Length

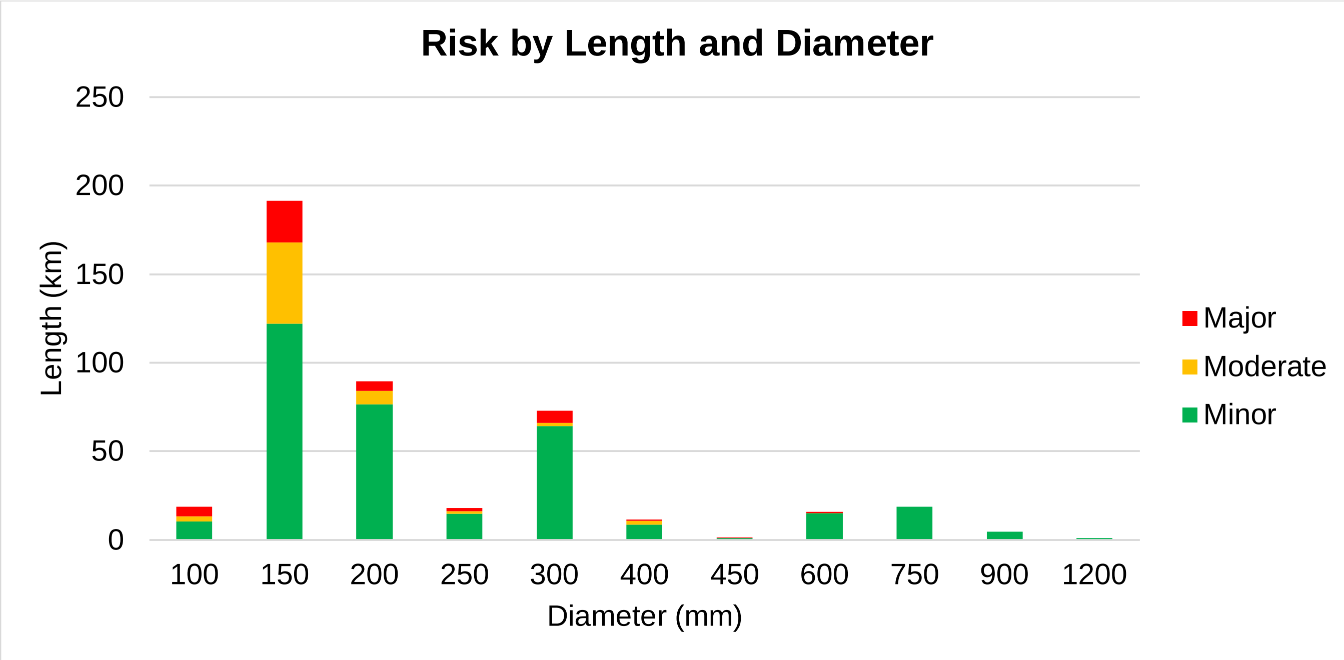


Figure 9: Risk Score by Length and Diameter

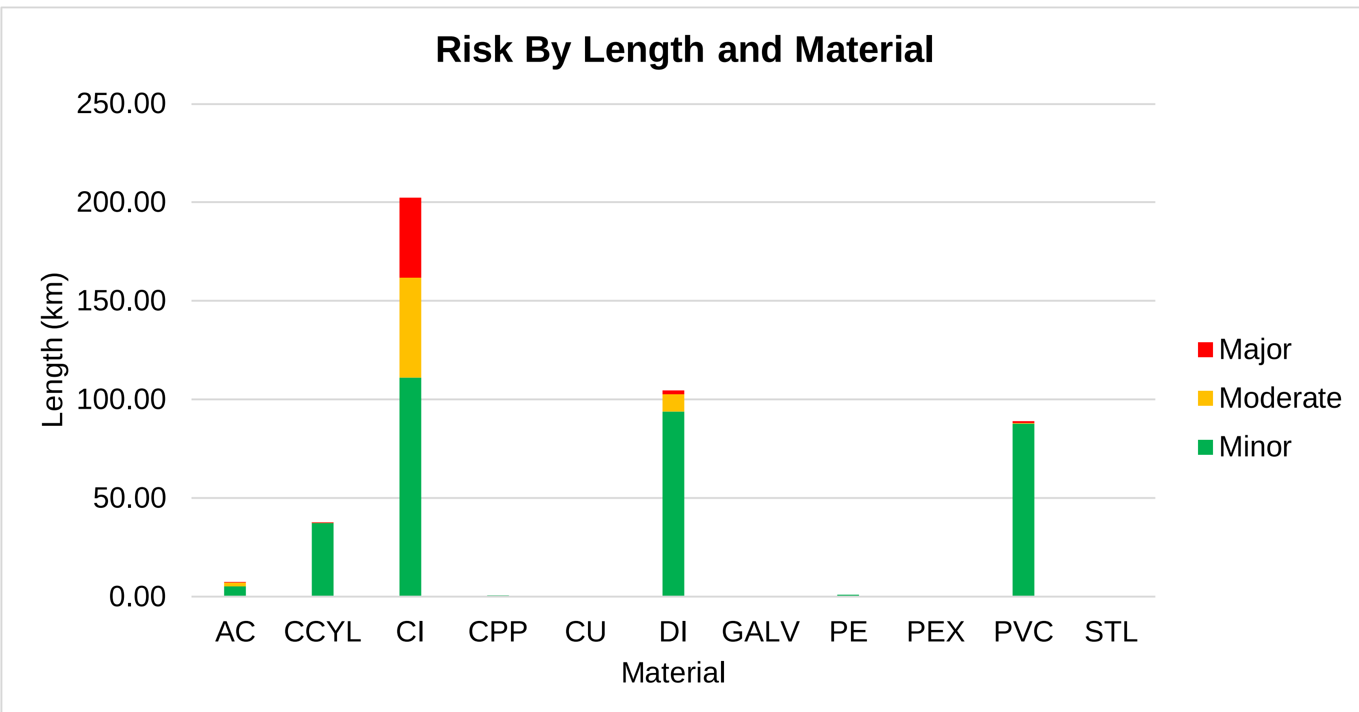


Figure 10: Risk Score by Length and Material

Figure 11: Risk Score Scatter Plot

3.2 Non-Linear Assets

3.2.1 Consequence of Failure

The consequence of failure score was assigned by AECOM and PUC using the CoF rating scale. Critical assets were identified for each non-linear asset part of the project by using formalized criteria established discussed in **Section 2.2.1** and typically included equipment that is critical to the functionality of the water system and that does not have redundancy. When deciding on the timing of asset renewal or replacement it is important to consider the criticality of an asset. Ideally, assets that have a high criticality rating (i.e. 4-Major and 5-Catastrophic) should be replaced before failure to prevent adverse impacts such as environmental disasters or severe injuries. Assets that have a low criticality rating (i.e. 3-Moderate, 2-Minor, and 1-Insignificant) may be allowed to run beyond the expected service life if a failure will not have an immediate negative impact. Please refer to **Appendix A** for a full listing of asset criticality for each asset within the inventory.

The overall histogram of the scores is shown in **Figure 12**. Additional statistics are demonstrated in **Figure 13**, **Table 11** and **Table 12**.

From **Figure 12** we can observe that of the 410 assets assessed, 36% were categorized as having a high consequence of failure and only 6% of assets have a very low consequence of failure (1-Insignificant). However, most assets (38%) were determined to have a moderate consequence of failure.

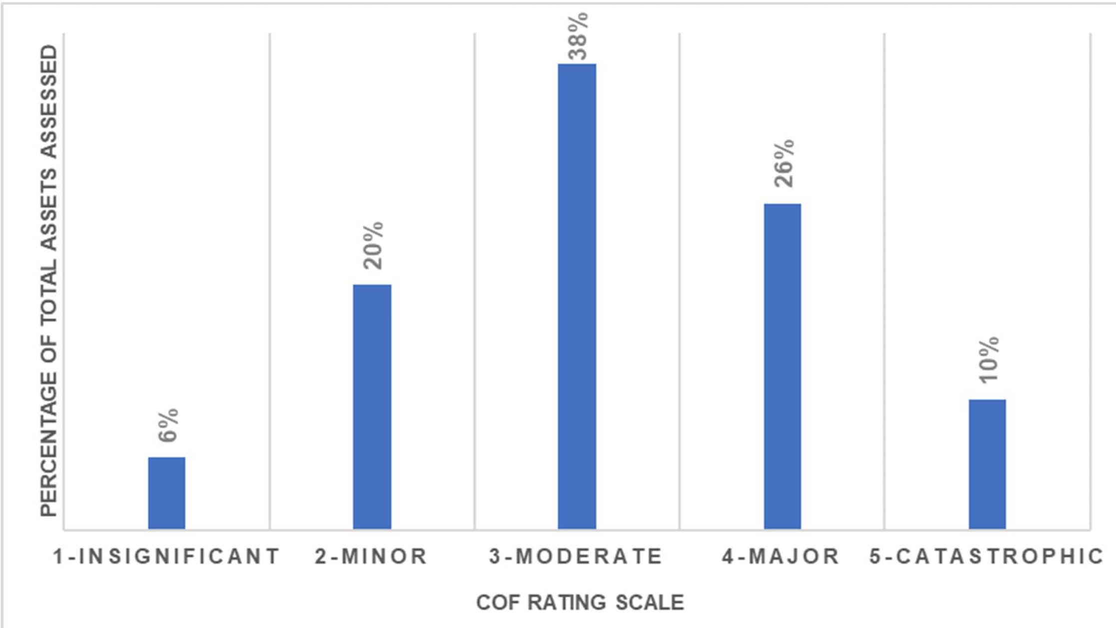
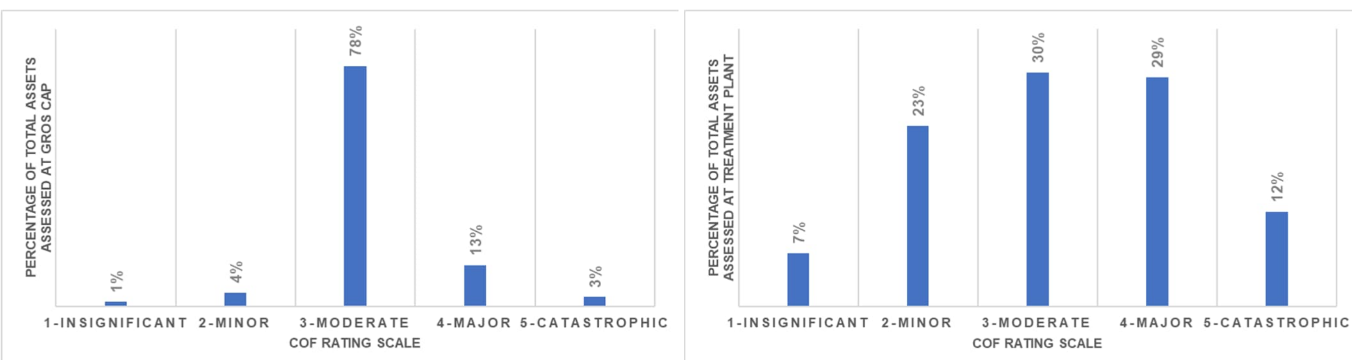


Figure 12: CoF Score Breakdown of Assets Part of Condition Assessment Exercise

Figure 13 provides further breakdown of CoF scores based on facility locations. At Gros Cap raw water pumping station, of the 68 assets, a majority (78%) were determined to be of moderate consequence of failure with only 16% of assets determined to be of high CoF. While at the surface water treatment plant 41% of assets were determined to be high CoF.



Gros Cap Raw Water Pumping Station **Surface Water Treatment Plant**

Figure 13: CoF Score Breakdown Based on Facility Location

Figure 14 represents CoF score as a function of replacement cost. Approximately 43% of the asset replacement costs were determined to be high or very high CoF and 42% were determined to be moderate CoF. As stated above, PUC should focus on replacement of all assets determined to be high CoF prior to end of asset service life or failure to prevent adverse impacts.

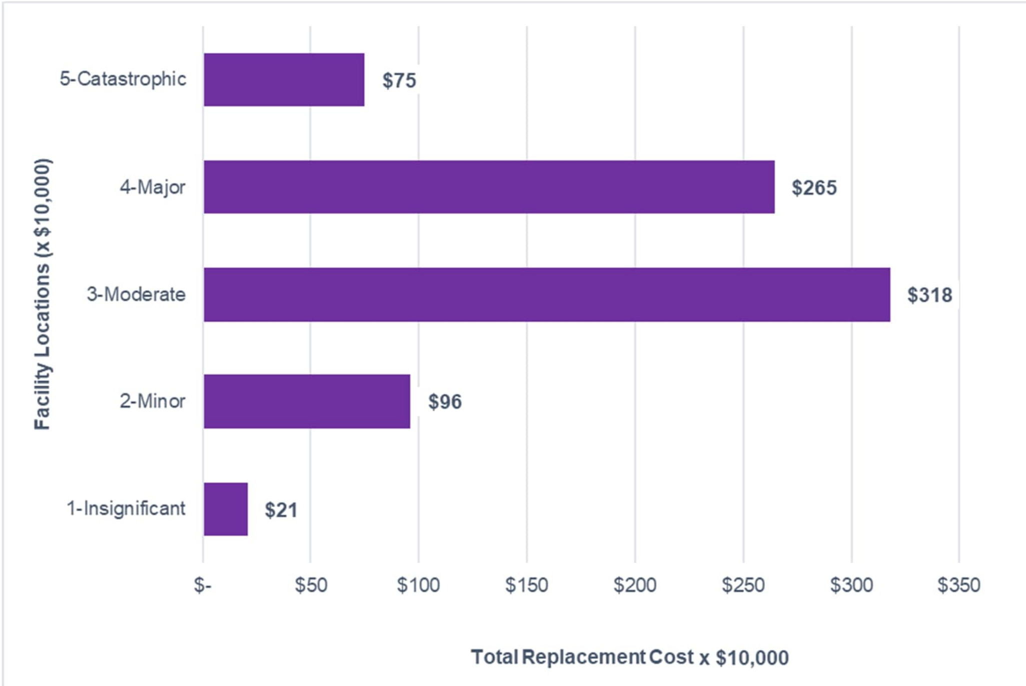


Figure 14: CoF Score Breakdown Based on Replacement Value

Table 11 provides further breakdown of CoF scores based on process location. Highest number of assets were recorded at the pipe gallery (basement) followed by high lift pumping station. At pipe gallery (basement), most assets (55%) were determined to be low to very low CoF with 35% assets determined to be high to very high CoF. For high lift pumping station, a majority of the assets (68%) were determined to be moderate or lower CoF.

Pressure reducing station had the highest number of assets determined to be very high CoF (47%), followed by motor control centre #1 (33%) and high lift pumping station (27%).

All assets at flocculation and filter chamber were determined to be of high CoF. Chemical facilities (Cl2 gas) and pipe galley (main floor) also had a majority of their assets determined to be a high CoF (63%).

Table 11: CoF Score Breakdown Based on Process Location (Hierarchy Level 3)

Process Location	1 - Very Low	2 - Low	3 - Moderate	4 - High	5 - Very High	Total No. of Assets
Chemical Facilities (M) - Alum	-	1	3	2	1	7
Chemical Facilities (M) - Blended Phosphate	-	-	4		-	4
Chemical Facilities (M) - Cl2 Gas	-	-	2	5	1	8
Flocculation & Filter Chambers	-	-		28	-	28
High Lift Pumping Station	3	10	38	4	20	75
Low Lift Pumping Station	1	11	35	5	1	53
Motor Control Centre #1 (M)	-	2	-	-	1	3
Motor Control Centre #2 (M)	-	-	4	4	-	8
Pipe Gallery (Basement)	14	40	10	27	8	99
Pipe Gallery (Main Floor)	2	12	-	24	-	38
Pressure Reducing Station	3	2	5	-	9	19
Pump Room (Gros Cap)	1	3	53	9	2	68
Grand Total	**24**	**81**	**154**	**108**	**43**	**410**

Table 12 provides further breakdown of CoF scores based on asset type and asset category. For both process mechanical and process electrical, most of the assets were determined to be moderate CoF (35% - 40%), followed by high CoF (25%). However, for process structural a majority of the assets were determined to be high CoF (52%).

Table 12: CoF Score Breakdown Based on Asset Category and Asset Type

Asset Category & Type	1 - Very Low	2 - Low	3 - Moderate	4 - High	5 - Very High	Total No. of Assets
Process Electrical	**10**	**26**	**56**	**35**	**12**	**139**
Actuator	-	2	12	13	1	28
Breaker	-	-	3	-	-	3
Control Panel	-	-	-	2	-	2
Disconnect	-	9	4	5	-	18
Engine	-	1	-	-	-	1
Feeder	-	-	-	-	1	1
Generator	-	-	-	-	1	1
MCC	-	-	-	-	1	1
Motor	2	10	25	6	5	48
Starter	-	4	12	9	-	25
Transformer	-	-	-	-	3	3
UV Treatment	4	-	-	-	-	4
Valve	4	-	-	-	-	4
Process Mechanical	**14**	**54**	**93**	**63**	**28**	**252**
Compressor	-	-	3	-	-	3
Filter	-	-	1	-	-	1
Gate	-	-	-	8	-	8
Gearbox	-	-	2	-	-	2
Injector	-	-	2	4	-	6
Mixer	-	1	3	4	-	8
Pressure Vessel	-	2	2	2	-	6
Pump	1	10	23	1	2	37
Regulator	-	-	-	-	1	1
Screen	-	-	2	-	-	2
Valve	13	41	55	44	25	178
Process Structural	**-**	**1**	**5**	**10**	**3**	**19**
Chemical Tanks	-	-	1	-	-	1
Hopper	-	-	1	-	-	1
Tanks / Basins	-	1	3	10	3	17
Grand Total	**24**	**81**	**154**	**108**	**43**	**410**

3.2.2 Risk Score

A risk score was calculated for each asset. The risk score reflects the probability of failure and the criticality ratings and was assigned using the following equation:

Risk Score = Probability of Failure x Criticality Rating

The purpose of the risk score is to identify assets that require immediate attention. Understanding the risk exposure for a given set of assets allows PUC to identify where the organization is most exposed, and to target investments to most effectively reduce that exposure. The range of the risk score is from 1 to 25. **Figure 15** presents a sample risk-based intervention plan that provides direction for asset interventions, ranging from monitoring asset condition or "run-to-failure" for low-risk assets to immediate replacement of the very high-risk assets.

5	Monitor	Monitor / Schedule Renewal	Fix Now!	Fix Now!	Fix Now!
4	Monitor	Monitor / Schedule Renewal	Fix Now!	Fix Now!	Fix Now!
3	Monitor	Monitor	Monitor / Schedule Renewal	Fix Now!	Fix Now!
2	Fix on Failure	Fix on Failure	Monitor	Monitor / Schedule Renewal	Schedule Renewal
1	Fix on Failure	Fix on Failure	Fix on Failure	Monitor	Monitor
	1	2	3	4	5

Figure 15: Sample Risk-Based Intervention Plan

The risk values defined for assets enables PUC to identify management strategies for different risk categories, especially for high-risk assets with a risk score in excess of 10, as presented in **Figure 15.** The failure of these assets present the greatest risk to the organization and should be avoided through close monitoring, scheduling interventions, and performing the necessary renewals / replacements before failure occurs. Asset intervention strategies will be discussed in further details in TM#5 – Asset Management Strategy.

Figure 16 provides a breakdown of the risk score of assets part of the condition assessment exercise. Of these, 92% of the assets (379 assets) were calculated to have a risk score of less than '10' and the reminder 8% of the assets (31 assets) had a risk score between '11' & '16'.

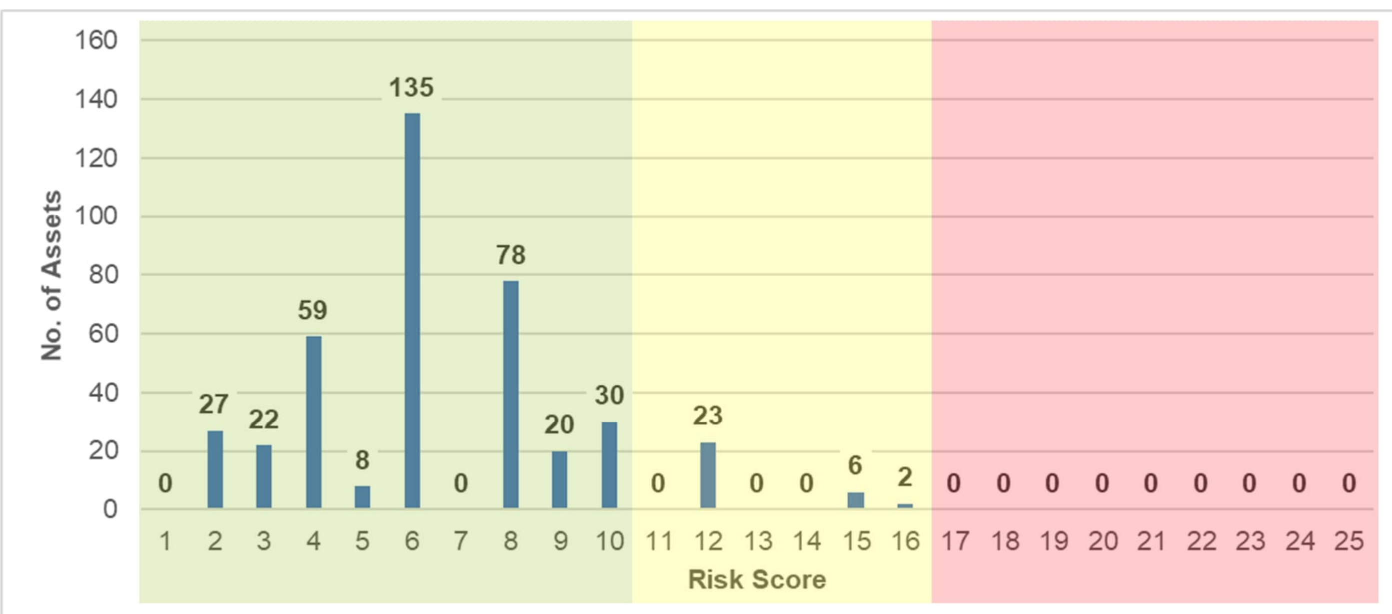


Figure 16: Risk Score Breakdown of Assets Part of Condition Assessment Exercise

Table 13 provides additional breakdown of risk scores based on facility location. All assets at Gros Cap Raw Water Pumping station were observed to have a risk score less than '10'. Of the 342 assets captured at Surface Water Treatment plant, 9% were observed to have a risk score between 11 & 16.

Table 13: Risk Score Breakdown Based on Facility Location

Risk Scores	Gros Cap Raw Water Pumping Station	Surface Water Treatment Plant
1	0	0
2	2	25
3	1	21
4	2	57
5	0	8
6	40	95
7	0	0
8	9	69
9	12	8
10	2	28
11	0	0
12	0	23
13	0	0
14	0	0
15	0	6
16	0	2
17 - 25	0	0
Grand Total	**68**	**342**

Table 14 provides a breakdown of risk score based on process category. No process structural assets had risk score more than '10'. For process electrical, 4% (5 assets) of the 139 assets had a risk score above 10 and for process structural, 10% (26 assets) of the 252 assets had a risk score above 10.

Table 14: Risk Score Breakdown Based on Process Category

Risk Scores	Process Electrical	Process Mechanical	Process Structural
1	0	0	0
2	11	16	0
3	5	16	1
4	23	35	1
5	2	6	0
6	47	84	4
7	0	0	0
8	30	38	10
9	6	14	0
10	10	17	3
11	0	0	0
12	5	18	0
13	0	0	0
14	0	0	0
15	0	6	0
16	0	2	0
17 - 25	0	0	0
Grand Total	**139**	**252**	**19**

To provide context for the risk values associated with PUC assets, **Figure 17** presents an overview of the replacement costs associated with PUC assets falling in the risk "buckets" of 1 to 25 (the highest risk score in the PUC inventory was 16). Of the total $7.75M replacement value of the inventoried assets, 97% of the replacement cost was for assets with a risk score below 10.

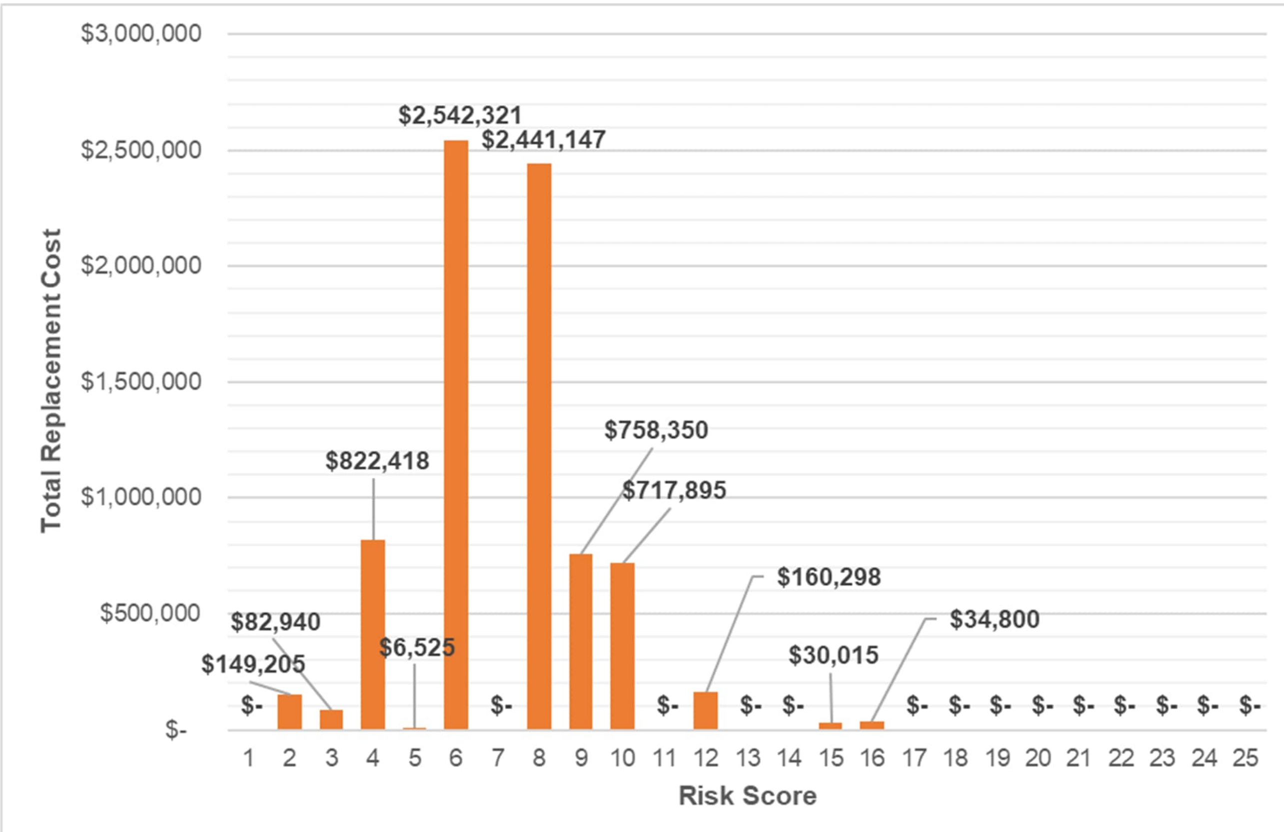


Figure 17: Replacement Costs Versus Risk

4. Summary and Recommendations

4.1 Summary

4.1.1 Water Facilities

CoF Scores

The observations made regarding consequence of failure of non-linear assets are summarized below:

- Of the 410 assets assessed, 36% were categorized as having a high or very high consequence of failure and only 6% of assets have a very low consequence of failure.
- At Gros Cap Raw Water Pumping Station, of the 68 assets, a majority (78%) were determined to be of low consequence of failure with only 16% of assets determined to be of high or very high CoF. While at the surface water treatment plant 41% of assets were determined to be high or very high CoF.
- Pressure reducing station had the highest number of assets determined to be very high CoF (47%), followed by motor control centre #1 (33%) and high lift pumping station (27%).
- All assets at flocculation and filter chamber were determined to be of high CoF. Chemical facilities (Cl2 gas) and pipe galley (main floor) also had most of their assets determined to be a high CoF (63%).

Risk Scores

The observations made regarding risk scores of non-linear assets are summarized below:

- Of these, 92% of the assets (379 assets) were calculated to have a risk score of less than '10' and the reminder 8% of the assets (31 assets) had a risk score between '11' & '16'.
- High risk assets are defined as those with a risk score of more than '10'. The failure of these assets presents the greatest risk to the organization and should be avoided through close monitoring, scheduling interventions, and performing the necessary renewals / replacements before failure occurs. All assets at Gros Cap Raw Water Pumping station were observed to have a risk score less than '10'. Of the 342 assets captured at Surface Water Treatment plant, 9% were observed to have a risk score between 11 & 16.
- No process structural assets had risk score more than '10'. For process electrical, 4% (5 assets) of the 139 assets had a risk score above 10 and for process structural, 10% (26 assets) of the 252 assets had a risk score above 10.

4.1.2 Linear Water Assets

Water networks are a critical component in any urban city. As buried infrastructure, it is out of sight and most often neglected. In addition, budget allocation constraints can sometimes impact the PUC's ability to maintain the entire network. Therefore, constructing reliable models that provide systematic approaches in prioritizing watermains for condition assessment, maintenance, and rehabilitation, is essential to ensure a proactive approach to asset management is applied throughout the design-life of watermains.

The main objective of this task was to design a reliable risk-assessment model to attain robust prioritization conclusions for PUC. The main objective was accomplished after considering the following:

- Industry Practice: A summary of existing practices toward infrastructure risk assessment is provided
- Consequence of Failure (CoF): A CoF model was designed based on four main categories, which are economic, social, environmental, and operational factors. The overall methodology of the CoF model relied on a hierarchy of factors and sub-factors that were aggregated to calculate a CoF index for each watermain.
- Risk Model: A risk score is computed considering the product equation of the CoF and LoF

Based on these objectives, the results attained pertinent to risk calculations are as follows:

CoF Model:

- The total length of watermain in the major category was 49 km;
- Roughly, 74 km of small to medium pipes (100 to 400 mm) was observed in the moderate CoF category; and
- Larger diameter pipelines (450 mm and larger) dominated the major category.

Risk Model:

- Roughly, 44 km of the total length was in the major risk category
- The major category was mostly represented by 150 mm pipes (24 km)
- Approximately, 40 km of large pipes was in the minor category
- The major category was mostly represented by cast iron pipes.

4.2 Recommendations

1. Based on the developed risk-based model, it is recommended to base future interventions and condition assessment practices based on a prioritized approach. Therefore, PUC will be able to balance the conflicting variables related to budget availability and criticality of the water pipes and non-linear assets.
2. It is also recommended to update/add CoF parameters based on any future strategic plan updates. Such modifications will ensure that identified critical assets are always aligned with the expected strategic objectives and policies of PUC.
3. It is recommended to update the geoprocessing methodologies of some CoF attributes based on the availability and accuracy of data. For example, it is recommended to conduct hydraulic scenarios/simulations for linear assets to measure the impact of failure in the pipe network. Such simulations would provide higher accuracies in assigning attribute values for the “Number of Service Connections” attribute.
4. It is recommended that a consequence of failure score be assigned to all assets at each facility to develop risk scores for asset intervention program.
5. Additional emphasis should be paid to the lag-time in acquiring spare-parts for repair or replacement of assets. This can be exercised by completing an asset inventory and better understanding of lag-times through discussions with maintenance staff and equipment suppliers.

Appendix TM3B

Appendix A

Non-Linear Asset Inventory List with Consequence of Failure and Risk Scores

Item ID	Asset Description	Level 1 – Functional Group	Level 2 – Facility Type / Location	Level 3 – Process Location	Level 4 – Asset Category	Level 5 (Asset Type)	Unique ID	Nameplate Present?	Install Year	Refurbishment Year	Manufacturer	Model	Serial Number	Size / Capacity	Unit of Measure	Operating Conditions	Condition Score (1 to 5 Scale)	CoF Score (1 to 5 Scale)	CoF Score Comments	Age	ESL	RUL	Replacement Cost (2020)	Project Cost (includes Markup)	Risk Score (1 to 25 Scale)
1	Booster Pump#304	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Pump	Missing	Yes	1983	NA	Brier Hydraulics Limited	NA	83-4003	5548	GPM	1170 RPM, TDH = 210	3	3	• Raw Water Pump • 347 L/S (30 MLD) pump (Water Permit) & Plant Firm Capacity is 40 MLD and RW Total Pumping Capacity is 90 MLD • Remaining redundancy is 50%	37	20	-17	$ 75,000	$ 108,750	9
2	Motor Pump#304	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000065	Yes	1983	NA	US Motors	NA	J2990309 640711-855	400	HP	575 Volts, Ph 3, Hz 60, 1180 RPM	2	3	• Raw Water Pump • 347 L/S (30 MLD) pump (Water Permit) & Plant Firm Capacity is 40 MLD and RW Total Pumping Capacity is 90 MLD • Remaining redundancy is 50%	37	20	-17	$ 35,000	$ 50,750	6
3	Motor Pump#303	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	Missing	Yes	1983	NA	US Motors	NA	J2990309 640710-855	400	HP	575 Volts, Ph 3, Hz 60, 1180 RPM	2	3	• Raw Water Pump • 347 L/S (30 MLD) pump (Water Permit) & Plant Firm Capacity is 40 MLD and RW Total Pumping Capacity is 90 MLD • Remaining redundancy is 50%	37	20	-17	$ 35,000	$ 50,750	6
4	Booster Pump 303	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Pump	Missing	Yes	1983	NA	Brier Hydraulics Limited		83-4002	5548	GPM	1170 RPM, TDH = 210	3	3	• Raw Water Pump • 347 L/S (30 MLD) pump (Water Permit) & Plant Firm Capacity is 40 MLD and RW Total Pumping Capacity is 90 MLD • Remaining redundancy is 50%	37	20	-17	$ 75,000	$ 108,750	9
5	Booster Pump 302	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Pump	Missing	Yes	1983	NA	Brier hydraulics limited	Not available	83-4005	2774	GPM	18000 m^3/day	2	3	• Raw Water Pump • 147 L/S (15 MLD) pump (Water Permit) & Firm Capacity is 40 MLD and Total Capacity is 90 MLD • Remaining redundancy is 87%	37	20	-17	$ 60,000	$ 87,000	6
6	Booster Pump Motor 302	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000063	Yes	1983	NA	U.S. motors	Not available	CJ2990274 840657-823	200	HP		2	3	• Raw Water Pump • 147 L/S (15 MLD) pump (Water Permit) & Firm Capacity is 40 MLD and Total Capacity is 90 MLD • Remaining redundancy is 87%	37	20	-17	$ 18,500	$ 26,825	6
7	Booster Pump 301	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Pump	Missing	Yes	1983	NA	Brier hydraulics limited	Not available	83-4004	2774	GPM	18000 m^3/day	2	2	• Raw Water Pump • 147 L/S (15 MLD) pump (Water Permit) & Firm Capacity is 40 MLD and Total Capacity is 90 MLD • Remaining redundancy is 87%	37	20	-17	$ 60,000	$ 87,000	4
8	Booster Pump Motor 301	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000062	Yes	1983	NA	U.S. motors	Not available	CJ2990274 840658-823	200	HP	575V, 60Hz, 3 Ph	2	2	• Raw Water Pump • 147 L/S (15 MLD) pump (Water Permit) & Firm Capacity is 40 MLD and Total Capacity is 90 MLD • Remaining redundancy is 87%	37	20	-17	$ 18,500	$ 26,825	4
9	Check Valve (BP 302) R.W. 8	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000080	Yes	1983	NA	Val-Matic	9800	Not available	16	in		3	3	• Valve failure will cause RW Pump 302 Priming to fail • Redundancy drop to 87% The 88% was based on the raw water pump flow rates with 30 MLD for pumps 3 and 4 and 15 MLD for pumps 1 and 2. The firm capacity of the plant is 40 MLD so if we lose one of the 15 MLD pumps then your redundancy will be (30+30+15-40)/(40)=87%	37	35	-2	$ 20,000	$ 29,000	9
10	Air relief valve (BP 302) RW 10	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000146	Yes	1983	NA	GA Industries	XGH21-KT	83-3649	2	in		2	3	• Valve failure will cause RW Pump 302 Priming to fail and it is advisable not to operate without priming • Redundancy drop to 87%	37	35	-2	$ 1,000	$ 1,450	6
11	Check Valve (BP 301) R.W. 14	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000079	Yes	1983	NA	Val-Matic	9800	Not available	16	in		3	3	• Valve failure will cause RW Pump 302 Priming to fail • Redundancy drop to 87%	37	35	-2	$ 20,000	$ 29,000	9
12	Air relief valve (BP301) RW 16	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000145	Yes	1983	NA	GA Industries	XGH21-KT	1503933649	2	in		2	3	• Valve failure will cause RW Pump 302 Priming to fail and it is advisable not to operate without priming • Redundancy drop to 87%	37	35	-2	$ 1,000	$ 1,450	6
13	Butterfly Valve BV-5 901	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000067	No	1983	NA	Not available	Not available		18	in		2	3	• Valve failure will cause RW Pump 301 Priming to fail and it is advisable not to operate without priming • Redundancy drop to 87%	37	35	-2	$ 8,000	$ 11,600	6
14	Actuator Butterfly Valve RW 13	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Actuator	100000066	Yes	1983	NA	Limitorque	H, LCT-1356/32	350112				2	3	• Valve failure will cause RW Pump 301 Priming to fail and it is advisable not to operate without priming • Redundancy drop to 87%	37	25	-12	$ 6,000	$ 8,700	6
15	Butterfly Valve, Actuator BV-4 901 BP301	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Actuator	100000067	No	1983	NA	Limitorque	Not available	2160030	24	in		2	3	• Valve failure will cause RW Pump 303 Priming to fail and it is advisable not to operate without priming • Redundancy drop to 50%	37	25	-12	$ 6,000	$ 8,700	6
16	Butterfly Valve BV-4 902 BP302	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000073	No	1983	NA	Limitorque	Not available	2160030	24	in		3	3	• Valve failure will cause RW Pump 303 Priming to fail and it is advisable not to operate without priming • Redundancy drop to 50%	37	35	-2	$ 12,000	$ 17,400	9
17	Actuator Butterfly Valve RW 7	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Actuator	100000074	Yes	1983	NA	Limitorque	H	350111				2	3	• Valve failure will cause RW Pump 303 Priming to fail and it is advisable not to operate without priming • Redundancy drop to 50%	37	25	-12	$ 6,000	$ 8,700	6
18	Butterfly Valve Motorized Manifold (BV3 RW1)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000148	No	1983	NA	Limitorque	Not available	Not available	30	in		2	3	• Valve failure will cause the raw water header to fail • Redundancy drop to 50% • Long term operation of the plant will be affected due to limited raw water storage	37	35	-2	$ 18,500	$ 26,825	6
19	Actuator Butterfly Valve RW 1 BV3	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Actuator	Missing	Yes	1983	NA	Limitorque	4	M030778	1700	RPM	575 V, 60 Hz, 1/3 HP	2	3	• Valve failure will cause the raw water header to fail • Redundancy drop to 50% • Long term operation of the plant will be affected due to limited raw water storage • Can be reduced to 2 if manual operation of the valve is approved	37	25	-12	$ 6,000	$ 8,700	6
20	Butterfly Valve BV2 RW12	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000139	No	1983	NA	Limitorque	Not available	Not available	30	in		2	4	• Valve failure will cause pumps 1 and 3 to be isolated and inoperable • Redundancy drop to 0% • Long term operation of the plant will be affected due to limited raw water storage No redundancy; will leave other processes running over capacity	37	35	-2	$ 18,500	$ 26,825	8
21	Plug Valve BV9 SW1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000140	No	1983	NA	Jenkins	200 WOG	Not available	6	in		2	3	• Valve failure will isolate surge tank 2 • Redundancy drop to 50%	37	35	-2	$ 1,200	$ 1,740	6
22	Plug Valve SW3 (BV 8)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000138	No	1983	NA	Jenkins	200 WOG	Not available	6	in		2	3	• Valve failure will isolate surge tank 1 • Redundancy drop to 50%	37	35	-2	$ 1,200	$ 1,740	6

Item ID	Asset Description	Level 1 – Functional Group	Level 2 – Facility Type / Location	Level 3 – Process Location	Level 4 – Asset Category	Level 5 (Asset Type)	Unique ID	Nameplate Present?	Install Year	Refurbishment Year	Manufacturer	Model	Serial Number	Size / Capacity	Unit of Measure	Operating Conditions	Condition Score (1 to 5 Scale)	CoF Score (1 to 5 Scale)	CoF Score Comments	Age	ESL	RUL	Replacement Cost (2020)	Project Cost (includes Markup)	Risk Score (1 to 25 Scale)
23	Air relief valve (cooling water line)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000151	Yes	1983	NA	Val Matic	100	Not available	1	in		2	1	• Failure will not affect the operation of the cooling water line	37	35	-2	$ 600	$ 870	2
24	Air Compressor 1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Compressor	Missing	Yes	1983	NA	Ingersoll Rand	242-5C	543788				2	3	• Compressor failure will fail surge tank 1 • Redundancy drop to 50%	37	20	-17	$ 8,700	$ 12,615	6
25	Motor Air Compressor Fan 1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000121	Yes	1983	NA	Baldor	36B01Z65	M5218T-5	5	HP	575V, 3Ph, 60Hz	2	3	• Compressor failure will fail surge tank 1 • Redundancy drop to 50%	37	20	-17	$ 2,000	$ 2,900	6
26	Compressor Tank 1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Pressure Vessel	100000119	Yes	1983	NA	Ingersoll Rand	Not available	458793	30	Gallon	600V, 3Ph, 60Hz	2	3	• Compressor failure will fail surge tank 1 • Redundancy drop to 50%	37	20	-17	$ 800	$ 1,160	6
27	Compressor Disconnect 1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Disconnect	1E+09	Yes	1983	NA	Westinghouse	Not available	JHU361	20	HP	600 V, 3 Ph, 30 A	2	3	• Compressor failure will fail surge tank 1 • Redundancy drop to 50%	37	25	-12	$ 1,000	$ 1,450	6
28	Compressor Tank 2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Pressure Vessel	100000118	Yes	1983	NA	Ingersoll Rand	Not available	458817	30	Gallon		2	3	• Compressor failure will fail surge tank 2 • Redundancy drop to 50%	37	20	-17	$ 800	$ 1,160	6
29	Motor Air Compressor Fan 2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000120	Yes	1983	NA	Baldor	36B01Z65	M3218T-5	5	HP	575V, 3Ph, 60Hz	2	3	• Compressor failure will fail surge tank 2 • Redundancy drop to 50%	37	20	-17	$ 2,000	$ 2,900	6
30	Air Compressor 2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Compressor	Missing	Yes	1983	NA	Ingersoll Rand	2475	4017589				2	3	• Compressor failure will fail surge tank 2 • Redundancy drop to 50%	37	20	-17	$ 9,100	$ 13,195	6
31	Compressor Disconnect 2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Disconnect	100000116	No	1983	NA	Westinghouse	Not available	JHU361	20	HP	600 V, 3 Ph, 30 A	2	3	• Compressor failure will fail surge tank 2 • Redundancy drop to 50%	37	25	-12	$ 1,000	$ 1,450	6
32	Screen 1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Screen	100000089	Yes	1983	NA	Rexnord	SC 409	Not available				2	3	• Raw water screens has a redundancy of 100% as the plant has two screens (one working + one standby) • Raw water screen 1 failure will cause redundancy to drop to 0% but the plant would still meet its firm capacity	37	25	-12	$154,000	$ 223,300	6
33	Gear box and motor Screen 1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000089	Yes	1983	NA	Falk	1040FZK4A S-281.0	83200-20303-01				2	3	• Raw water screens has a redundancy of 100% as the plant has two screens (one working + one standby) • Raw water screen 1 failure will cause redundancy to drop to 0% but the plant would still meet its firm capacity 50% redundancy; duty & stand-by; can still operate if 1 screen fails.	37	20	-17	$ 2,000	$ 2,900	6
34	Bar screen 1 disconnect	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Disconnect	100000113	Yes	1983	NA	Westinghouse	Not available	JHU361	20	HP	600 V, 3 Ph, 30 A	2	3	• Raw water screens has a redundancy of 100% as the plant has two screens (one working + one standby) • Raw water screen 1 failure will cause redundancy to drop to 0% but the plant would still meet its firm capacity 50% redundancy; duty & stand-by; can still operate if 1 screen fails	37	25	-12	$ 1,000	$ 1,450	6
35	Motorized Ball Valve, Screen 1 (Valve)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000142	No	1983	NA	Not available	Not available	Not available	2	in		3	3	• Raw water screens has a redundancy of 100% as the plant has two screens (one working + one standby) • Raw water screen 1 failure will cause redundancy to drop to 0% but the plant would still meet its firm capacity	37	35	-2	$ 1,100	$ 1,595	9
36	Motorized Ball Valve, Screen 1 (Motor)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000142	Yes	1983	NA	Canadian worcester controls	10M 754 W	73 series	2	in	115V/0.7A/60Hz	3	3	• Raw water screens has a redundancy of 100% as the plant has two screens (one working + one standby) • Raw water screen 1 failure will cause redundancy to drop to 0% but the plant would still meet its firm capacity 50% redundancy; duty & stand-by; can still operate if 1 screen fails.	37	20	-17	$ 2,000	$ 2,900	9
37	Screen 2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Screen	100000090	Yes	1983	NA	Rexnord	SC 409	Not available				2	3	• Raw water screens has a redundancy of 100% as the plant has two screens (one working + one standby) • Raw water screen 1 failure will cause redundancy to drop to 0% but the plant would still meet its firm capacity 50% redundancy; duty & stand-by; can still operate if 1 screen fails.	37	25	-12	$154,000	$ 223,300	6
38	Gear box and motor Screen 2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000090	Yes	1983	NA	Falk	1040FZK4A S-281.0	83200-20303-02				2	3	• Raw water screens has a redundancy of 100% as the plant has two screens (one working + one standby) • Raw water screen 1 failure will cause redundancy to drop to 0% but the plant would still meet its firm capacity 50% redundancy; duty & stand-by; can still operate if 1 screen fails.	37	20	-17	$ 2,000	$ 2,900	6
39	Motorized Ball Valve, Screen 2 (Valve)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000143	No	2014	NA	Not available	Not available	Not available	2	in		2	3	• Raw water screens has a redundancy of 100% as the plant has two screens (one working + one standby) • Raw water screen 1 failure will cause redundancy to drop to 0% but the plant would still meet its firm capacity 50% redundancy; duty & stand-by; can still operate if 1 screen fails.	6	35	29	$ 1,100	$ 1,595	6
40	Motorized Ball Valve, Screen 2 (Motor)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000143	Yes	1983	NA	Canadian worcester controls	10M 754 W	73 series	2	in	115V/0.7A/60Hz	3	3	• Raw water screens has a redundancy of 100% as the plant has two screens (one working + one standby) • Raw water screen 1 failure will cause redundancy to drop to 0% but the plant would still meet its firm capacity 50% redundancy; duty & stand-by; can still operate if 1 screen fails.	37	20	-17	$ 2,000	$ 2,900	9
41	Barr screen 2 disconnect	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Disconnect	100000114	Yes	1983	NA	Westinghouse	Not available	JHU361	20	HP	600 V, 3 Ph, 30 A	2	3	• Raw water screens has a redundancy of 100% as the plant has two screens (one working + one standby) • Raw water screen 1 failure will cause redundancy to drop to 0% but the plant would still meet its firm capacity 50% redundancy; duty & stand-by; can still operate if 1 screen fails	37	25	-12	$ 1,000	$ 1,450	6
42	Starter Pump 303 Raw Water	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Starter	100000099	Yes	2016	NA	SAF	MS6-420-C	15 04 896	420A		600V, 3 Ph, 60 Hz	2	3	• Raw Water Pump • 347 L/S (30 MLD) pump (Water Permit) & Firm Capacity is 60 MLD and Total Capacity is 90 MLD • Remaining redundancy is 50%	4	30	26	$ 16,000	$ 23,200	6
43	Starter Pump 304 Raw Water	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Starter	100000098	Yes	1983	NA	SAF	SR6-700-6	15-6422	700A		600V, 3 Ph, 60 Hz	3	3	• Raw Water Pump • 347 L/S (30 MLD) pump (Water Permit) & Firm Capacity is 60 MLD and Total Capacity is 90 MLD • Remaining redundancy is 50%	37	30	-7	$ 16,000	$ 23,200	9

Item ID	Asset Description	Level 1 – Functional Group	Level 2 – Facility Type / Location	Level 3 – Process Location	Level 4 – Asset Category	Level 5 (Asset Type)	Unique ID	Nameplate Present?	Install Year	Refurbishment Year	Manufacturer	Model	Serial Number	Size / Capacity	Unit of Measure	Operating Conditions	Condition Score (1 to 5 Scale)	CoF Score (1 to 5 Scale)	CoF Score Comments	Age	ESL	RUL	Replacement Cost (2020)	Project Cost (includes Markup)	Risk Score (1 to 25 Scale)
44	Starter Pump 302 Raw Water	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Starter	100000097	Yes	1983	NA	SAF	SR6-700-6	15-6422	700A		600V, 3 Ph, 60 Hz	3	3	• Raw Water Pump • 147 L/S (15 MLD) pump (Water Permit) & Firm Capacity is 40 MLD and Total Capacity is 90 MLD • Remaining redundancy is 87%	37	30	-7	$ 16,000	$ 23,200	9
45	Starter Pump 301 Raw Water	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Starter	100000096	Yes	1983	NA	SAF	SR6-700-6	15-6422	700A		600V, 3 Ph, 60 Hz	3	3	• Raw Water Pump • 147 L/S (15 MLD) pump (Water Permit) & Firm Capacity is 40 MLD and Total Capacity is 90 MLD • Remaining redundancy is 87%	37	30	-7	$ 16,000	$ 23,200	9
46	Monorail disconnect	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Disconnect	100000102	Yes	1983	NA	Westinghouse	Not available	JHU361	20	HP	600 V, 3 Ph, 30 A	2	2	• Monorail failure will not affect operation but can hinder repair activities which is minor	37	25	-12	$ 1,000	$ 1,450	4
47	Check Valve (on p/p#304) R.W. #3	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000081	Yes	1983	NA	ValMatic	9800	NA	24	in	150 PSI	3	3	• Valve failure will cause RW Pump 304 to fail • Redundancy drop to 50%	37	35	-2	$ 26,000	$ 37,700	9
48	Check Valve (on p/p#303) R.W. #19	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000078	Yes	1983	NA	ValMatic	9800		24	in	150 PSI	2	3	• Valve failure will cause RW Pump 303 to fail • Redundancy drop to 50%	37	35	-2	$ 26,000	$ 37,700	6
49	Valve Butterfly (Pump #4)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000076	Yes	1983	NA	Not Available			24	in		2	3	• Main valve isolating LLP 4 based on the photos and valve size • Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	37	35	-2	$ 12,000	$ 17,400	6
50	Operator Butterfly Valve (RW#2) (Pump#4)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Actuator	100000075	Yes	1983	NA	LimiTorque	SMC 04	M030F69			0.33 HP, 60 HZ	2	3	• Main valve isolating LLP 4 based on the photos and valve size • Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	37	25	-12	$ 6,000	$ 8,700	6
51	Valve Butterfly BV 4-903 (Pump #3)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000070	Yes	1983	NA	Not Available			24	in		2	3	• Main valve isolating LLP 4 based on the photos and valve size • Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	37	35	-2	$ 12,000	$ 17,400	6
52	Operator Butterfly Valve (RW#18) (Pump#4)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Actuator	100000069	Yes	1983	NA	LimiTorque	SMC 04	19030770			0.33 HP, Freq 60 HZ	2	3	• Main valve isolating LLP 4 based on the photos and valve size • Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	37	25	-12	$ 6,000	$ 8,700	6
53	Valve Butterfly (RW#24)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000141	No	1983	NA	Vanessa			16	in		2	5	• Based on the photo, this seems to be the valve isolating Surge Tank 2 (BV-9) • Based on the PUC comment that the surge tanks should have a criticality of 5 and that both tanks are needed then it was assigned a score of 5	37	35	-2	$ 6,500	$ 9,425	10
54	Valve Butterfly (BV8) (RW#23)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000137	No	1983	NA	Vanessa			16	in		2	5	• BV 8 in the drawings of Gross CAP is the valve isolating Surge Tank 1 • Based on the PUC comment that the surge tanks should have a criticality of 5 and that both tanks are needed then it was assigned a score of 5	37	35	-2	$ 6,500	$ 9,425	10
55	Surge Tank #1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Pressure Vessel	100000114	Yes	1983	NA	O'Connor Tanks Limited	H-5176.5	5.635993			200 PSIG/F	2	4	• Water surge system redundancy drop to 0%	37	20	-17	$241,200	$ 349,740	8
56	Surge Tank #2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Pressure Vessel	100000115	Yes	1983	NA	O'Connor Tanks Limited	H-5176.5	5.635994			200 PSIG/F	2	4	• Water surge system redundancy drop to 0%	37	20	-17	$241,200	$ 349,740	8
57	Air Valve Surge Tank #2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000160	No	1983	NA	Conbraco Industries			1	in		2	4	• Valve failure will affect the operation of the surge tank • The shown valves in the photos are for the level indicator and not air relief. Those ones are not critical and are just isolation valves. Score should remain low in my opinion	37	35	-2	$ 1,000	$ 1,450	8
58	Air Valve Surge Tank #2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000161	No	1983	NA	Conbraco Industries			1	in		2	4	• Valve failure will affect the operation of the surge tank • The shown valves in the photos are for the level indicator and not air relief. Those ones are not critical and are just isolation valves. Score should remain low in my opinion	37	35	-2	$ 1,000	$ 1,450	8
59	Control Panel Surge Tank #2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Control Panel	100000133	No	1983	NA	Hammond Manufacturing	1418-D8				120 volt	2	4	• Failure of the Panel will affect the surge protection Tank #2	37	25	-12	$ 5,500	$ 7,975	8
60	Air Valve Surge Tank #1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000158	No	1983	NA	Conbraco Industries			1	in		2	4	• Valve failure will affect the operation of the surge tank • The shown valves in the photos are for the level indicator and not air relief. Those ones are not critical and are just isolation valves. Score should remain low in my opinion	37	35	-2	$ 1,000	$ 1,450	8
61	Air Valve Surge Tank #1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000159	No	1983	NA	Conbraco Industries			1	in		2	4	• Valve failure will affect the operation of the surge tank • The shown valves in the photos are for the level indicator and not air relief. Those ones are not critical and are just isolation valves. Score should remain low in my opinion	37	35	-2	$ 1,000	$ 1,450	8
62	Control Panel Surge Tank #1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Control Panel	100000132	No	1983	NA	Hammond Manufacturing	1418-D8				120 volt	2	4	• Failure of the Panel will affect the surge protection Tank #1	37	25	-12	$ 5,500	$ 7,975	8

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63	Valve Limitorque (Main)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000131	Yes	1983	NA	LimiTorque	VBT9.5/8	M002454	1200 x 1200	mm	NA	2	3	• Gate valves used for isolating the raw water screens • Based on 100% redundancy of the two screens and the interconnectivity of the two raw water wells, this won't affect production The photos don't show which valve is this but they seem to be the gate valves used in the gross cap station to isolate the screens. Based on 100% redundancy of the screens this was given a score of 3. Those are 6 valves but only 5 are in the gross cap PS drawings	37	35	-2	$ 34,000	$ 49,300	6
64	Valve Limitorque	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000130	Yes	1983	NA	LimiTorque	VBT9.5/8	M002450	1200 x 1200	mm	NA	2	3	• Gate valves used for isolating the raw water screens • Based on 100% redundancy of the two screens and the interconnectivity of the two raw water wells, this won't affect production The photos don't show which valve is this but they seem to be the gate valves used in the gross cap station to isolate the screens. Based on 100% redundancy of the screens this was given a score of 3. Those are 6 valves but only 5 are in the gross cap PS drawings	37	35	-2	$ 34,000	$ 49,300	6
65	Valve Limitorque	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000128	Yes	1983	NA	LimiTorque	VBT9.5/8	M002455	1200 x 1200	mm	NA	2	3	• Gate valves used for isolating the raw water screens • Based on 100% redundancy of the two screens and the interconnectivity of the two raw water wells, this won't affect production	37	35	-2	$ 34,000	$ 49,300	6
66	Valve Torque	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000126	Yes	1983	NA	LimiTorque	VBT9.5/8	M002446	1200 x 1200	mm	NA	2	3	• Gate valves used for isolating the raw water screens • Based on 100% redundancy of the two screens and the interconnectivity of the two raw water wells, this won't affect production The photos don't show which valve is this but they seem to be the gate valves used in the gross cap station to isolate the screens. Based on 100% redundancy of the screens this was given a score of 3. Those are 6 valves but only 5 are in the gross cap PS drawings	37	35	-2	$ 34,000	$ 49,300	6
67	Valve Torque	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000127	Yes	1983	NA	LimiTorque	VBT9.5/8	M002448	1200 x 1200	mm	NA	2	3	• Gate valves used for isolating the raw water screens • Based on 100% redundancy of the two screens and the interconnectivity of the two raw water wells, this won't affect production The photos don't show which valve is this but they seem to be the gate valves used in the gross cap station to isolate the screens. Based on 100% redundancy of the screens this was given a score of 3. Those are 6 valves but only 5 are in the gross cap PS drawings	37	35	-2	$ 34,000	$ 49,300	6
68	Valve Torque	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000129	Yes	1983	NA	LimiTorque	VBT9.5/8	M002452	1200 x 1200	mm	NA	2	3	• Gate valves used for isolating the raw water screens • Based on 100% redundancy of the two screens and the interconnectivity of the two raw water wells, this won't affect production The photos don't show which valve is this but they seem to be the gate valves used in the gross cap station to isolate the screens. Based on 100% redundancy of the screens this was given a score of 3. Those are 6 valves but only 5 are in the gross cap PS drawings	37	35	-2	$ 34,000	$ 49,300	6
69	Air Relief Low Lift 1	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000404	Yes	1986	NA	Not available	Not available	1502843683	1	in		2	2	• Valve failure will cause LL Pump 1 Priming to fail • Redundancy is 100%	34	35	1	$ 600	$ 870	4
70	Air Relief Valve low lift 2	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000415	Yes	1986	NA	Not available	Not available	1502843683	1	in		2	3	• Valve failure will cause LL Pump 2 Priming to fail • Redundancy drop to 87%	34	35	1	$ 600	$ 870	6
71	Air Relief Valve low lift 4	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000444	Yes	1986	NA	Not available	Not available	1502843683	1	in		2	3	• Valve failure will cause LL Pump 4 Priming to fail • Redundancy drop to 87%	34	35	1	$ 600	$ 870	6
72	Air Relief Valve low lift 3	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000428	Yes	1986	NA	Not available	Not available	1502843683	1	in		2	3	• Valve failure will cause LL Pump 3 Priming to fail • Redundancy drop to 87%	34	35	1	$ 600	$ 870	6
73	Low Lift Pump #1	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Pump	300000407	Yes	1986	NA	Peerless Pump	16HH	244570	175	L/s		2	2	• Total LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Redundancy is 100%	34	20	-14	$ 25,000	$ 36,250	4
74	Low Lift Pump Motor #1	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Pump	300000401	Yes	1986	NA	U.S. Motors	RUE WPI	9402981-940 R2119182 K0460257	30	HP	575V/60Hz/3Ph	2	2	• Total LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Redundancy is 100%	34	20	-14	$ 3,500	$ 5,075	4
75	Low Lift Pump #2	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Pump	300000419	Yes	1986	NA	Peerless Pump	20HH	244582	350	L/s		2	3	• Total LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Redundancy drop to 87%	34	20	-14	$ 35,000	$ 50,750	6
76	Low Lift Pump Motor #2	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Pump	300000418	Yes	1986	NA	U.S. Motors	RUE WPI	9403070-943 R2119261 K0460264	60	HP	575V/60Hz/3Ph	2	3	• Total LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Redundancy drop to 87%	34	20	-14	$ 5,500	$ 7,975	6
77	Low Lift Pump #3	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Pump	300000431	Yes	1986	NA	Peerless Pump	20HH	244581	350	L/s		2	3	• Total LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Redundancy drop to 87%	34	20	-14	$ 35,000	$ 50,750	6
78	Low Lift Pump Motor #3	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Pump	300000430	Yes	1986	NA	U.S. Motors	RUE WPI	9403070-943 R2119260 K0460264	60	HP	575V/60Hz/3Ph	2	3	• Total LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Redundancy drop to 87%	34	20	-14	$ 5,500	$ 7,975	6
79	Low Lift Pump #4	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Pump	300000447	Yes	1986	NA	Peerless Pump	20HH	244583	350	L/s		2	3	• Total LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Redundancy drop to 87%	34	20	-14	$ 35,000	$ 50,750	6
80	Low Lift Pump Motor #4	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Pump	300000446	Yes	1986	NA	U.S. Motors	RUE WPI	9403070-943 R2119262 K0460264	60	HP	575V/60Hz/3Ph	2	3	• Total LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Redundancy drop to 87%	34	20	-14	$ 5,500	$ 7,975	6
81	Mixer Inlet Blender #3	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Mixer	300000398	Yes	1986	NA	Lightnin	8-LBS-5	180159				3	3	• Plant Firm Capacity is 40 MLD according to water permit • Mixer is installed on pump outlet and losing a mixer will take the pump offline • Redundancy drop to 87%	34	40	6	$ 35,600	$ 51,620	9

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82	Mixer Inlet Blender Motor #3	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Motor	300000397	Yes	1986	NA	Brook crompton Parkinson Ltd	2425209-01		5	HP	575V/60HZ/3Ph	2	3	• Plant Firm Capacity is 40 MLD according to water permit • Mixer is installed on pump outlet and losing a mixer will take the pump offline • Redundancy drop to 87%	34	20	-14	$ 2,000	$ 2,900	6
83	Mixer Inlet Blender #4	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Mixer	300000439	Yes	1986	NA	Lightnin	8-LBS-5	480157				3	3	• Plant Firm Capacity is 40 MLD according to water permit • Mixer is installed on pump outlet and losing a mixer will take the pump offline • Redundancy drop to 87%	34	40	6	$ 35,600	$ 51,620	9
84	Mixer Inlet Blender Motor #4	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Motor	300000439	Yes	1986	NA	Brook crompton Parkinson Ltd	2425209-01		5	HP	575V/60HZ/3Ph	2	3	• Plant Firm Capacity is 40 MLD according to water permit • Mixer is installed on pump outlet and losing a mixer will take the pump offline • Redundancy drop to 87%	34	20	-14	$ 2,000	$ 2,900	6
85	Mixer Inlet Blender #1	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Mixer	300000424	Yes	1986	NA	Lightnin	8-LBS-5	480160				3	2	• Plant Firm Capacity is 40 MLD according to water permit • Mixer is installed on pump outlet and losing a mixer will take the pump offline • Redundancy is 100%	34	40	6	$ 35,600	$ 51,620	6
86	Mixer Inlet Blender Motor #1	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Motor	300000423	Yes	1986	NA	Brook crompton Parkinson Ltd	2425209-01		5	HP	575V/60HZ/3Ph	2	2	• Plant Firm Capacity is 40 MLD according to water permit • Mixer is installed on pump outlet and losing a mixer will take the pump offline • Redundancy is 100%	34	20	-14	$ 2,000	$ 2,900	4
87	Mixer Inlet Blender Motor #2	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Motor	300000411	Yes	1986	NA	Brook crompton Parkinson Ltd	2425209-01		5	HP	575V/60HZ/3Ph	2	3	• Plant Firm Capacity is 40 MLD according to water permit • Mixer is installed on pump outlet and losing a mixer will take the pump offline • Redundancy drop to 87%	34	20	-14	$ 2,000	$ 2,900	6
88	Mixer Inlet Blender #2	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Mixer	300000412	Yes	1986	NA	SPXFLOW	8-LBS-5	34701				2	3	• Plant Firm Capacity is 40 MLD according to water permit • Mixer is installed on pump outlet and losing a mixer will take the pump offline • Redundancy drop to 87%	34	40	6	$ 35,600	$ 51,620	6
89	Isolation Sluice Gate Valve S.G. 1	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	Missing	Yes	1986	NA	Limitorque	VBT3/5	M003505	5	in		3	3	• This gate isolates raw water well#1 and well#2 and losing this gate will take two of the pumps offline • Redundancy drop to 50%	34	35	1	$ 25,200	$ 36,540	9
90	Valve gate east inlet surge relief	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000741	No	1986	NA	Jenkins	200 WOG		12	in		2	5	• Losing the surge relief valve will affect the protection of the raw water wells Also protect transmission main between marshal drive tanks and treatment plant. If failed, if start and stop flow from marshal drive it could rupture transmission main or damage piping in the plant. • In the drawing and the drinking water permit there is no explanation if the surge relief system has any redundancy or nor. The assumption was that one surge relief tank will be sufficient and that's why a low score of 2 was assigned. If both tanks has to be in service, then a score of 5 is acceptable. • Based on the drawings from the gross cap PS, I would be more inclined to assume that one tank is enough. The drawings show that each two pumps have their own surge tank and there is a valve to switch to the other tank but I can't confirm	34	35	1	$ 4,000	$ 5,800	10
91	Valve gate east inlet surge relief	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000743	No	1986	NA	Jenkins	200 WOG		12	in		2	5	• Losing the surge relief valve will affect the protection of the raw water wells Also protect transmission main between marshal drive tanks and treatment plant. If failed, if start and stop flow from marshal drive it could rupture transmission main or damage piping in the plant. • In the drawing and the drinking water permit there is no explanation if the surge relief system has any redundancy or nor. The assumption was that one surge relief tank will be sufficient and that's why a low score of 2 was assigned. If both tanks has to be in service, then a score of 5 is acceptable. • Based on the drawings from the gross cap PS, I would be more inclined to assume that one tank is enough. The drawings show that each two pumps have their own surge tank and there is a valve to switch to the other tank but I can't confirm	34	35	1	$ 4,000	$ 5,800	10
92	Valve gate west inlet surge relief	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000744	No	1986	NA	Jenkins	200 WOG		12	in		2	5	• Losing the surge relief valve will affect the protection of the raw water wells	34	35	1	$ 4,000	$ 5,800	10
93	Valve gate west inlet surge relief	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000746	No	1986	NA	Jenkins	200 WOG		12	in		2	5	• Losing the surge relief valve will affect the protection of the raw water wells	34	35	1	$ 4,000	$ 5,800	10

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94	Valve, Inlet surge relief west	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000745	No	1986	NA	GA industries inc			12	in		2	5	• Losing the surge relief valve will affect the protection of the raw water wells Also protect transmission main between marshal drive tanks and treatment plant. If failed, if start and stop flow from marshal drive it could rupture transmission main or damage piping in the plant. • In the drawing and the drinking water permit there is no explanation if the surge relief system has any redundancy or nor. The assumption was that one surge relief tank will be sufficient and that's why a low score of 2 was assigned. If both tanks has to be in service, then a score of 5 is acceptable. • Based on the drawings from the gross cap PS, I would be more inclined to assume that one tank is enough. The drawings show that each two pumps have their own surge tank and there is a valve to switch to the other tank but I can't confirm	34	35	1	$ 4,000	$ 5,800	10
95	Valve Inlet surge relief east	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000742	No	1986	NA	GA industries inc			12	in		2	5	• Losing the surge relief valve will affect the protection of the raw water wells	34	35	1	$ 4,000	$ 5,800	10
96	Valve ball raw water isolating	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000748	Yes	1986	NA	Bingham-Willamette co	84012	15028436	24	in		2	5	• Losing this valve will disrupt raw water supply to the plant and affect plant firm capacity	34	35	1	$ 20,000	$ 29,000	10
97	Actuator for Valve ball raw water isolating	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Electrical	Actuator	300000748	Yes	1986	NA	Limitorque	SMC 00 003-172	L375071	24	in		2	5	• Losing this valve will disrupt raw water supply to the plant and affect plant firm capacity • As it was found that this is the only raw water isolation valve on the header within the gross cap PS building then it has zero redundancy and was elevated to 5	34	25	-9	$ 6,000	$ 8,700	10
98	Motor for Valve ball raw water isolating	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Electrical	Motor	300000748	Yes	1986	NA	Limitorque		77V6874M-7K	75	HP		2	5	• Losing this valve will disrupt raw water supply to the plant and affect plant firm capacity As it was found that this is the only raw water isolation valve on the header within the gross cap PS building then it has zero redundancy and was elevated to 7	34	20	-14	$ 11,000	$ 15,950	10
99	Actuator Low Lift #1 Isolating Valve	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Actuator	300000399	No	1986	NA	Limitorque		JM036008		na	1700 RPM, 575V, .33 HP	2	2	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 100%	34	25	-9	$ 6,000	$ 8,700	4
100	Actuator Low Lift #1 Gear Box	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Actuator	300000400	Yes	1986	NA	Torkmatic		289476	59.1	Ratio		2	2	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 100%	34	25	-9	$ 6,000	$ 8,700	4
101	Valve Low Lift #1 Isolating	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000402	Yes	1986	NA	Jenkins	150B		18	in		2	2	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 100%	34	35	1	$ 10,000	$ 14,500	4
102	Valve Low Lift #1 Check	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000406	Yes	1986	NA	Jenkins	200 WOG	AB 7125 EO	10	in		2	2	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 100%	34	35	1	$ 9,000	$ 13,050	4
103	Valve Low Lift #2 Check	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000413	Yes	1986	NA	Jenkins	175WOC	AB7125EM	14	in		2	3	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	34	35	1	$ 16,000	$ 23,200	6
104	Valve Low Lift #2 Isolating	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000408	Yes	1986	NA	Jenkins	150B		18	in		2	3	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	34	35	1	$ 10,000	$ 14,500	6
105	Actuator Low Lift #2 Isolating Valve	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Actuator	300000408	No	1986	NA	Limitorque		JM036007		na	1700 RPM, 575V, .33 HP	2	3	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	34	25	-9	$ 6,000	$ 8,700	6
106	Actuator Low Lift #2 Gear Box	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Actuator	300000410	Yes	1986	NA	Torkmatic		289475	59.1	Ratio		2	3	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	34	25	-9	$ 6,000	$ 8,700	6
107	Valve Low Lift #3 Check	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000425	Yes	1986	NA	Jenkins	175WOC	AB7125EM	14	in		2	3	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	34	35	1	$ 16,000	$ 23,200	6
108	Valve Low Lift #3 Isolating	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000422	Yes	1986	NA	Jenkins	150B		18	in		2	3	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	34	35	1	$ 10,000	$ 14,500	6
109	Actuator Low Lift #3 Gear Box	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Actuator	300000421	Yes	1986	NA	Torkmatic		289477	59.1	Ratio		2	3	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	34	25	-9	$ 6,000	$ 8,700	6
110	Actuator Low Lift #3 Isolating Valve	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Actuator	300000420	No	1986	NA	Limitorque		M002006		na	1700 RPM, 575V, .33 HP	2	3	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	34	25	-9	$ 6,000	$ 8,700	6
111	Valve Low Lift #4 Check	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000441	Yes	1986	NA	Jenkins	175WOC	AB7125EM	14	in		2	3	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	34	35	1	$ 16,000	$ 23,200	6

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112	Valve Low Lift #4 Isolating	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000437	Yes	1986	NA	Jenkins	150B		18	in		2	3	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	34	35	1	$ 10,000	$ 14,500	6
113	Actuator Low Lift #4 Isolating Valve	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Actuator	300000435	No	1986	NA	Limitorque		JM036009		na	1700 RPM, 575V, .33 HP, 60HZ	2	3	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	34	25	-9	$ 6,000	$ 8,700	6
114	Actuator Low Lift #4 Gear Box	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Actuator	300000436	Yes	1986	NA	Torkmatic		290374	59.1	Ratio		2	3	• Firm LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Losing the valve will isolate the pump • Redundancy is 87%	34	25	-9	$ 6,000	$ 8,700	6
115	Energy Recovery Turbines	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Motor	Missing	Yes	2010	NA	EPACT-HPE		BTP708120400 1			1770 HP, 60 HZ, 3 Phase, 575 Volts	2	1	• Energy recovery system will not affect water production	10	20	10	$ 11,000	$ 15,950	2
116	Valve Butterfly Energy Turbine Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000752	Yes	2010	NA	Dzurik			24	in		2	1	• Energy recovery system will not affect water production	10	35	25	$ 12,000	$ 17,400	2
117	Valve Butterfly Energy Turbine Bypass	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000752	Yes	2010	NA	Dzurik		908854R017	24	in		2	1	• Energy recovery system will not affect water production	10	35	25	$ 12,000	$ 17,400	2
118	Valve Butterfly Energy Turbine Outlet	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000754	Yes	2010	NA	Dzurik		93885147R017	24	in		2	1	• Energy recovery system will not affect water production	10	35	25	$ 12,000	$ 17,400	2
119	Valve Butterfly Raw Water Well 1 Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000755	Yes	1986	NA	Jenkins	150B	AB2544K0A2	30	in		2	3	• Losing one raw water well bring the Low lift pumping redundancy to 50%	34	35	1	$ 18,500	$ 26,825	6
120	Butterfly Valve Raw Well	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000751	Yes	1986	NA	Jenkins	150B	AB2544HM	24	in		2	3	• Losing one raw water well bring the Low lift pumping redundancy to 50%	34	35	1	$ 12,000	$ 17,400	6
121	Blender Motor #1 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	No	1986	NA	Sylvania		T77U031	30	A	600V/60Hz/3ph	2	2	• Plant Firm Capacity is 40 MLD according to water permit • Mixer is installed on pump outlet and losing a mixer will take the pump offline • Redundancy is 100%	34	30	-4	$ 10,000	$ 14,500	4
122	Blender Motor #2 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	No	1986	NA	Sylvania		T77U031	30	A	600V/60Hz/3ph	2	3	• Plant Firm Capacity is 40 MLD according to water permit • Mixer is installed on pump outlet and losing a mixer will take the pump offline • Redundancy drop to 87%	34	30	-4	$ 10,000	$ 14,500	6
123	Blender Motor #3 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	No	1986	NA	Sylvania		T77U031	30	A	600V/60Hz/3ph	2	3	• Plant Firm Capacity is 40 MLD according to water permit • Mixer is installed on pump outlet and losing a mixer will take the pump offline • Redundancy drop to 87%	34	30	-4	$ 10,000	$ 14,500	6
124	Blender Motor #4 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	No	1986	NA	Sylvania		T77U031	30	A	600V/60Hz/3ph	2	3	• Plant Firm Capacity is 40 MLD according to water permit • Mixer is installed on pump outlet and losing a mixer will take the pump offline • Redundancy drop to 87%	34	30	-4	$ 10,000	$ 14,500	6
125	Low lift Motor #1 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			60	A	600V/60Hz/3ph	2	2	• Valve failure will cause LL Pump 1 Priming to fail • Redundancy is 100%	34	30	-4	$ 10,000	$ 14,500	4
126	Low lift Motor #2 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			100	A	600V/60Hz/3ph	2	3	• Valve failure will cause LL Pump 2 Priming to fail • Redundancy drop to 87%	34	30	-4	$ 13,000	$ 18,850	6
127	Low lift Motor #3 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			100	A	600V/60Hz/3ph	2	3	• Valve failure will cause LL Pump 4 Priming to fail • Redundancy drop to 87%	34	30	-4	$ 13,000	$ 18,850	6
128	Low lift Motor #4 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			100	A	600V/60Hz/3ph	2	3	• Valve failure will cause LL Pump 3 Priming to fail • Redundancy drop to 87%	34	30	-4	$ 13,000	$ 18,850	6
129	ATS	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	MCC	Missing	No	2011	2018	ASCO	J07ATS030 225R5X0	652220	225 A		600V/3ph/	2	5	• Losing the low lift PS ATS will cause the plant to stop running	2	30	28	$ 25,000	$ 36,250	10
130	Floc agitator #3 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			15	A	600V/60Hz/3ph	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	30	-4	$ 10,000	$ 14,500	8
131	Floc agitator #4 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			15	A	600V/60Hz/3ph	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	30	-4	$ 10,000	$ 14,500	8
132	Floc agitator #2 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			15	A	600V/60Hz/3ph	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	30	-4	$ 10,000	$ 14,500	8
133	Floc agitator #1 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			15	A	600V/60Hz/3ph	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	30	-4	$ 10,000	$ 14,500	8
134	Low lift #2 capacitor bank	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	No	1986	NA	ASEA			15	kVa	600V/60Hz/3ph	2	3	• Total LLPS capacity is 40 MLD and total LLPS capacity is 105 MLD • Redundancy drop to 87%	34	30	-4	$ 10,000	$ 14,500	6
135	Inline Booster Pump Motor Starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	Yes	1986	NA	Sylvania	T77U031	7707	25	A		2	4	• Unique asset with similar description could not be identified in the as-built drawings. Based on PUC comment that the inline booster pump was needed to supply carrier water for the chemical system then it was increased to 4 along with associated assets	34	30	-4	$ 10,000	$ 14,500	8

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136	Floc agitator #1 disconnect	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Electrical	Disconnect	Missing	No	1986	NA	Westinghouse			30	A	600V/60Hz/3ph	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	25	-9	$ 1,000	$ 1,450	8
137	Floc agitator #2 disconnect	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Electrical	Disconnect	Missing	No	1986	NA	Westinghouse			30	A	600V/60Hz/3ph	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	25	-9	$ 1,000	$ 1,450	8
138	Floc agitator #3 disconnect	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Electrical	Disconnect	Missing	No	1986	NA	Westinghouse			30	A	600V/60Hz/3ph	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	25	-9	$ 1,000	$ 1,450	8
139	Floc agitator #4 disconnect	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Electrical	Disconnect	Missing	No	1986	NA	Westinghouse			30	A	600V/60Hz/3ph	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	25	-9	$ 1,000	$ 1,450	8
140	MCC E Feeder	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #1 (M)	Process Electrical	Feeder	Missing	No	1986	2011	Westinghouse			250	A	600V/60Hz/3ph	2	5	• Losing the MCC will affect the plant production	9	30	21	$ 10,000	$ 14,500	10
141	High lift #3 starter	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #2 (M)	Process Electrical	Starter	Missing	No	1986	NA	Westinghouse			540	A	600V/60Hz/3ph	3	3	• The plant has a firm capacity and each HLP is 30 MLD • The capacity is 50%	34	30	-4	$ 16,000	$ 23,200	9
142	Surface wash pump Motor #2 starter	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #1 (M)	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			60	A	600V/60Hz/3ph	2	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	30	-4	$ 10,000	$ 14,500	4
143	Surface wash pump Motor #1 starter	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #1 (M)	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			60	A	600V/60Hz/3ph	2	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	30	-4	$ 10,000	$ 14,500	4
144	Backwash pump Motor #1 starter	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #2 (M)	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			200	A	600V/60Hz/3ph	2	4	• Losing backwash will affect production and losing one pump will make redundancy 0%	34	30	-4	$ 13,000	$ 18,850	8
145	Backwash pump Motor #2 starter	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #2 (M)	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			200	A	600V/60Hz/3ph	2	4	• Losing backwash will affect production and losing one pump will make redundancy 0%	34	30	-4	$ 13,000	$ 18,850	8
146	Supernatant pump Motor #1 starter	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #2 (M)	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			9	A	600V/60Hz/3ph	2	4	• Supernatant pump is needed to discharge the decanted water to Little Carp creek • This pump has a redundancy of 0%	34	30	-4	$ 5,000	$ 7,250	8
147	Sludge pump Motor #2 starter	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #2 (M)	Process Electrical	Starter	Missing	No	1986	NA	Sylvania			25	A	600V/60Hz/3ph	2	4	• Sludge pump is needed to discharge the sludge to sewer • This pump has a redundancy of 0%	34	30	-4	$ 10,000	$ 14,500	8
148	Soda Ash compressor breaker	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #2 (M)	Process Electrical	Breaker	Missing	No	2015	NA	Westinghouse				A	600V/60Hz/3ph	2	3	• Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; compliance point for corrosion abatement. Compressor not critical to operation, full time service not required, downtime allows addition of backup compressor. Low humidity in plant has reduced operational need for process to support Soda Ash system, can be a 2	5	20	15	$ 5,000	$ 7,250	6
149	Soda Ash makeup system breaker	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #2 (M)	Process Electrical	Breaker	Missing	No	2015	NA	Westinghouse				A	600V/60Hz/3ph	2	3	• Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; compliance point for corrosion abatement.	5	20	15	$ 5,000	$ 7,250	6
150	Soda Ash hot water heater system breaker	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #2 (M)	Process Electrical	Breaker	Missing	No	2015	NA	Westinghouse				A	600V/60Hz/3ph	2	3	• Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; compliance point for corrosion abatement.	5	20	15	$ 5,000	$ 7,250	6
151	Alum Pump No. 1	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Alum	Process Mechanical	Pump	300000812	Yes	2018	NA	Prominent		2017115631	42	L/s	120VAC/60Hz	2	3	• Alum pumps are needed to run the plant and assuming that running the plant requires at least two pumps to achieve the needed dose which is not identified in the drinking water permit • Redundancy is 33% Only 1 alum pump is needed to run at plant capacity.	2	20	18	$ 5,500	$ 7,975	6
152	Alum Pump No. 2	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Alum	Process Mechanical	Pump	300000813	Yes	2018	NA	Prominent		2016179648	42	L/s	120VAC/60Hz	2	3	• Alum pumps are needed to run the plant and assuming that running the plant requires at least two pumps to achieve the needed dose which is not identified in the drinking water permit • Redundancy is 33% Only 1 alum pump is needed to run at plant capacity.	2	20	18	$ 5,500	$ 7,975	6
153	Alum Pump No. 3	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Alum	Process Mechanical	Pump	300000814	Yes	2018	NA	ProMinent		2017115626	42	L/s	120VAC/60Hz	2	3	• Alum pumps are needed to run the plant and assuming that running the plant requires at least two pumps to achieve the needed dose which is not identified in the drinking water permit • Redundancy is 33% Only 1 alum pump is needed to run at plant capacity.	2	20	18	$ 5,500	$ 7,975	6
154	Alum Tank No. 1	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Alum	Process Structural	Tanks / Basins	300000028	No	2018	NA				11000	L		2	4	• Losing alum tank will affect production and losing one tank will make redundancy 0%	2	60	58	$ 59,700	$ 86,565	8
155	Alum Tank No. 2	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Alum	Process Structural	Tanks / Basins	300000029	No	2018	NA				11000	L		2	4	• Losing alum tank will affect production and losing one tank will make redundancy 0%	2	60	58	$ 59,700	$ 86,565	8

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156	Alum Day Tank	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Alum	Process Structural	Tanks / Basins	300000027	No	2018	NA				245	L		2	2	• Losing alum day tank will affect production but the drawings don't show it so the pumps can draw directly from the storage tanks • Alum can be drawn straight from storage tanks in an emergency.	2	60	58	$ 1,000	$ 1,450	4
157	Chlorine Vacuum Regulator	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Cl2 Gas	Process Mechanical	Regulator	300000791	No	2015	NA	Evoqua	W3T75615	BZ1460492-1				1	5	• Losing the vacuum regulator will cause chlorination to be affected and the plant will not be operated	5	20	15	$ 4,500	$ 6,525	5
158	Pre chlorine injector	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Cl2 Gas	Process Mechanical	Injector	300000788	No	2016	NA	Evoqua	W3T99146					1	3	• Pre Chlorine is not needed for regulatory purposes but needed to prevent operational problems at the plant	4	20	16	$ 3,000	$ 4,350	3
159	Standby chlorine injector	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Cl2 Gas	Process Mechanical	Injector	300000789	No	2016	NA	Evoqua	W3T99146					1	4	• Post chlorinator is needed for disinfection and has 100% redundancy	4	20	16	$ 3,000	$ 4,350	4
160	Post chlorine injector	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Cl2 Gas	Process Mechanical	Injector	300000790	No	2016	NA	Evoqua	W3T99146					1	4	• Post chlorinator is needed for disinfection and has 100% redundancy	4	20	16	$ 3,000	$ 4,350	4
161	Post chlorine injector solenoid	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Cl2 Gas	Process Mechanical	Injector	300000787	No	2016	NA	ASCO		T517554			120VAC	1	4	• Post chlorinator is needed for disinfection and has 100% redundancy	4	20	16	$ 1,400	$ 2,030	4
162	Standby chlorine injector solenoid	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Cl2 Gas	Process Mechanical	Injector	300000796	No	2016	NA	ASCO		T517554			120VAC	1	4	• Post chlorinator is needed for disinfection and has 100% redundancy	4	20	16	$ 1,400	$ 2,030	4
163	Pre chlorine injector solenoid	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Cl2 Gas	Process Mechanical	Injector	300000795	No	2016	NA	ASCO		T517554			120VAC	1	3	• Pre Chlorine is not needed for regulatory purposes but needed to prevent operational problems at the plant	4	20	16	$ 1,400	$ 2,030	3
164	Blended Phosphate Pump No. 1	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Blended Phosphate	Process Mechanical	Pump	Missing	Yes	2015	NA	ProMinent		2014247945	19.1	L/s	115VAC/60Hz	2	3	• Phosphate system is needed for corrosion control however its short term failure won't cause the production to stop Score increased from 2 to 3; regulatory requirement.	5	20	15	$ 7,500	$ 10,875	6
165	Blended Phosphate Pump No. 2	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Blended Phosphate	Process Mechanical	Pump	Missing	Yes	2015	NA	ProMinent		2014247945	19.1	L/s	115VAC/60Hz	2	3	• Phosphate system is needed for corrosion control however its short term failure won't cause the production to stop Score increased from 2 to 3; regulatory requirement.	5	20	15	$ 7,500	$ 10,875	6
166	Blended Phosphate Tank No. 1	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Blended Phosphate	Process Structural	Tanks / Basins	Missing	No	2015	NA				600	L		2	3	• Phosphate system is needed for corrosion control however its short term failure won't cause the production to stop	5	60	55	$ 1,500	$ 2,175	6
167	Blended Phosphate Tank No. 2	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Blended Phosphate	Process Structural	Tanks / Basins	Missing	No	2015	NA	Chemline	DMT135	673W	600	L		2	3	• Phosphate system is needed for corrosion control however its short term failure won't cause the production to stop Score increased from 2 to 3; regulatory requirement.	5	60	55	$ 1,500	$ 2,175	6
168	Soda Ash Hopper	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Structural	Hopper	Missing	No	2015	NA	Felxicon	75866	2014F0702-ALP63				2	3	• Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; regulatory requirement.	5	30	25	$ 65,000	$ 94,250	6
169	Soda Ash feeder	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	Missing	Yes	2015	NA	U.S. Motors						2	3	• Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; regulatory requirement.	5	20	15	$ 2,000	$ 2,900	6
170	Soda Ash mixer	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	Missing	No	2015	NA	SPX						2	3	• Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; regulatory requirement.	5	20	15	$ 2,000	$ 2,900	6
171	Soda Ash transfer pump motor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	Missing	Yes	2015	NA	E line	EM102	ELP1P3G	1.4	A		2	3	• Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; regulatory requirement.	5	20	15	$ 2,000	$ 2,900	6
172	Soda Ash Filter	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Filter	Missing	No	2015	NA	Hayward						2	3	• Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; regulatory requirement.	5	20	15	$ 2,500	$ 3,625	6
173	Soda Ash transfer pump	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	Missing	Yes	2015	NA	Goulds	3196	7040123	9	m^3/h		2	3	• Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; regulatory requirement.	5	20	15	$ 7,100	$ 10,295	6
174	Soda Ash Solution Tank	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Structural	Chemical Tanks	Missing	No	2015	NA	ACO	OT500		1100	L		2	3	• Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; regulatory requirement.	5	30	25	$ 2,000	$ 2,900	6
175	Soda Ash Tank Mixer	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	Missing	No	2015	NA	SPX						2	3	• Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; regulatory requirement.	5	20	15	$ 2,000	$ 2,900	6
176	Soda Ash dosing pump no. 1	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	Missing	Yes	2015	NA	Bredel	BREDAL 25	70771				2	3	• Soda Ash system is needed for pH stabilization however (failure of 1 pump) its in the short term failure won't cause the production to stop this score should remain at 2 as there is 100% redundancy for the dosing pumps	5	20	15	$ 21,300	$ 30,885	6
177	Soda Ash dosing pump no. 2	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	Missing	Yes	2015	NA	Bredel	BREDAL 25	70770				2	3	• Soda Ash system is needed for pH stabilization however (failure of 1 pump) its in the short term failure won't cause the production to stop this score should remain at 2 as there is 100% redundancy for the dosing pumps	5	20	15	$ 21,300	$ 30,885	6

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178	Soda Ash dosing pump no. 1 gearbox	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Gearbox	Missing	Yes	2015	NA	Bredel	CB3133 SBT					2	3	• Soda Ash system is needed for pH stabilization however (failure of 1 pump) its in the short term failure won't cause the production to stop this score should remain at 2 as there is 100% redundancy for the dosing pumps	5	20	15	Cost Included in Pump	Cost Included in Pump	6
179	Soda Ash dosing pump no. 1 motor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	Missing	Yes	2015	NA	Baldor	35J302M21 8G1		0.75	HP	575V/60HZ/3	2	3	• Soda Ash system is needed for pH stabilization however (failure of 1 pump) its in the short term failure won't cause the production to stop	5	20	15	$ 500	$ 725	6
180	Soda Ash dosing pump no. 2 gearbox	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Gearbox	Missing	Yes	2015	NA	Bredel	CB3133 SBT					2	3	• Soda Ash system is needed for pH stabilization however (failure of 1 pump) its in the short term failure won't cause the production to stop this score should remain at 2 as there is 100% redundancy for the dosing pumps	5	20	15	Cost Included in Pump	Cost Included in Pump	6
181	Soda Ash dosing pump no. 2 motor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	Missing	Yes	2015	NA	Baldor	35J302M21 8G1		0.75	HP	575V/60HZ/3	2	3	• Soda Ash system is needed for pH stabilization however (failure of 1 pump) its in the short term failure won't cause the production to stop this score should remain at 2 as there is 100% redundancy for the dosing pumps	5	20	15	$ 500	$ 725	6
182	Soda Ash Compressor Tank	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Structural	Tanks / Basins	Missing	Yes	2015	NA	Atlas Copco	Not available	Not available	80	Gallon		1	3	• Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; no backup; regulatory requirement.Compressor not critical to operation of Soda Ash system, can be a 2	5	60	55	$ 3,600	$ 5,220	3
183	Soda Ash Compressor Motor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	Missing	Yes	2015	NA	Baldor	36G548S59 4G1		5	HP	575V/60HZ/3	1	3	• Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; no backup; regulatory requirement.Compressor not critical to operation of Soda Ash system, can be a 2	5	20	15	$ 2,000	$ 2,900	3
184	Soda Ash Compressor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Compressor	Missing	Yes	2015	NA	Atlas copco	AR5V5753 P2P	9610502152				1	3	• Soda Ash system is needed for pH stabilization however its short term failure won't cause the production to stop Score increased from 2 to 3; no backup; regulatory requirement.Compressor not critical to operation of Soda Ash system, can be a 2	5	20	15	$ 6,700	$ 9,715	3
185	UV System 3	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	UV Treatment	Missing	Yes	2017	NA	VIQUA	PRO20	160402463	20		120VAC/1 single	2	1	• Assuming on UV reactor per filter which is necessary for achieving the disinfection level • Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters Score decreased from 4 to 1; filter for internal use; not distribution or production.	3	30	27	$ 6,900	$ 10,005	2
186	UV System 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	UV Treatment	Missing	Yes	2017	NA	VIQUA	PRO20	160402461	20		120VAC/1 single	2	1	• Assuming on UV reactor per filter which is necessary for achieving the disinfection level • Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters Score decreased from 4 to 1; filter for internal use; not distribution or production.	3	30	27	$ 6,900	$ 10,005	2
187	UV System 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	UV Treatment	Missing	Yes	2017	NA	VIQUA	PRO20	160402462	20		120VAC/1 single	2	1	• Assuming on UV reactor per filter which is necessary for achieving the disinfection level • Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters Score decreased from 4 to 1; filter for internal use; not distribution or production.	3	30	27	$ 6,900	$ 10,005	2
188	UV System 4	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	UV Treatment	Missing	Yes	2017	NA	VIQUA	PRO20	160402464	20		120VAC/1 single	2	1	• Assuming on UV reactor per filter which is necessary for achieving the disinfection level • Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters Score decreased from 4 to 1; filter for internal use; not distribution or production.	3	30	27	$ 6,900	$ 10,005	2
189	UV System 1 Solenoid Valve	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Valve	Missing	Yes	2017	NA	VIQUA		A546863	20	in	6.9 Watts/24 VDC	2	1	• Assuming on UV reactor per filter which is necessary for achieving the disinfection level • Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters Score decreased from 4 to 1; filter for internal use; not distribution or production.	3	35	32	$ 1,200	$ 1,740	2

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190	UV System 2 Solenoid Valve	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Valve	Missing	Yes	2017	NA	VIQUA		A495288	20	in	6.9 Watts/24 VDC	2	1	• Assuming on UV reactor per filter which is necessary for achieving the disinfection level • Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters Score decreased from 4 to 1; filter for internal use; not distribution or production.	3	35	32	$ 1,200	$ 1,740	2
191	UV System 3 Solenoid Valve	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Valve	Missing	Yes	2017	NA	VIQUA		A496579	20	in	6.9 Watts/24 VDC	2	1	• Assuming on UV reactor per filter which is necessary for achieving the disinfection level • Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters Score decreased from 4 to 1; filter for internal use; not distribution or production.	3	35	32	$ 1,200	$ 1,740	2
192	UV System 4 Solenoid Valve	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Valve	Missing	Yes	2017	NA	VIQUA		A546863	20	in	6.9 Watts/24 VDC	2	1	• Assuming on UV reactor per filter which is necessary for achieving the disinfection level • Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters Score decreased from 4 to 1; filter for internal use; not distribution or production.	3	35	32	$ 1,200	$ 1,740	2
193	Surface wash booster pump no. 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Pump	Missing	Yes	1986	NA	Peerless Pump		428711	277	GPM		3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	20	-14	$ 10,600	$ 15,370	6
194	Surface wash booster pump no. 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Pump	Missing	Yes	1986	NA	Peerless Pump		428711	277	GPM		3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	20	-14	$ 10,600	$ 15,370	6
195	Surface wash booster pump no. 1 motor	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Motor	Missing	Yes	1986	NA	U.S. Motors	R	M-082194328	2.5	HP	575V/60HZ/3	2	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	20	-14	$ 1,000	$ 1,450	4
196	Surface wash booster pump no. 2 motor	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Motor	Missing	Yes	1986	NA	U.S. Motors	R	M-102482728	2.5	HP	575V/60HZ/3 Ph	2	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	20	-14	$ 1,000	$ 1,450	4
197	Valve gate, surface wash line	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000695	Yes	1986	NA	Jenkins	200 WOG		4	in		3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,000	$ 1,450	6
198	valve BFP, scour system	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000378	Yes	1986	NA	Watts	909	161167	4	in		3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 2,800	$ 4,060	6
199	Valve gate, surface wash line	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000694	Yes	1986	NA	Jenkins	200 WOG		4	in		3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,000	$ 1,450	6
200	Valve, gate W surface wash pump discharge	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000693	Yes	1986	NA	Jenkins	200 WOG		4	in		3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,000	$ 1,450	6
201	Valve, gate E surface wash pump discharge	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000690	Yes	1986	NA	Jenkins	200 WOG		4	in		3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,000	$ 1,450	6
202	Valve, gate E surface wash pump inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000688	Yes	1986	NA	Jenkins	200 WOG		6	in		3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,200	$ 1,740	6
203	Valve, gate W surface wash pump supply	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000691	Yes	1986	NA	Jenkins	200 WOG		6	in		3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,200	$ 1,740	6
204	Valve Check west surface wash pump	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000692	No	1986	NA	Not available	Not available	Not available	4	in		3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 3,500	$ 5,075	6
205	Valve gate, surface wash pump bypass	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000687	Yes	1986	NA	Jenkins	200 WOG		4	in		3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,000	$ 1,450	6
206	Valve gate, plant water supply	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000685	Yes	1986	NA	Jenkins	200 WOG		6	in		3	5	• Plant water supply is needed for cooling the pumps and providing the needed potable water across the plant but is not crucial for running • No redundancy is available for the water supply system Score increased from 4 to 5; no redundancy	34	35	1	$ 1,200	$ 1,740	15
207	Valve gate, plant water supply pump bypass	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000686	Yes	1986	NA	Jenkins	200 WOG		6	in		3	5	• Plant water supply is needed for cooling the pumps and providing the needed potable water across the plant but is not crucial for running • No redundancy is available for the water supply system Score increased from 4 to 5; no redundancy	34	35	1	$ 1,200	$ 1,740	15
208	Valve gate, plant water meter bypass	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000684	Yes	1986	NA	Jenkins	200 WOG		6	in		3	5	• Plant water supply is needed for cooling the pumps and providing the needed potable water across the plant but is not crucial for running • No redundancy is available for the water supply system Score increased from 4 to 5; no redundancy	34	35	1	$ 1,200	$ 1,740	15
209	Valve gate, plant water supply	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000683	Yes	1986	NA	Jenkins	200 WOG		6	in		3	5	• Plant water supply is needed for cooling the pumps and providing the needed potable water across the plant but is not crucial for running • No redundancy is available for the water supply system Score increased from 4 to 5; no redundancy	34	35	1	$ 1,200	$ 1,740	15

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210	Strainer, plant water supply	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	Missing	No	1986	NA	Rockwell	Not available	Not available	4	in		3	5	• Plant water supply is needed for cooling the pumps and providing the needed potable water across the plant but is not crucial for running • No redundancy is available for the water supply system Score increased from 4 to 5; no redundancy	34	35	1	$ 3,900	$ 5,655	15
211	Valve Check east surface wash pump	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000689	No	1986	NA	Not available	Not available	Not available	4	in		3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 3,500	$ 5,075	6
212	surface wash pump no. 1 disconnect	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Disconnect	Missing	Yes	1986	NA	Westinghouse		NU362	60	A	600V/3Ph	2	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	25	-9	$ 1,000	$ 1,450	4
213	surface wash pump no. 2 disconnect	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Disconnect	Missing	Yes	1986	NA	Westinghouse		NU362	60	A	600V/3Ph	2	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	25	-9	$ 1,000	$ 1,450	4
214	DP-ED step down transformer for panel	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Transformer	Missing	Yes	1986	NA	Polygon	5H1-15CR-3C	5688-20 844	10	kV	600V/3Ph	2	5	• The transformers are needed to run the plant	34	25	-9	$ 1,500	$ 2,175	10
215	DP-EB step down transformer for panel	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Transformer	Missing	Yes	1986	NA	Polygon	5H1-25CR-3C	5803-10	25	kVa	600V/3Ph	2	5	• The transformers are needed to run the plant	34	25	-9	$ 2,800	$ 4,060	10
216	Valve gate inline booster pump	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000699	No	1986	NA	Jenkins	200 WOG		4	in		3	4	Unique asset with similar description could not be identified in the as-built drawings. Based on PUC comment that the inline booster pump was needed to supply carrier water for the chemical system then it was increased to 4 along with associated assets	34	35	1	$ 1,000	$ 1,450	12
217	Valve gate inline booster pump	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000698	No	1986	NA	Jenkins	200 WOG		4	in		3	4	Unique asset with similar description could not be identified in the as-built drawings. Based on PUC comment that the inline booster pump was needed to supply carrier water for the chemical system then it was increased to 4 along with associated assets	34	35	1	$ 1,000	$ 1,450	12
218	Valve butterfly inline booster pump	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000700	No	1986	NA	Not available	Not available		4	in		3	4	Unique asset with similar description could not be identified in the as-built drawings. Based on PUC comment that the inline booster pump was needed to supply carrier water for the chemical system then it was increased to 4 along with associated assets	34	35	1	$ 1,125	$ 1,631	12
219	Valve butterfly inline booster bypass	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000702	No	1986	NA	Not available	Not available		4	in		3	4	Unique asset with similar description could not be identified in the as-built drawings. Based on PUC comment that the inline booster pump was needed to supply carrier water for the chemical system then it was increased to 4 along with associated assets	34	35	1	$ 1,125	$ 1,631	12
220	Valve check inline booster bypass	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000701	No	1986	NA	Not available	Not available		4	in		3	4	Unique asset with similar description could not be identified in the as-built drawings. Based on PUC comment that the inline booster pump was needed to supply carrier water for the chemical system then it was increased to 4 along with associated assets	34	35	1	$ 3,500	$ 5,075	12
221	Valve gate inline booster pump	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Pump	300000593	Yes	2015	NA	Peerless pump	2X2X10 PV	2687368				2	4	Unique asset with similar description could not be identified in the as-built drawings. Based on PUC comment that the inline booster pump was needed to supply carrier water for the chemical system then it was increased to 4 along with associated assets	5	20	15	$ 1,700	$ 2,465	8
222	Valve gate inline booster pump motor	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Motor	300000593	Yes	2015	NA	WEG		JM010504W	10	HP	600V/3Ph	2	4	Unique asset with similar description could not be identified in the as-built drawings. Based on PUC comment that the inline booster pump was needed to supply carrier water for the chemical system then it was increased to 4 along with associated assets	5	20	15	$ 4,000	$ 5,800	8
223	Valve gate inline booster pump disconnect	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Disconnect	Missing	Yes	1986	NA	Westinghouse	NU361		30	A	600V/3Ph	2	4	Unique asset with similar description could not be identified in the as-built drawings. Based on PUC comment that the inline booster pump was needed to supply carrier water for the chemical system then it was increased to 4 along with associated assets	34	25	-9	$ 1,000	$ 1,450	8
224	Valve pressure control inline booster pump	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000594	No	2018	NA	Singer						1	4	Unique asset with similar description could not be identified in the as-built drawings. Based on PUC comment that the inline booster pump was needed to supply carrier water for the chemical system then it was increased to 4 along with associated assets	2	35	33	$ 675	$ 979	4
225	DP-EC step down transformer for panel	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Alum	Process Electrical	Transformer	Missing	Yes	1986	NA	Polygon	5H1-25CR-3C	5803-5	25	kVa	600V/3Ph	2	5	• The transformers are needed to run the plant	34	25	-9	$ 2,800	$ 4,060	10
226	Valve filter #1 filtrate	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000236	No	1986	NA	JENKINS	AB 2544 EM		14	in		3	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 3,000	$ 4,350	12
227	Valve actuator filter #1 filtrate	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Actuator	300000236	Yes	1986	NA	Limitorque	4		0.4	HP	120 VAC	3	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	25	-9	$ 6,000	$ 8,700	12
228	Valve actuator filter #2 filtrate	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Actuator	300000237	Yes	1986	NA	Limitorque	4		0.4	HP	120 VAC	3	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	25	-9	$ 6,000	$ 8,700	12

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229	Valve filter #2 filtrate	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000237	No	1986	NA	JENKINS	AB 2544 EM		14	in		3	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 3,000	$ 4,350	12
230	Valve filter #3 filtrate	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000238	No	1986	NA	JENKINS	AB 2544 EM		14	in		3	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 3,000	$ 4,350	12
231	Valve actuator filter #3 filtrate	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Actuator	300000238	Yes	1986	NA	Limitorque	4		0.4	HP	120 VAC	3	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	25	-9	$ 6,000	$ 8,700	12
232	Valve actuator filter #4 filtrate	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Actuator	300000239	Yes	1986	NA	Limitorque	4		0.4	HP	120 VAC	3	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	25	-9	$ 6,000	$ 8,700	12
233	Valve filter #4 filtrate	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000239	No	1986	NA	JENKINS	AB 2544 EM		14	in		3	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 3,000	$ 4,350	12
234	Valve Butterfly BW waste header isolation	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000680	No	1986	NA	JENKINS	AAB 2544 HM		24	in		3	5	• This valve is needed to allow filter backwash which is necessary to run the plant	34	35	1	$ 12,000	$ 17,400	15
235	Valve Butterfly BW tank 1 inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000681	No	1986	NA	JENKINS	AAB 2544 HM		24	in		3	4	• The backwash tanks has a full redundancy and losing one tank will reduce the redundancy	34	35	1	$ 12,000	$ 17,400	12
236	Valve Butterfly BW tank 2 inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000682	No	1986	NA	JENKINS	AAB 2544 HM		24	in		3	4	• The backwash tanks has a full redundancy and losing one tank will reduce the redundancy	34	35	1	$ 12,000	$ 17,400	12
237	Valve plug, suction sludge pump BW Tank No. 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000188	No	1986	NA	Dezurik			4	in		4	3	• The sludge valves will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,000	$ 1,450	12
238	Valve actuator plug, suction sludge pump, BW tank No. 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000188	Yes	1986	NA	Keystone Valve	150-952-270-777-002	02728-75222-02	1.1	A	110V/single phase/60 Hz	2	3	• The sludge valves will be needed during BW tank operation but the tank can still be used	34	35	1	$ 5,000	$ 7,250	6
239	Valve plug, suction sludge pump BW Tank No. 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	Missing	No	1986	NA	Dezurik			4	in		4	3	• The sludge valves will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,000	$ 1,450	12
240	Valve actuator plug, suction sludge pump, BW tank No. 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	Missing	Yes	1986	NA	Keystone Valve	150-952-270-777-002	02563-72491-01	1.1	A	110V/single phase/60 Hz	2	3	• The sludge valves will be needed during BW tank operation but the tank can still be used	34	35	1	$ 5,000	$ 7,250	6
241	Valve plug, BW tank sludge pump 1 suction	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000671	Yes	1986	NA	Dezurik	EJ4	907059	4	in		2	3	• The sludge valves will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,000	$ 1,450	6
242	Valve plug, BW tank sludge pump 2 suction	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000675	Yes	1986	NA	Dezurik	EJ4	907059	4	in		2	3	• The sludge valves will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,000	$ 1,450	6
243	Valve plug, sludge pump 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000677	No	1986	NA	Dezurik	EJ4	907059	4	in		2	3	• The sludge valves will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,000	$ 1,450	6
244	Valve plug, sludge pump 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000673	No	1986	NA	Dezurik	EJ4	907059	4	in		2	3	• The sludge valves will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,000	$ 1,450	6
245	Valve plug, sludge pump 1 (to truck)	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000674	No	1986	NA	Dezurik	EJ4	907059	4	in		2	3	• The sludge valves will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,000	$ 1,450	6
246	Valve plug, sludge pump 2 (to truck)	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000678	No	1986	NA	Dezurik	EJ4	907059	4	in		2	3	• The sludge valves will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,000	$ 1,450	6
247	Valve Butterfly Raw Water Well 2 Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000756	Yes	1986	NA	Jenkins	150B	AB2544K0A2	30	in		2	3	• Losing one raw water well bring the Low lift pumping redundancy to 50%	34	35	1	$ 18,500	$ 26,825	6
248	Valve low lift Water Level Control	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000240	Yes	1986	NA	Power Plant Supply Company		1502843683	30	in		2	3	Assuming that this is the LIT needed to triger low level alarms for the LLPs operation then this can cause operational problems over the long run if not functioning properly so it is assumed to be a critical asset.	34	35	1	$ 10,000	$ 14,500	6
249	Valve Butterfly Filter 1 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000715	Yes	1986	NA	Jenkins	2242 EL		4	in	200 PSIG	3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,125	$ 1,631	6
250	Valve Butterfly Filter 1 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000717	Yes	1986	NA	Jenkins	2242 EL		4	in	200 PSIG	3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,125	$ 1,631	6
251	Valve Butterfly Filter 1 Backwash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000718	Yes	1986	NA	Jenkins			20	in	1700 RPM, 575 Volts, .33 HP	2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 10,000	$ 14,500	8
252	Actuator Valve Butterfly Filter 1 Backwash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000718	Yes	1986	NA	Limitorque			20	in	1700 RPM, 575 Volts, .33 HP	2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	25	-9	$ 6,000	$ 8,700	8
253	Actuator Valve Butterfly Filter 1 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000714	Yes	1986	NA	Limitorque		39321	24	in	NA	2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	25	-9	$ 6,000	$ 8,700	8
254	Valve Butterfly Filter 1 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000714	No	1986	NA	Jenkins	-	-	24	in		4	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 12,000	$ 17,400	16
255	Valve Piston Filter 1 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000716	No	1986	NA	Jenkins	2242 EL		4	in	200 PSIG	3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 4,700	$ 6,815	6

Item ID	Asset Description	Level 1 – Functional Group	Level 2 – Facility Type / Location	Level 3 – Process Location	Level 4 – Asset Category	Level 5 (Asset Type)	Unique ID	Nameplate Present?	Install Year	Refurbishment Year	Manufacturer	Model	Serial Number	Size / Capacity	Unit of Measure	Operating Conditions	Condition Score (1 to 5 Scale)	CoF Score (1 to 5 Scale)	CoF Score Comments	Age	ESL	RUL	Replacement Cost (2020)	Project Cost (includes Markup)	Risk Score (1 to 25 Scale)
256	Valve Butterfly Filter 1 Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000713	Yes	1986	NA	Jenkins		M030814	24	in	1700 RPM, 575 Volts, 1 HP	2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 12,000	$ 17,400	8
257	Valve Plug Floc Tank 2 Drain Valve	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000739	No	1986	NA	DEZURIK			6	in		2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 1,200	$ 1,740	8
258	Valve Plug Floc Tank 1 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000740	No	1986	NA	DEZURIK			6	in		2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 1,200	$ 1,740	8
259	Valve Butterfly Filter 2 Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000719	Yes	1986	NA	Limitorque		J039332	24	in	NOCONP	3	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 12,000	$ 17,400	12
260	Valve Butterfly Filter 2 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000720	Yes	1986	NA	Jenkins		290356	24	in		4	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 12,000	$ 17,400	16
261	Actuator Valve Butterfly Filter 2 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000720	Yes	1986	NA	Limitorque			24	in		2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	25	-9	$ 6,000	$ 8,700	8
262	Valve Butterfly Filter 2 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000721	Yes	1986	NA	Jenkins			4	in	200 PSIG	3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,125	$ 1,631	6
263	Valve Piston Filter 2 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000722	No	1986	NA	-	-	-	4	in		2	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 4,700	$ 6,815	4
264	Valve Butterfly Filter 2 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000723	Yes	1986	NA	Jenkins		223ZEL	4	in	200 PSIG	2	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,125	$ 1,631	4
265	Valve Butterfly Filter 2 Backwash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000724	Yes	1986	NA	Jenkins			20	in		2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 10,000	$ 14,500	8
266	Actuator Valve Butterfly Filter 2 Backwash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000724	Yes	1986	NA	Limitorque			20	in	1700 RPM, 575 Volts, .33 HP	2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	25	-9	$ 6,000	$ 8,700	8
267	Valve Butterfly Filter 3 Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000725	Yes	1986	NA	Jenkins		J039332	24	in		2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 12,000	$ 17,400	8
268	Actuator Valve Butterfly Filter 3 Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000725	Yes	1986	NA	Limitorque		J039325	24	in	NOCONP	2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	25	-9	$ 6,000	$ 8,700	8
269	Valve Butterfly Filter 3 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000726	Yes	1986	NA	Jenkins			24	in		2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 12,000	$ 17,400	8
270	Actuator Valve Butterfly Filter 3 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000726	Yes	1986	NA	Limitorque						2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 5,000	$ 7,250	8
271	Valve Butterfly Filter 3 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000727	No	2008	NA	-	-	-	4	in		3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	12	35	23	$ 1,125	$ 1,631	6
272	Valve Butterfly Filter 3 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000729	Yes	1986	NA	Jenkins		2232EL	4	in	200 PSIG	3	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,125	$ 1,631	6
273	Valve Piston Filter 3 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000728	No	1986	NA	-	-	-	4	in		2	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 4,700	$ 6,815	4
274	Valve Butterfly Filter 3 Backwash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000730	Yes	1986	NA	Jenkins			20	in		2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 10,000	$ 14,500	8
275	Actuator Valve Butterfly Filter 3 Backwash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000730	Yes	1986	NA	Limitorque					1700 RPM, 575 Volts	2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	25	-9	$ 6,000	$ 8,700	8
276	Valve Butterfly Filter 4 Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000731	Yes	1986	NA	Jenkins			24	in		2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 12,000	$ 17,400	8
277	Actuator Valve Butterfly Filter 4 Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000731	Yes	1986	NA	Limitorque		J039324	24	in	NOCONP	2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	25	-9	$ 6,000	$ 8,700	8
278	Valve Butterfly Filter 4 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000732	Yes	1986	NA	Jenkins			24	in		2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 12,000	$ 17,400	8
279	Actuator Valve Butterfly Filter 4 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000732	Yes	1986	NA	Limitorque					NV	2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	25	-9	$ 6,000	$ 8,700	8

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280	Valve Butterfly Filter 4 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000733	Yes	1986	NA	Jenkins			4	in	200 PSIG	2	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,125	$ 1,631	4
281	Valve Butterfly Filter 4 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000735	Yes	1986	NA	Jenkins			4	in		4	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 1,125	$ 1,631	8
282	Valve Piston Filter 4 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000734	No	1986	NA	-	-	-	4	in		2	2	• Losing surface wash will affect filter performance on the long-term but won't affect production	34	35	1	$ 4,700	$ 6,815	4
283	Valve Butterfly Filter 4 Backwash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000736	Yes	1986	NA	Jenkins			20	in		2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	35	1	$ 10,000	$ 14,500	8
284	Actuator Valve Butterfly Filter 4 Backwash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000736	Yes	1986	NA	Limitorque					1700 RPM, 575 Volts	2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	25	-9	$ 6,000	$ 8,700	8
285	Valve Plug Floc Tank 4 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000737	No	1986	NA	DEZURIK			6	in		2	1	• Floc Tank drain is needed only for tank cleaning so not a critical asset	34	35	1	$ 1,200	$ 1,740	2
286	Valve Plug Floc Tank 3 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000738	No	1986	NA	DEZURIK			6	in		2	1	• Floc Tank drain is needed only for tank cleaning so not a critical asset	34	35	1	$ 1,200	$ 1,740	2
287	Mixer #1 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Mechanical	Mixer	300000193	Yes	1986	NA	Lightnin	XLEVM-1-5	480154			NA	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	40	6	$ 36,300	$ 52,635	8
288	Motor #1 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Electrical	Motor	300000194	Yes	1986	NA	Eurodrive	DF22DT90 L	12.43425.4/1			1.5 HP, 300 - 1500 RPM, 575V,60 HZ	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	20	-14	$ 800	$ 1,160	8
289	Sluice Gate # N-1 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Mechanical	Gate	Missing	No	1986	NA	-	-	-	24x24	in		2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	20	-14	$ 13,700	$ 19,865	8
290	Mixer #2 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Mechanical	Mixer	Missing	Yes	1986	NA	Lightnin	XLEVM-1-5	480156			NA	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	40	6	$ 36,300	$ 52,635	8
291	Motor #2 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Electrical	Motor	Missing	Yes	1986	NA	SEW-Eurodrive	DF22DT90 L	12.43425.4/1			1.5 HP, 300 - 1500 RPM, 575V,60 HZ	3	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	20	-14	$ 800	$ 1,160	12
292	Sluice Gate # S-2 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Mechanical	Gate	Missing	No	1986	NA	-	-	-	24x24	in		2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	20	-14	$ 13,700	$ 19,865	8
293	Mixer #3 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Mechanical	Mixer	Missing	Yes	1986	NA	Lightnin	XLEVM-1-5	480155			NA	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	40	6	$ 36,300	$ 52,635	8
294	Motor #3 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Electrical	Motor	Missing	Yes	1986	NA	SEW-Eurodrive	DF22DT90 L6	12.43425.4/3			1.5 HP, 300 - 1500 RPM,330 - 575V,60 HZ	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	20	-14	$ 800	$ 1,160	8
295	Sluice Gate # N-3 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Mechanical	Gate	Missing	No	1986	NA	-	-	-	24x24	in		2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	20	-14	$ 13,700	$ 19,865	8
296	Sluice Gate # N-4 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Mechanical	Gate	Missing	No	1986	NA	-	-	-	24x24	in		2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	20	-14	$ 13,700	$ 19,865	8
297	Mixer #4 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Mechanical	Mixer	Missing	Yes	1986	NA	Lightnin	XLEVM-1-5	480153			NA	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	40	6	$ 36,300	$ 52,635	8
298	Motor #4 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Electrical	Motor	Missing	Yes	1986	NA	SEW-Eurodrive	DF22DT90 L6	12.43425.4/2			1.5 HP, 300 - 1500 RPM,330 - 575V,60 HZ	2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	20	-14	$ 800	$ 1,160	8
299	Sluice Gate # S-1 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Mechanical	Gate	Missing	No	1986	NA	-	-	-	24x24	in		2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	20	-14	$ 13,700	$ 19,865	8

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300	Sluice Gate # N-2 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Mechanical	Gate	Missing	No	1986	NA	-	-	-	24x24	in		2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	20	-14	$ 13,700	$ 19,865	8
301	Sluice Gate # S-3 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Mechanical	Gate	Missing	No	1986	NA	-	-	-	24x24	in		2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	20	-14	$ 13,700	$ 19,865	8
302	Sluice Gate # S-4 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Mechanical	Gate	Missing	No	1986	NA	-	-	-	24x24	in		2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	20	-14	$ 13,700	$ 19,865	8
303	Mixer Chamber #4	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Structural	Tanks / Basins	Missing	No	1986	NA	-	-	-				2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	60	26	$ 53,920	$ 78,185	8
304	Mixer Chamber #3	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Structural	Tanks / Basins	Missing	No	1986	NA	-	-	-				2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	60	26	$ 53,920	$ 78,185	8
305	Mixer Chamber #2	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Structural	Tanks / Basins	Missing	No	1986	NA	-	-	-				2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	60	26	$ 53,920	$ 78,185	8
306	Mixer Chamber #1	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Structural	Tanks / Basins	Missing	No	1986	NA	-	-	-				2	4	• The two stage floc tank capacity is 40 MLD according to the water permit and the plant firm capacity is 40 MLD • Losing any of the 4 floc tanks will cause the flocculation redundancy to 0% but the tanks can be run as a single stage flocculation which will affect plant performance	34	60	26	$ 53,920	$ 78,185	8
307	Filter Chamber #1	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Structural	Tanks / Basins	Missing	No	1986	NA	-	-	-				2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	60	26	$ 65,886	$ 95,534	8
308	Filter Chamber #2	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Structural	Tanks / Basins	Missing	No	1986	NA	-	-	-				2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	60	26	$ 65,886	$ 95,534	8
309	Filter Chamber #3	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Structural	Tanks / Basins	Missing	No	1986	NA	-	-	-				2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	60	26	$ 65,886	$ 95,534	8
310	Filter Chamber #4	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chambers	Process Structural	Tanks / Basins	Missing	No	1986	NA	-	-	-				2	4	• Each filter has a capacity of 10.6 MLD according to the drinking water permit so all of the filters are needed for meeting the licence • The redundancy is 0% with all 4 filters	34	60	26	$ 65,886	$ 95,534	8
311	Valve Backwash #2 Suction	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000180	Yes	1986	NA	Jenkins	Jenkins		24	in		2	5	• Losing backwash will affect production but one pump should be sufficient to backwash any of the filters (100% redundancy) Score increased from 4 to 5. This could be reduced as there is 100% redundancy. According to design documents, 2 backwash pumps need to operate under some temperature conditions to achieve rated plant capacity. For day to day operations at present demand, 1 pump is sufficient, but won't meet capacity rating at all conditions.	34	35	1	$ 8,000	$ 11,600	10
312	Pump Backwash #2	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000179	Yes	1986	NA	Warren Pumps Houdaille		82104-2	16-DLB-20		7530 GPM, 710 RPM	2	5	• Losing backwash will affect production but one pump should be sufficient to backwash any of the filters (100% redundancy) Score increased from 4 to 5. This could be reduced as there is 100% redundancy. According to design documents, 2 backwash pumps need to operate under some temperature conditions to achieve rated plant capacity. For day to day operations at present demand, 1 pump is sufficient, but won't meet capacity rating at all conditions.	34	20	-14	$ 61,000	$ 88,450	10
313	Valve Backwash Pump #2 Check	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000177	Yes	1986	NA	Jenkins			16	in		2	5	• Losing backwash will affect production but one pump should be sufficient to backwash any of the filters (100% redundancy) Score increased from 4 to 5. This could be reduced as there is 100% redundancy. According to design documents, 2 backwash pumps need to operate under some temperature conditions to achieve rated plant capacity. For day to day operations at present demand, 1 pump is sufficient, but won't meet capacity rating at all conditions.	34	35	1	$ 20,000	$ 29,000	10

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314	Valve Backwash #2 Discharge	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000178	Yes	1986	NA	Jenkins			16	in		2	5	• Losing backwash will affect production but one pump should be sufficient to backwash any of the filters (100% redundancy) Score increased from 4 to 5. This could be reduced as there is 100% redundancy. According to design documents, 2 backwash pumps need to operate under some temperature conditions to achieve rated plant capacity. For day to day operations at present demand, 1 pump is sufficient, but won't meet capacity rating at all conditions.	34	35	1	$ 4,000	$ 5,800	10
315	Motor Backwash Pump #2 Discharge Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000176	Yes	1986	NA	Limitorque		JM036122			1700 RPM, .33 HP, 575 Volts	2	5	• Losing backwash will affect production but one pump should be sufficient to backwash any of the filters (100% redundancy) Score increased from 4 to 5. This could be reduced as there is 100% redundancy. According to design documents, 2 backwash pumps need to operate under some temperature conditions to achieve rated plant capacity. For day to day operations at present demand, 1 pump is sufficient, but won't meet capacity rating at all conditions.	34	20	-14	$ 11,000	$ 15,950	10
316	Motor Backwash Pump #2	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000174	Yes	1986	NA	Canadian General Electric	148379	GX1170			100 HO, 719 RPM, 575 Volts, phase 3, 60 Hz	2	5	• Losing backwash will affect production but one pump should be sufficient to backwash any of the filters (100% redundancy) Score increased from 4 to 5. This could be reduced as there is 100% redundancy. According to design documents, 2 backwash pumps need to operate under some temperature conditions to achieve rated plant capacity. For day to day operations at present demand, 1 pump is sufficient, but won't meet capacity rating at all conditions.	34	20	-14	$ 11,000	$ 15,950	10
317	Valve Backwash #1 Suction	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000181	Yes	1986	NA	Jenkins			24	in		2	5	• Losing backwash will affect production but one pump should be sufficient to backwash any of the filters (100% redundancy) Score increased from 4 to 5. This could be reduced as there is 100% redundancy. According to design documents, 2 backwash pumps need to operate under some temperature conditions to achieve rated plant capacity. For day to day operations at present demand, 1 pump is sufficient, but won't meet capacity rating at all conditions.	34	35	1	$ 8,000	$ 11,600	10
318	Pump Backwash #1	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000173	Yes	1986	NA	Warren Pumps Houdaille		82104-1			7530 GPM, 710 RPM, Imp Dia 173/4	2	5	• Losing backwash will affect production but one pump should be sufficient to backwash any of the filters (100% redundancy) Score increased from 4 to 5. This could be reduced as there is 100% redundancy. According to design documents, 2 backwash pumps need to operate under some temperature conditions to achieve rated plant capacity. For day to day operations at present demand, 1 pump is sufficient, but won't meet capacity rating at all conditions.	34	20	-14	$ 61,000	$ 88,450	10
319	Valve Check - Backwash Pump #2	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000171	Yes	1986	NA	Jenkins			16	in		2	5	• Losing backwash will affect production but one pump should be sufficient to backwash any of the filters (100% redundancy) Score increased from 4 to 5. This could be reduced as there is 100% redundancy. According to design documents, 2 backwash pumps need to operate under some temperature conditions to achieve rated plant capacity. For day to day operations at present demand, 1 pump is sufficient, but won't meet capacity rating at all conditions.	34	35	1	$ 20,000	$ 29,000	10
320	Valve Backwash Pump #1 Discharge	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000170	Yes	1986	NA	Jenkins			16	in		2	5	• Losing backwash will affect production but one pump should be sufficient to backwash any of the filters (100% redundancy) Score increased from 4 to 5. This could be reduced as there is 100% redundancy. According to design documents, 2 backwash pumps need to operate under some temperature conditions to achieve rated plant capacity. For day to day operations at present demand, 1 pump is sufficient, but won't meet capacity rating at all conditions.	34	35	1	$ 4,000	$ 5,800	10
321	Motor Backwash Pump #1 Discharge Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000169	Yes	1986	NA	Limitorque		JM036121			1700 RPM, .33 HP, 575 Volts	2	5	• Losing backwash will affect production but one pump should be sufficient to backwash any of the filters (100% redundancy) Score increased from 4 to 5. This could be reduced as there is 100% redundancy. According to design documents, 2 backwash pumps need to operate under some temperature conditions to achieve rated plant capacity. For day to day operations at present demand, 1 pump is sufficient, but won't meet capacity rating at all conditions.	34	20	-14	$ 11,000	$ 15,950	10

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322	Motor Backwash Pump #1	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000172	Yes	1986	NA	Canadian General Electric	148379	GX1170			100 HP, 710 RPM, 575 Volts, phase 3, 60 Hz	2	5	• Losing backwash will affect production but one pump should be sufficient to backwash any of the filters (100% redundancy) Score increased from 4 to 5. This could be reduced as there is 100% redundancy. According to design documents, 2 backwash pumps need to operate under some temperature conditions to achieve rated plant capacity. For day to day operations at present demand, 1 pump is sufficient, but won't meet capacity rating at all conditions.	34	20	-14	$ 15,000	$ 21,750	10
323	Surge Tank #2	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pressure Vessel	300000158	Yes	1986	NA	DTE Industries Limited					NA	2	2	• Two surge tanks for the high lift PS so a redundancy of 100% Is present	34	20	-14	$ 55,000	$ 79,750	4
324	Surge Tank #1	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pressure Vessel	300000149	Yes	1986	NA	DTE Industries Limited					NA	2	2	• Two surge tanks for the high lift PS so a redundancy of 100% Is present	34	20	-14	$ 55,000	$ 79,750	4
325	Valve Surge Tank #2 Isolation	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000157	Yes	1986	NA	Jenkins			16	in		2	2	• Two surge tanks for the high lift PS so a redundancy of 100% Is present	34	35	1	$ 4,300	$ 6,235	4
326	Valve Surge Tank #1 Isolation	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000150	Yes	1986	NA	Jenkins			16	in		2	2	• Two surge tanks for the high lift PS so a redundancy of 100% Is present	34	35	1	$ 4,300	$ 6,235	4
327	Motor Surge Tank #1 Compressor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000153	Yes	1986	NA	Baldor	M3311T-5				7 1/2 HP, 575 Volts, 1725 RPM, 60 HZ, Phase 3	2	2	• Two surge tanks for the high lift PS so a redundancy of 100% Is present	34	20	-14	$ 3,500	$ 5,075	4
328	Motor Surge Tank #2 Compressor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000154	Yes	1986	NA	Baldor	M3311T-5				7 1/2 HP, 575 Volts, 1725 RPM, 60 HZ, Phase 3	2	2	• Two surge tanks for the high lift PS so a redundancy of 100% Is present	34	20	-14	$ 3,500	$ 5,075	4
329	Disconnect Surge Tank #1 Compressor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Disconnect	300000151	Yes	1986	NA	Nova Line					NA	2	2	• Two surge tanks for the high lift PS so a redundancy of 100% Is present	34	25	-9	$ 1,000	$ 1,450	4
330	Disconnect Surge Tank #2 Compressor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Disconnect	300000152	Yes	1986	NA	Nova Line					NA	2	2	• Two surge tanks for the high lift PS so a redundancy of 100% Is present	34	25	-9	$ 1,000	$ 1,450	4
331	Suction Header Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000524	Not Accessible	1986	NA	-	-	-				3	1	• The valve is needed to isolate the future pump but can be replaced by a blind flange temporarily	34	20	-14	$ 40,500	$ 58,725	3
332	Suction Header Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000522	Not Accessible	1986	NA	-	-	-				3	3	• The plant has a firm capacity and each HLP is 30 MLD • The capacity is 50%	34	20	-14	$ 40,500	$ 58,725	9
333	Suction Header Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000523	Not Accessible	1986	NA	-	-	-				3	3	• The plant has a firm capacity and each HLP is 30 MLD • The capacity is 50%	34	20	-14	$ 40,500	$ 58,725	9
334	Suction Header Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000525	Not Accessible	1986	NA	-	-	-				3	3	• The plant has a firm capacity and each HLP is 30 MLD • The capacity is 50%	34	20	-14	$ 40,500	$ 58,725	9
335	Valve check, sludge pump 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000672	No	1986	NA	Hilllens BBK	2016	3574B	4	in		2	2	• The sludge pumps will be needed during BW tank operation but the tank can still be used	34	35	1	$ 3,500	$ 5,075	4
336	Valve check, sludge pump 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000676	No	1986	NA	Hillens BBK	2016	3574B	4	in		2	2	• The sludge pumps will be needed during BW tank operation but the tank can still be used	34	35	1	$ 3,500	$ 5,075	4
337	Pump, sludge pump 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Pump	Missing	Yes	1986	NA	Moyno	AM14451-3 ZL	2F036G1 CDQ3 AAA				3	2	• The sludge pumps will be needed during BW tank operation but the tank can still be used	34	20	-14	$ 4,000	$ 5,800	6
338	Pump Motor, sludge pump 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Motor	Missing	Yes	1986	NA	Brook Crompton Parkinson Ltd	DP	2315011-57	10	HP	575V/60HZ/3, 12 or 9 Amp	3	2	• The sludge pumps will be needed during BW tank operation but the tank can still be used	34	20	-14	Cost Included in Pump	Cost Included in Pump	6
339	Pump, sludge pump 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Pump	Missing	Yes	1986	NA	Moyno	AM194130 3-2 FG	2F036G1 CDQ3 AAA				5	2	• The sludge pumps will be needed during BW tank operation but the tank can still be used	34	20	-14	$ 4,000	$ 5,800	10
340	Pump Motor, sludge pump 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Motor	Missing	Yes	1986	NA	Brook Crompton Parkinson Ltd	DP	2315011-57	10	HP	575V/60HZ/3, 12 or 9 Amp	3	2	• The sludge pumps will be needed during BW tank operation but the tank can still be used	34	20	-14	Cost Included in Pump	Cost Included in Pump	6
341	Valve plug, sludge to emergency tank truck	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000679	No	1986	NA	Dezurik	EJ4	907059	4	in		2	2	• The sludge pumps will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,000	$ 1,450	4
342	Valve plug, BW tank 2 bottom level	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000661	No	1986	NA	Dezurik			8	in		2	1	• The valve is needed to determine the decant level of the tank	34	35	1	$ 1,500	$ 2,175	2
343	Valve plug, BW tank 2 middle level	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000660	No	1986	NA	Dezurik			8	in		2	1	• The valve is needed to determine the decant level of the tank	34	35	1	$ 1,500	$ 2,175	2
344	Valve plug, BW tank 2 top level	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000661	No	1986	NA	Dezurik			8	in		2	1	• The valve is needed to determine the decant level of the tank	34	35	1	$ 1,500	$ 2,175	2
345	Valve plug, BW tank 1 bottom level	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000658	No	1986	NA	Dezurik			8	in		2	1	• The valve is needed to determine the decant level of the tank	34	35	1	$ 1,500	$ 2,175	2
346	Valve plug, BW tank 1 middle level	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000657	No	1986	NA	Dezurik			8	in		2	1	• The valve is needed to determine the decant level of the tank	34	35	1	$ 1,500	$ 2,175	2
347	Valve plug, BW tank 1 top level discharge	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000656	No	1986	NA	Dezurik			8	in		2	1	• The valve is needed to determine the decant level of the tank	34	35	1	$ 1,500	$ 2,175	2
348	Disconnect, sludge pump 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Disconnect	Missing	Yes	1986	NA	D	81641	T1	30	Amp	600V/3Ph/60hz	2	2	• The sludge pumps will be needed during BW tank operation but the tank can still be used	34	25	-9	$ 1,000	$ 1,450	4

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349	Disconnect, sludge pump 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Disconnect	Missing	Yes	1986	NA	D	81641	T1	30	Amp	600V/3Ph/60hz	2	2	• The sludge pumps will be needed during BW tank operation but the tank can still be used	34	25	-9	$ 1,000	$ 1,450	4
350	Valve plug, supernatant pump 2 suction	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000665	No	1986	NA	Dezurik			8	in		2	2	• The supernatant pumps will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,500	$ 2,175	4
351	Valve plug, supernatant pump 2 discharge	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000667	No	1986	NA	Dezurik			8	in		2	2	• The supernatant pumps will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,500	$ 2,175	4
352	Valve check, supernatant pump 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000666	No	1986	NA	Hilllens BBK	TJPE 2016		6	in		3	2	• The supernatant pumps will be needed during BW tank operation but the tank can still be used	34	35	1	$ 6,500	$ 9,425	6
353	Pump, supernatant no. 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Pump	Missing	Yes	1986	2011	Fairbanks Morse		2229529				2	2	• The supernatant pumps will be needed during BW tank operation but the tank can still be used	9	20	11	$ 16,400	$ 23,780	4
354	Pump Motor, supernatant no. 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Motor	Missing	Yes	1986	2011	Brook Corporation Parkinson	A132258	231531001	7.5	HP	575V/60HZ/3	2	2	• The supernatant pumps will be needed during BW tank operation but the tank can still be used	9	20	11	$ 3,500	$ 5,075	4
355	Pump, supernatant no. 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Pump	Missing	Yes	1986	2011	Fairbanks Morse		1794070				2	2	• The supernatant pumps will be needed during BW tank operation but the tank can still be used	9	20	11	$ 16,400	$ 23,780	4
356	Pump Motor, supernatant no. 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Motor	Missing	Yes	1986	2011	Brook Corporation Parkinson	A132258	231531001	7.5	HP	575V/60HZ/3	2	2	• The supernatant pumps will be needed during BW tank operation but the tank can still be used	9	20	11	$ 3,500	$ 5,075	4
357	Valve plug, supernatant pump 1 discharge	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000664	No	1986	NA	Dezurik			8	in		2	2	• The supernatant pumps will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,500	$ 2,175	4
358	Valve plug, supernatant pump 1 suction	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000662	No	1986	NA	Dezurik			8	in		2	2	• The supernatant pumps will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,500	$ 2,175	4
359	Valve check, supernatant pump 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000663	No	1986	NA	Hilllens BBK	TJPE 2016		6	in		3	2	• The supernatant pumps will be needed during BW tank operation but the tank can still be used	34	35	1	$ 6,500	$ 9,425	6
360	Valve plug, BW tanks to supernatant line	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000668	No	1986	NA	Dezurik			8	in		2	2	• The supernatant pumps will be needed during BW tank operation but the tank can still be used	34	35	1	$ 1,500	$ 2,175	4
361	Disconnect, supernatant pump #1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Disconnect	Missing	Yes	1986	NA	Westinghouse Canada Inc.	NU361		30	HP	600V/3Ph/60hz	2	2	• The supernatant pumps will be needed during BW tank operation but the tank can still be used	34	25	-9	$ 1,000	$ 1,450	4
362	Disconnect, supernatant pump #2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Disconnect	Missing	Yes	1986	NA	Westinghouse Canada Inc.	NU361		30	HP	600V/3Ph/60hz	2	2	• The supernatant pumps will be needed during BW tank operation but the tank can still be used	34	25	-9	$ 1,000	$ 1,450	4
363	Valve plug, decant to pond valve	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000669	No	1986	NA	Dezurik			8	in		2	2	• The supernatant valve can be directed in two direction so the redundancy is 100%	34	35	1	$ 1,500	$ 2,175	4
364	Valve plug, decant to overflow	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000670	No	1986	NA	Dezurik			8	in		2	2	• The supernatant valve can be directed in two direction so the redundancy is 100%	34	35	1	$ 1,500	$ 2,175	4
365	Valve, BFP	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000810	No	2018	NA	Watts	Not available	Not available	2	in		1	4	This a BFP for the belnded phosphate so assigning a score of 4 based on PUC's requirement.	2	35	33	$ 620	$ 899	4
366	Valve, BFP Alum	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000783	No	2018	NA	Watts	Not available	Not available	2	in		1	4	• This BFP is needed to run the alum system necessary for coagulation	2	35	33	$ 620	$ 899	4
367	Valve, BFP Chlorine	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Cl2 Gas	Process Mechanical	Valve	300000784	No	2018	NA	Watts	Not available	Not available	2	in		1	4	• This BFP is needed to run the chlorine system necessary for disinfection	2	35	33	$ 620	$ 899	4
368	Valve, butterfly backwash flow control	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000186	No	1986	NA	Jenkins			20	in		3	4	• This valve is needed to control the backwash flow necessary to run the filters	34	35	1	$ 10,000	$ 14,500	12
369	Valve Actuator Motor, butterfly backwash flow control	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000185	Yes	2011	NA	Rotork	IQS 12	D141910101	0.34	kW	120V/single phase	2	4	• This valve is needed to control the backwash flow necessary to run the filters	9	35	26	$ 5,000	$ 7,250	8
370	Valve Actuator Gearbox, butterfly backwash flow control	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000185	Yes	2011	NA	Rotork	IW5/IR1	T1912501-001				2	4	• This valve is needed to control the backwash flow necessary to run the filters	9	35	26	$ 5,000	$ 7,250	8
371	Valve, butterfly backwash flow control, filter tank	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000747	No	1986	NA	Jenkins			24	in		3	4	• This valve is needed to control the backwash flow necessary to run the filters	34	35	1	$ 8,000	$ 11,600	12
372	Valve Actuator Motor, butterfly backwash flow control filter tanks	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000747	Yes	1986	NA	Limitorque	SMC 03	M041779	0.4	HP	120V/single phase	3	4	• This valve is needed to control the backwash flow necessary to run the filters	34	35	1	$ 5,000	$ 7,250	12
373	Valve Actuator Gearbox, butterfly level control filter tanks	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000747	Yes	1986	NA	Torque matic		290358	250			3	4	• The valve is needed to control the level inside the filters	34	35	1	$ 5,000	$ 7,250	12
374	Valve HL #3 Suction	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000129	Yes	1986	NA	Jenkins			20	in		2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	34	35	1	$ 6,500	$ 9,425	6
375	Pump HL #3	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000128	Yes	1986	NA	Patterson Pump Division		84BT-8093-A12	4360	m3	RPM - 1160, Head - 170	2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	34	20	-14	$ 40,000	$ 58,000	6
376	Motor HL #3	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000127	Yes	1986	NA	Westinghouse Canada Inc.	HSA	3-17S7410			300 HP, 575 Volts, 3 Phase, 60 HZ, 1186 RPM	2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	34	20	-14	$ 25,500	$ 36,975	6
377	Valve HL#3 Check	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000126	No	2013	NA	Jenkins			12	in		2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	7	35	28	$ 12,500	$ 18,125	6
378	Valve HL#3 Discharge	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000125	No	2013	NA	Dezurik		20141126D	16	in		2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	7	35	28	$ 4,000	$ 5,800	6

Item ID	Asset Description	Level 1 – Functional Group	Level 2 – Facility Type / Location	Level 3 – Process Location	Level 4 – Asset Category	Level 5 (Asset Type)	Unique ID	Nameplate Present?	Install Year	Refurbishment Year	Manufacturer	Model	Serial Number	Size / Capacity	Unit of Measure	Operating Conditions	Condition Score (1 to 5 Scale)	CoF Score (1 to 5 Scale)	CoF Score Comments	Age	ESL	RUL	Replacement Cost (2020)	Project Cost (includes Markup)	Risk Score (1 to 25 Scale)
379	Motor HL#3 Discharge Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000124	Yes	2013	NA	Limitorque	152469-001	L110179			Rated Torque - 1500ft/lb and 2034 Nm, 515-600 V, 60 HZ, 0.26 Hp,	2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	7	20	13	$ 5,000	$ 7,250	6
380	Valve HL #2 Suction	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000123	Yes	1986	NA	Jenkins			20	in		2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	34	35	1	$ 6,500	$ 9,425	6
381	Pump HL #2	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000122	Yes	1986	NA	Patterson Pump Division		84BT-8092-A12	4360	m3	RPM - 1160, Head - 170	2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	34	20	-14	$ 40,000	$ 58,000	6
382	Motor HL #2	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000121	Yes	1986	NA	Westinghouse Canada Inc.	HSA	2-17S7410			300 HP, 575 Volts, 3 Phase, 60 HZ, 1186 RPM	2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	34	20	-14	$ 25,500	$ 36,975	6
383	Valve HL#2 Check	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000786	No	2012	NA	Schlumburg			12	in		2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	8	35	27	$ 12,500	$ 18,125	6
384	Valve HL#2 Discharge	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000785	No	2012	NA	Dezurik		20130320D	16	in		2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	8	35	27	$ 4,000	$ 5,800	6
385	Motor HL#2 Discharge Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000801	Yes	2012	NA	Limitorque		L1055083			Rated Torque - 1500ft/lb and 2034 Nm, 515-600 V, 60 HZ, 0.26 Hp,	2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	8	20	12	$ 5,000	$ 7,250	6
386	Motor Future High Lift Discharge Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000133	No	1986	NA	Limitorque						2	1	• The valve is needed to isolate the future pump but can be replaced by a blind flange temporarily	34	20	-14	$ 5,000	$ 7,250	2
387	Valve Future High Lift Discharge	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000134	Yes	1986	NA	Jenkins			20	in		2	1	• The valve is needed to isolate the future pump but can be replaced by a blind flange temporarily	34	35	1	$ 6,500	$ 9,425	2
388	Valve Pipe Leading to Surface Wash Pumps	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000130	Yes	1986	NA	Jenkins			6	in		2	5	• Losing surface wash will affect filter performance on the long-term but won't affect production valve is used to supply water for the chemical systems	34	35	1	$ 1,200	$ 1,740	10
389	Valve HL #1 Suction	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000117	Yes	1986	NA	Jenkins			20	in		2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	34	35	1	$ 6,500	$ 9,425	6
390	Pump HL #1	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000116	Yes	2011	NA	Patterson Pump Division		84BT-8094-A12	4360	m3	RPM - 1160, Head - 170	2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	9	20	11	$ 40,000	$ 58,000	6
391	Motor HL #1	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000115	Yes	1986	NA	Westinghouse Canada Inc.	HSA	1-17S7410			300 HP, 575 Volts, 3 Phase, 60 HZ, 1186 RPM	2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	34	20	-14	$ 25,500	$ 36,975	6
392	Valve HL#1 Check	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000114	No	2011	NA	Schlumburg			12	in		2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	9	35	26	$ 12,500	$ 18,125	6
393	Valve HL#1 Discharge	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000113	No	2011	NA	Dezurik		20120424D	16	in		2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	9	35	26	$ 4,000	$ 5,800	6
394	Motor HL#1 Discharge Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000112	Yes	2011	NA	Limitorque		L971486			Rated Torque - 1500ft/lb and 2034 Nm, 515-600 V, 60 HZ, 0.26 Hp,	2	3	• The plant has a firm capacity 40 MLD and each HLP is 30 MLD • The redundancy is 50%	9	20	11	$ 5,000	$ 7,250	6
395	Generator Backup Pump	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000142	Yes	1986	NA	Cotta Transmission Co.	SR12E	164348			NA	2	2	• Emergency power supply for HLP1 but the system already have a backup generator for all pumps so this would be a minor failure We believe that the score for the diesel motor for HLP1 shouldn't be increased as this would assume a power failure and a backup generator failure which would be a double Failure.	34	20	-14	$120,000	$ 174,000	4
396	Pump Engine Diesel (WWT)	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Engine	300000140	Yes	1986	NA	John Deere		RG6619AD522 16			NA	2	2	• Emergency power supply for HLP1 but the system already have a backup generator for all pumps so this would be a minor failure We believe that the score for the diesel motor for HLP1 shouldn't be increased as this would assume a power failure and a backup generator failure which would be a double Failure.	34	20	-14	$ 30,000	$ 43,500	4
397	Valve Backflow Preventor Chlorine	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000782	Yes	1986	NA	Watts		7732	2	in	175 PSI	2	4	• This BFP is needed to run the chlorine system necessary for disinfection	34	35	1	$ 1,600	$ 2,320	8
398	Valve Top Valve After Discharge Surge	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000108	No	1986	NA	Jenkins			12	in		2	5	• Isolation valve on the single discharge line from the HLPs with 0% redundancy	34	35	1	$ 4,000	$ 5,800	10
399	Valve Lower Valve Before Discharge Surge	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000109	No	1986	NA	Jenkins			12	in		2	5	• Isolation valve on the single discharge line from the HLPs with 0% redundancy	34	35	1	$ 4,000	$ 5,800	10
400	Motor Treated Water Isolating	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000110	No	1986	NA	Limitorque					.94 HP, 60 HZ, 575 V, 60 HZ, ph 3	2	4	• This valve is needed to isolate the HLPs for repairs	34	20	-14	$ 5,000	$ 7,250	8
401	Valve Treated Water Isolating	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000111	No	1986	NA	Willamette Valve Inc.		84013	24	in		2	4	• This valve is needed to isolate the HLPs for repairs	34	35	1	$ 15,500	$ 22,475	8

Item ID	Asset Description	Level 1 – Functional Group	Level 2 – Facility Type / Location	Level 3 – Process Location	Level 4 – Asset Category	Level 5 (Asset Type)	Unique ID	Nameplate Present?	Install Year	Refurbishment Year	Manufacturer	Model	Serial Number	Size / Capacity	Unit of Measure	Operating Conditions	Condition Score (1 to 5 Scale)	CoF Score (1 to 5 Scale)	CoF Score Comments	Age	ESL	RUL	Replacement Cost (2020)	Project Cost (includes Markup)	Risk Score (1 to 25 Scale)
402	Generator Backup Power	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Generator	300000139	Yes	1986	NA	Leroy Somer		A2510L7			160 kwh, 200 kva, 1800 RPM, 600 - 347v, 3 pH, 60 HZ,	2	5	• Emergency power is not necessary for production Score increased from 1 to 5; Llpump #4 should be more critical since it runs on generator; disaster recover	34	35	1	$120,000	$ 174,000	10
403	Backflow Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000809	Yes	1986	NA	Watts		7168	1	in		2	5	Based on PUC's requirement, the asset score to match the generator backup power since LLP#4 runs on this generator which is critical. This valve supplies cooling water to the engine. Should be serviceable in order to operate the backup diesel. This valve supplies cooling water to the engine. Should be serviceable in order to operate the backup diesel.	34	35	1	$ 1,600	$ 2,320	10
404	Tank Emergency Power Fuel #1	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Structural	Tanks / Basins	300000164	No	1986	NA	-	-	-				2	5	• Emergency power is not necessary for production Score increased from 1 to 5; Llpump #4 should be more critical since it runs on generator; disaster recovery	34	60	26	$ 3,400	$ 4,930	10
405	Tank Emergency Power Fuel #2	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Structural	Tanks / Basins	300000165	No	1986	NA	-	-	-				2	5	• Emergency power is not necessary for production Score increased from 1 to 5; Llpump #4 should be more critical since it runs on generator; disaster recovery	34	60	26	$ 3,400	$ 4,930	10
406	Tank Emergency Power Fuel #3	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Structural	Tanks / Basins	300000166	No	1986	NA	-	-	-				2	5	• Emergency power is not necessary for production Score increased from 1 to 5; Llpump #4 should be more critical since it runs on generator; disaster recovery	34	60	26	$ 3,400	$ 4,930	10
407	Valve butterfly pressure reducing	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000749	Yes	1986	NA	Jenkins			24	in		2	2	• The valve is needed for the pressure relief system isolation	34	35	1	$ 8,000	$ 11,600	4
408	Actuator Valve butterfly pressure reducing	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000749	Yes	1986	NA	Master gear co	MFF36S3	A6145				2	2	• The valve is needed for the pressure relief system isolation	34	35	1	$ 5,000	$ 7,250	4
409	Valve butterfly, level bypass	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000757	No	1986	NA	Jenkins			24	in		3	3	• This valve is needed to protect the raw water supply	34	35	1	$ 8,000	$ 11,600	9
410	Treated Water Surge Relief Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	Missing	No	1986	NA	Jenkins			12	in		2	4	• The valve is needed for the protecting the discharge header of the HLPS	34	35	1	$ 15,500	$ 22,475	8

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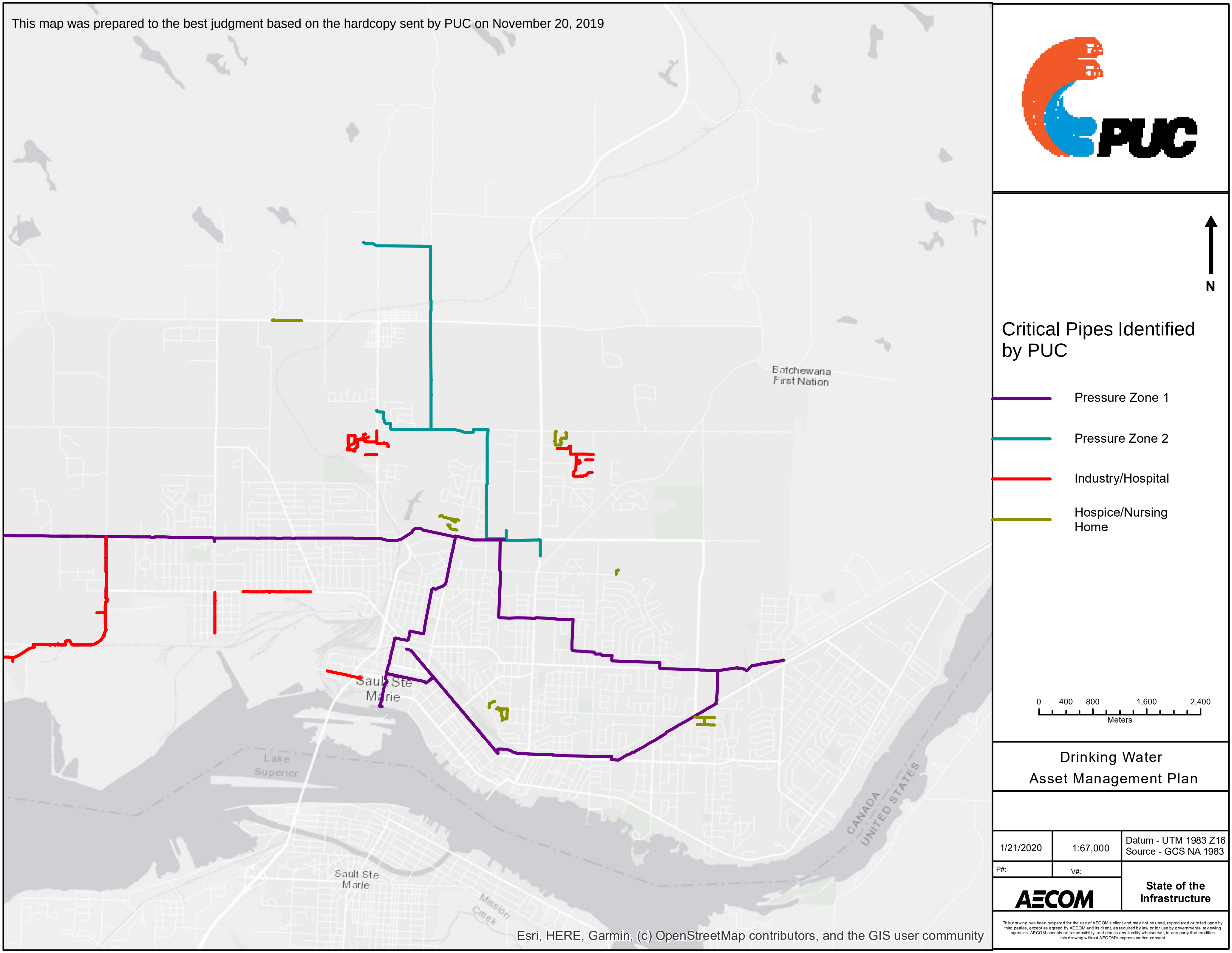
Appendix TM3B

Appendix B

Critical Customers Pipelines Identified by PUC



Drinking Water
Asset Management Plan

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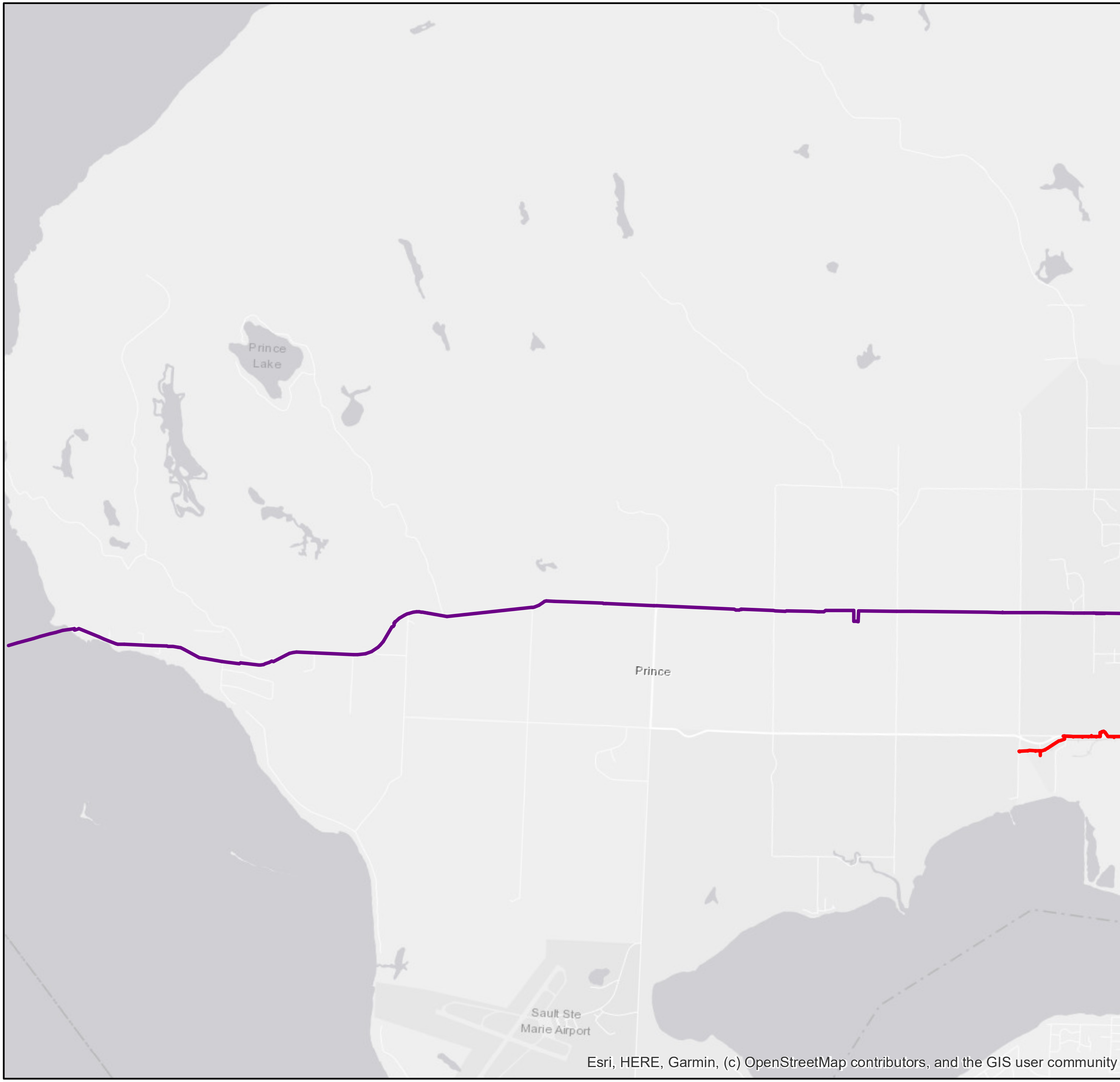


N

Critical Pipes Identified by PUC

- Pressure Zone 1
- Pressure Zone 2
- Industry/Hospital
- Hospice/Nursing Home

0 400 800 1,600 2,400
Meters

Drinking Water
Asset Management Plan

1/21/2020	1:67,000	Datum - UTM 1983 Z16 Source - GCS NA 1983
P#:	V#:	**State of the Infrastructure**

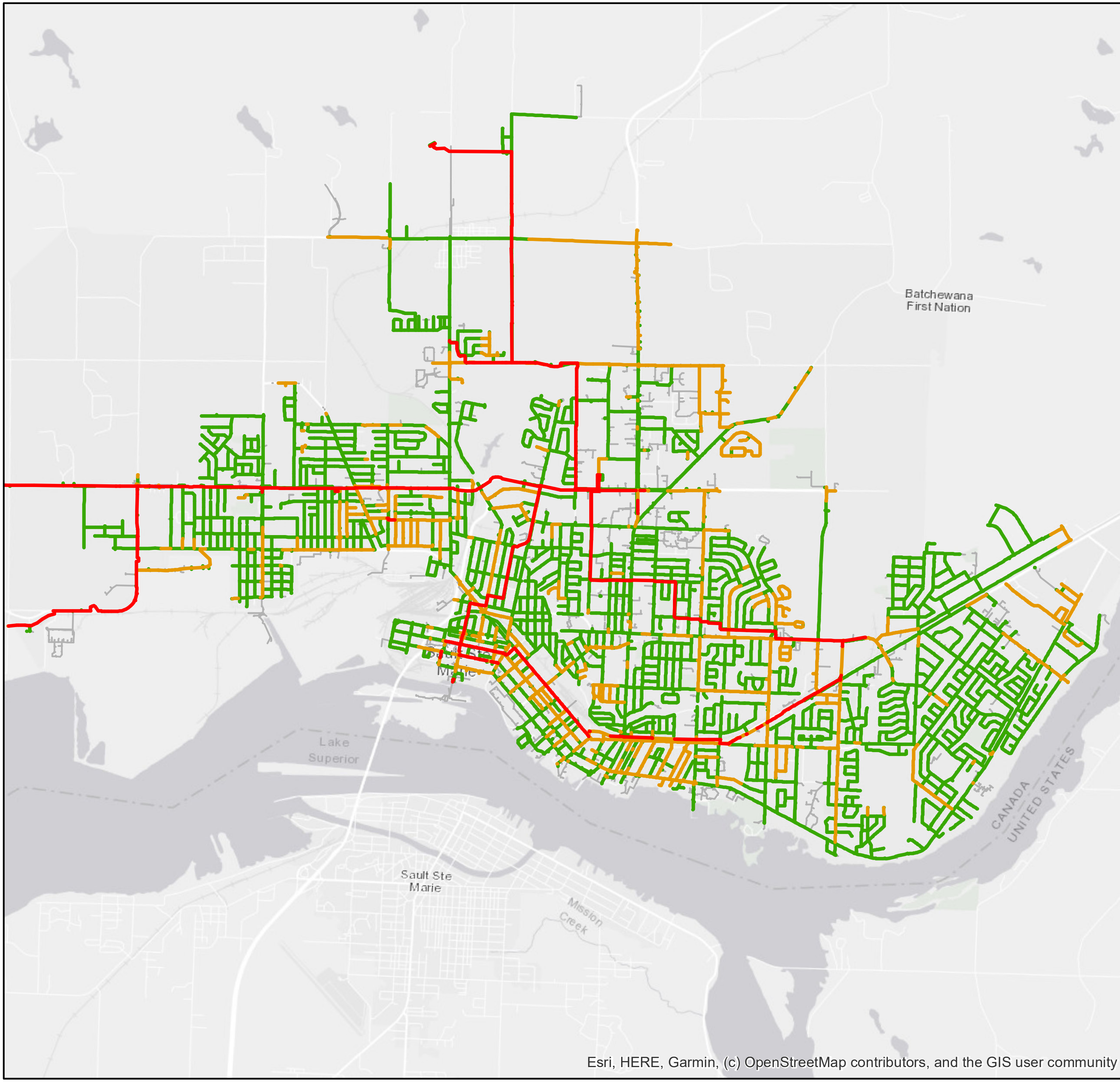
AECOM

Map location: C:\PUC Calibration Session\Figures - Map Template.mxd
Date Saved: 1/21/2020 10:05:20 AM

Appendix TM3B

Appendix C

Linear Water Assets Consequence of Failure Map



Drinking Water
Asset Management Plan

6/8/2020	1:65,998	Datum - UTM 1983 Z16 Source - GCS NA 1983
P#:	V#:	CoF Map

AECOM

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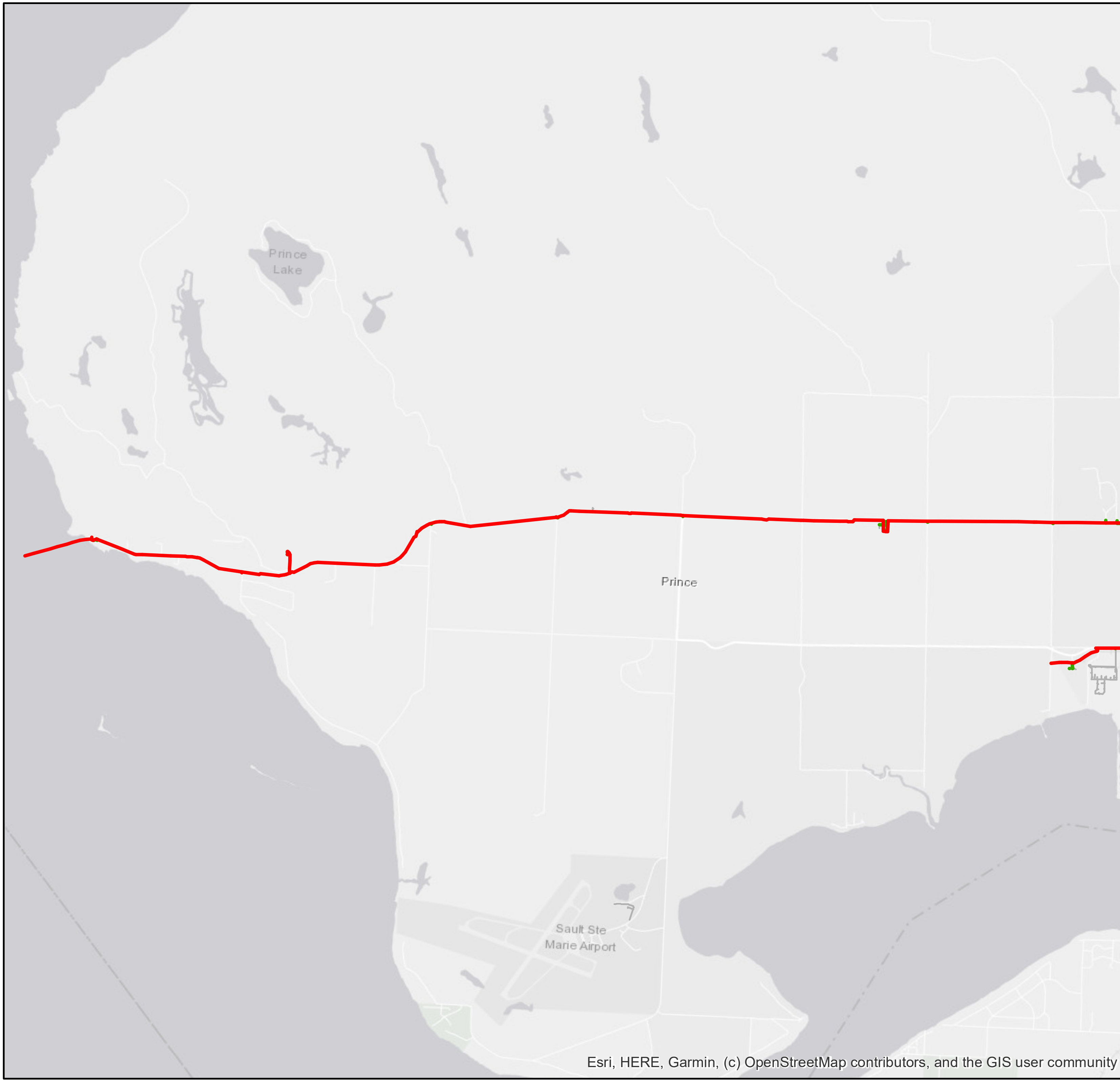

N

CoF

- Major
- Moderate
- Minor
- Others

0 400 800 1,600 2,400
Meters

Drinking Water
Asset Management Plan

6/8/2020	1:65,998	Datum - UTM 1983 Z16 Source - GCS NA 1983
P#:	V#:	**CoF Map**

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Map location: C:\PUC Calibration Session\Figures - Map Template.mxd
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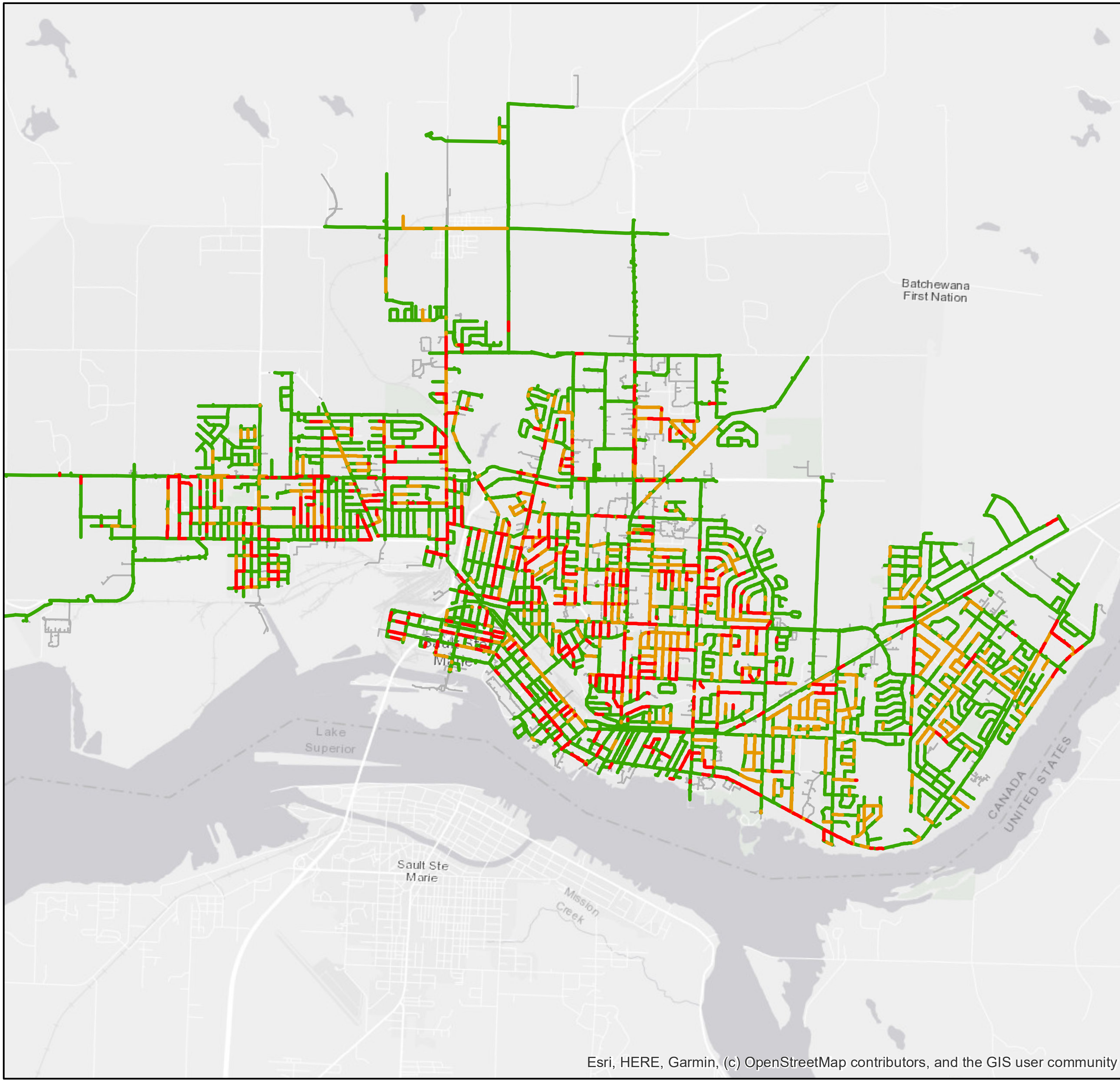
Appendix TM3B

Appendix D

Linear Assets Risk Map



Drinking Water
Asset Management Plan

6/8/2020	1:65,998	Datum - UTM 1983 Z16 Source - GCS NA 1983
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AECOM

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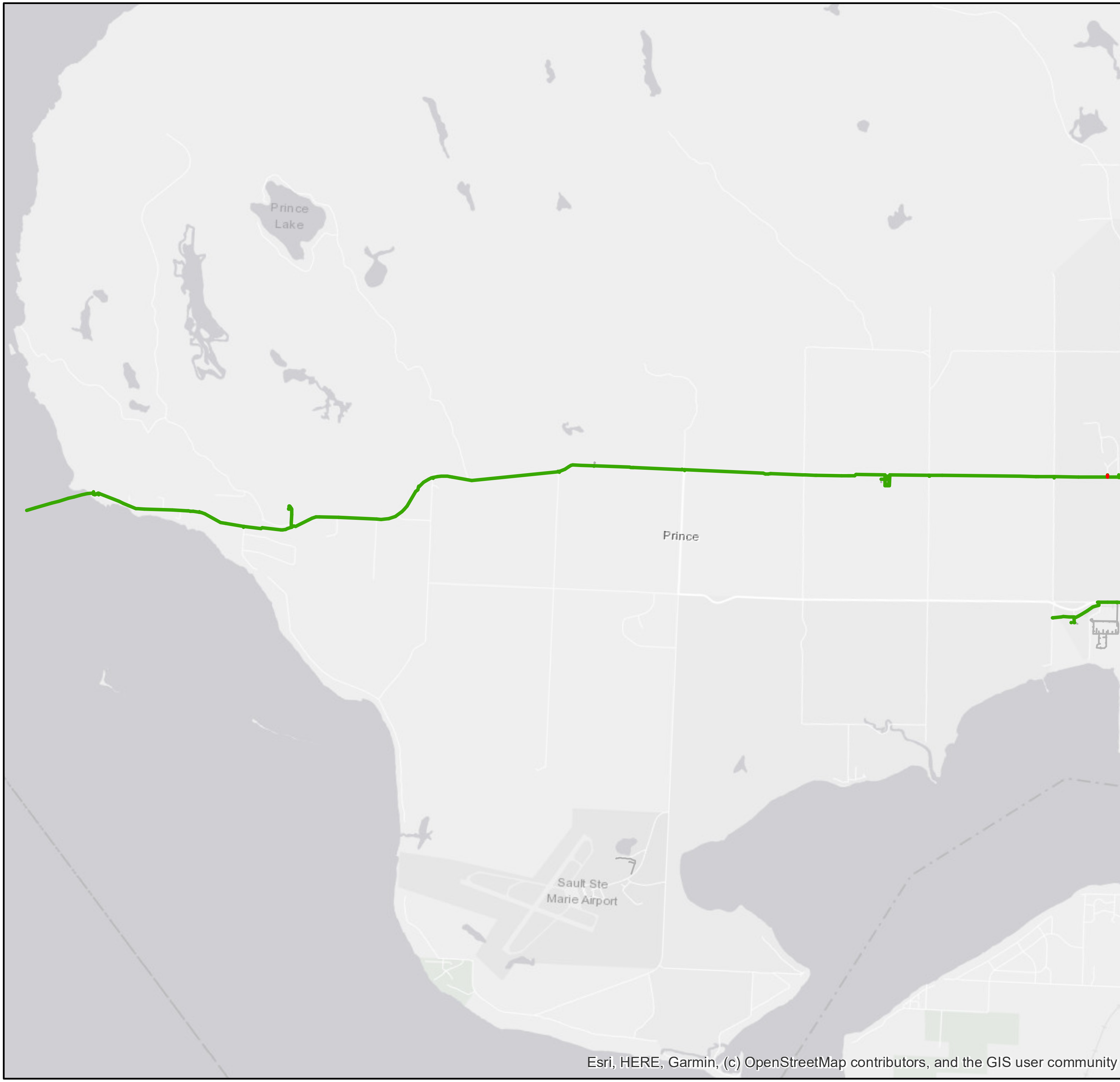

N

Risk

- Major
- Minor
- Others

0 400 800 1,600 2,400
Meters

Drinking Water
Asset Management Plan

6/8/2020	1:65,998	Datum - UTM 1983 Z16 Source - GCS NA 1983
P#:	V#:	**Risk Map**

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Map location: C:\PUC Calibration Session\Figures - Map Template.mxd
Date Saved: 6/8/2020 3:07:58 PM

Contact

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Project Manager
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AECOM Imagine it. Delivered.

Appendix C

PUC Services Inc. Water Treatment Facility Mechanical and Electrical Infrastructure Study

AECOM Imagine it. Delivered.

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To: Mitchell Paradis, P.Eng.
Protection and Control Engineer
PUC Services Inc.
500 Second Line E,
Sault Ste Marie, Ontario P6B 4K1

cc: Rick Talvitie, P.Eng., Project Manager
Wael Ali, P.Eng., Electrical Group Manager

Date: December 2, 2020

Project #: Project #60636362

From: Neil Garnham, P. Eng
Daniel Celic, P. Eng

Memorandum

Subject: **PUC Services Inc. Water Treatment Facility Mechanical and Electrical Infrastructure Study**

1. Introduction

The objective of this memorandum is to document the high-level visual condition assessment of the infrastructure, equipment, and treatment processes at PUC Water Facilities, including the Water Treatment Plant, Gros Cap Intake Station, Shannon Well, Steelton Well, Lorna Well, PZ2 Booster Station and Goulais Well. The assessments will be used to determine the required intervention strategy, such as maintenance, rehabilitation, or replacement and suggestions for design efficiencies. The condition grading scale identified in **Table 1** can be used to determine the priority of the upgrades and determine the magnitude of the risk.

Table 1: Asset Condition Grading Scale

Grade	Condition	Description
0	Non-Existent	Asset abandoned or no longer exists.
1	Very Good	Sound physical condition designed to meet current standards. Asset likely to perform adequately with routine maintenance for 10 years or more. No work required.
2	Good	Acceptable physical condition; minimal short-term failure risk but potential for deterioration in long term (10 years plus). Only minor work required (if any).
3	Fair	Significant deterioration evident; failure unlikely within the next 2 years but further deterioration likely and major replacement likely within the next 5-10 years. Minor components or isolated sections of the asset need replacement or repair now, but asset still functions safely at an adequate level of service. Work required but asset is still serviceable.
4	Poor	Components function but require a high level of maintenance to remain operational. Likely to cause a marked deterioration in performance in the short-term. Likely need to replace most or all of the asset within 2 years. No immediate risk to health or safety but work required within 2 years to ensure asset remains safe. Substantial work required in the short-term, asset barely serviceable.
5	Very Poor	Failed or failure imminent. Immediate need to replace most or all of the asset. Health and safety hazards exist that present a possible risk to public safety or asset cannot be serviced or operated without risk to personnel. Major work or replacement required urgently.

A walk-through facility condition assessment was conducted by AECOM with operations staff at the facilities on September 1st and 2nd, 2020.

Standard templates were used to record visual observations and photographs were taken to document the observations. AECOM staff from each of the two major design disciplines (mechanical and electrical) reviewed the general condition of major equipment to identify existing and future replacement and maintenance needs. The facility assessments completed by the project team were limited to a one-time visual review of the assets at the time of the walk-through. The project team did not dismantle or operate equipment during the inspections. Restricted access areas such as roofs, tanks, and confined spaces were not inspected during the walk-through.

Assets inspected during the walk-through generally consisted of the following:

- Mechanical equipment (HVAC, fans, piping, plumbing, etc.)
- Electrical (MCCs, pump motors, etc.)

It should be noted that the lifespan of any equipment or structure can be dependent on maintenance approaches and activities. Equipment that is maintained regularly and repaired promptly as necessary may last longer than its typical service lifespan. As such, the service lifespans indicated below were used as a general guide to identify when replacement could be anticipated.

- Process– 20 to 30 years
- Mechanical (fans and pumps) – 15 to 25 years
- Electrical – 15 to 25 years

The following sections present the results of the walk-through condition assessment, categorized by facility and discipline. Each sub-section presents notes recorded by each discipline lead as well as short- and long-term recommendations.

1.1 Definitions

The following is a table of acronyms used throughout the report:

Table 1. Acronym Definitions

Acronym	Definition
AC	Air Conditioning
AHU	Air Handling Unit
ANSI	American National Standards Institute
BAS	Building Automation System
CSA	Canadian Standards Association
ESA	Electrical Safety Authority
FLOC	Flocculation
HFCF	Hydrochlorofluorocarbons
HP	Horsepower
HVAC	Heating Ventilation and Air Conditioning
LSI	Long Short Instantaneous current protection
LSIG	Long Short Instantaneous and Ground Fault current protection
MCC	Motor Control Centre

Acronym	Definition
PFC	Power Factor Correction
PPE	Personal Protective Equipment
SCADA	Station Control and Data Acquisition
SPD	Surge Protection Device
VFD	Variable Frequency Drive
WTP	Water Treatment Plant

2. Water Treatment Plant

2.1 Mechanical

2.1.1 General

The existing building was constructed in 1984, with a few updates in 1987. All the existing mechanical systems appear to be from the original construction.

No maintenance records were provided for review, and therefore the following comments are based on the existing conditions which were visible and observed during the on-site review.

It is understood that natural gas is available in this area.

2.1.2 Ground Floor Offices - HVAC

The existing Carrier 50EC-016-101TA packaged unit (AHU-2), Photo M2, has exceeded its estimated service life expectancy and utilizes R22 (HCFC) refrigerant. HCFC refrigerants have been phased out and are no longer commercially available, including HCFC equipment. It is our opinion that this unit should be replaced.

This unit serves the ground floor office areas (highlighted in yellow) in Figure M1.

This office unit also includes a ducted electric heater attached to the main supply duct, installed in 1987, and appears to be in good condition, Photo M3.

No Building Automation System (BAS) was observed.

Ductwork and associated accessories appear to be functional, but they are lacking efficiency in performance. There are apparent patches and leakage throughout the system, Photo M4.

There are no humidifier or dehumidifier module in the AHU-2, and the condenser air exhaust is very close to the fresh air intake.

The Control Room utilizes portable humidifiers, as the air within the room becomes too dry in winter, as reported by facility staff. The ducted type humidifier was removed some time ago and it is no longer operational, Photo M5.

The Control Room should be maintained within satisfactory temperature and humidity setpoints for both staff comfort and the proper operation of computerized process control systems.

The entire office area includes a raised floor for data cabling. There are four (4) in-floor electric heaters and two (2) thermostats serving the Control Room, which appear to be functional, but are outdated, Photo M6.

The Staff Room/Lunchroom includes three (3) in-floor electric heaters with two (2) thermostats.

Thermostats throughout the facility are mechanical type thermostats, and do not include energy-saving/occupancy-controlled setpoints, Photo M7.

Space heating is provided utilizing a combination of floor-mounted electric cabinet heaters and semi-recessed electric force flow heaters, located throughout the office area. They appear to be in moderate visible condition. Photo M8.

Washrooms, locker rooms, laboratory cabinet hood, and storage rooms are provided with localized exhaust systems. Exhaust air make-up is provided by infiltration from adjacent spaces.

Air is returned to AHU-2 via a transfer grille located above the entry door to the AHU-2 room. Return air from the office areas is transferred through this grille, and the corridor occupied space, Photo M9.

The process side of the facility includes only a basement level ventilation system. Other than basement floor ventilation, the process side areas do not include a means of mechanical ventilation. Ventilation is being provided by natural infiltration. Only roof mounted fan exhausts were observed.

No separation exists between the process area and the office areas, resulting in the mixing of return air from both areas. A pressure differential between these two occupancies does not exist. This lack of separation increases energy consumption. Return air is discharged to the outdoors without any energy recovery.

Score: Poor – 4

Short Term Recommendations:

- All thermostats are recommended to be converted to energy-saving type.
- Connect all electric heaters to a thermostat if not already connected.
- All maintenance works need to be done periodically and recorded.
- Clean and repair all existing cabinet heaters and force flow heaters.
- Change all rusty or faulty electric heaters.
- Clean and replace all filters.
- Check all fire dampers, replace them if necessary.

Long Term Recommendations:

- AHU-2, along with its components, need to be replaced.
- Include humidifier and dehumidifier modules in the AHU-2.
- All ductwork, duct insulation, etc. are recommended to be replaced.
- Add centralized Building Automation System (BAS).
- Convert AHU-2 to a natural gas-fired unit with more energy-efficient options.
- Change the heating system to natural gas-fired. Existing electric heating coil and electric heaters may remain for redundancy.
- Extend AHU-2 return air closer to the office area or use ducted return.
- Use demand based ventilation based on indoor air quality.
- Infiltration needs to be reduced, and all the leaks from the building or the ducts need to be stopped.
- Control humidity in the control room throughout the year.

2.1.3 Process Side Rooms - HVAC

The process side includes one (1) air handling unit, AHU-1, Photo M10.

The unit's make and model are Carrier 39ED19 with the following modules:

. MXB1 (Mixing Box / Top and rear inlets with standard dampers)

. HVF1 (High-Velocity Filter Module)

. VCS1 (Vertical Cooling Coil)

. FCS2 (Forward Curved Fan)

The cooling coil's make, and model are Carrier Model 280W162.

The cooling coil is equipped with one (1) 65 mmØ (2½"Ø) Honeywell 2-way valve with 50 mmØ (2"Ø) piping and a by-pass, Photo M11. The cooling coil water is supplied from water reservoirs, and it ranges between 5°C - 20°C depending on the time of the year, as reported by facility staff. The water temperature is observed as S:18.5/R:19 °C at the time of our visit. We believe that the cooling capacity is heavily affected by the water supply temperature throughout the year. We were unable to determine whether the return water goes back to the drinking water system, and the supply water includes any backflow prevention.

The cooling coil pipes are insulated with 25mm (1") aluminum foiled fiberglass insulation. No insulation jacketing was observed. Even though some rust is present, the pipes were observed to be functional.

This unit is connected to a commercial type dehumidifier unit, Photo M12.

The dehumidifier's make and model are CargoCaire Honeycombe Model HC-4500-EA Special. It is equipped with a ducted type inline reactivation electric heater and a ducted filter. The reactivation air is discharged to the outdoors through the roof.

We were unable to see the inside of both units, and there are no maintenance records available. Based on their appearances and the facility staff's report, these units are functional.

No Building Automation System (BAS) was observed.

This unit serves the Pressure Reducing Station with a single supply air diffuser and a single exhaust air grille (these are located on one side of the room). It also serves the High Lift Station, as highlighted by the yellow areas in Photo M13. There were a few grilles and diffusers observed in the pipe gallery area as well.

The thermostat and the humidistat are located in the High Lift Station. These are also old and outdated.

Both supply and return ducts are uninsulated round ducts except in the crawl space section. The only insulated duct is the supply duct in the crawl space, which is aluminum foiled fiberglass insulation without any insulation jacketing. The ducts were in moderate condition, with the exception of some patches and leakage observed, Photo M14.

The air is returned from the Pressure Reducing Room and the High Lift Station. There is also one open-ended air inlet on the air handling unit, Photo M15.

The unit performance, energy tracking, and maintenance records were not available.

There are two (2) diesel engine powered pumps (one (1) existing and one (1) for the future) in the High Lift Station. When these diesel pumps start running, the atmospheric fresh air enters the room through two (2) wall motorized dampers/louvers, Photo M16, to accommodate diesel combustion and cooling air. This air also introduces unconditioned air into the High Lift Station when the diesel engines run.

Space heating is provided by floor-mounted electric cabinet heaters. While they appear to be functional, most are corroded, old, and not reliable, Photo M17.

We observed that some of the cabinet heaters are running even though heating is not required. It is likely these heaters are not connected to a thermostat, or built-in thermostats are set incorrectly.

Score: Fair – 3

Short Term Recommendations:

- All thermostats are recommended to be converted to energy-saving type.
- Connect all electric heaters to a thermostat if not already connected.
- All maintenance work needs to be done periodically and recorded.
- Clean and repair all existing cabinet heaters and force flow heaters.
- Replace corroded or dysfunctional electric cabinet heaters.
- Clean and repair all existing unit heaters.
- Repair or replace any leaking duct and worn-out insulation.
- Repair all missing or broken pipe insulation.
- Replace filters and clean strainers.
- Check all back-draft dampers, replace them if they are not operational.
- Check all fire dampers, replace them if necessary.

Long Term Recommendations:

- AHU-1, along with its components, needs to be removed and replaced with more efficient heat recovery options.
- Convert the reactivation heater module to a natural gas-fired type.
- Ductwork, duct insulation, etc. are recommended to be replaced.
- Add centralized Building Automation System-BAS.
- Change the heating system to natural gas fired. Existing electric heating coil and electric heaters may be maintained for redundancy.
- A more stable, consistent and closed-loop cooling system design is recommended. Separate cooling system from the drinking water system and avoid contamination or any backflow.
- Separate diesel pump combustion and cooling air from the ambient air.
- Use variable ventilation air based on indoor air quality.
- Infiltration and duct leakage need to be reduced to acceptable values.
- Humidity levels need to be monitored and controlled throughout the year.

2.1.4 Other Rooms and Spaces - HVAC

There are areas outside of air handler AHU-1 and AHU-2 coverage. These areas do not include a means of mechanical ventilation. Ventilation is being provided by infiltration. Roof exhaust fan’s were observed. These fans have exceeded their estimated life expectancy and need to be replaced.

Mechanically unventilated areas in the basement floor are shown in yellow in Photo M18.

Both crawl spaces in the basement level have no ventilation or exhaust, Photo M19. A heavy chemical odour was present in the crawl space between gridline D-F/1-4.

Mechanically unventilated areas on the ground floor are highlighted in yellow as per Figure M20. The majority of these areas include dedicated exhaust systems, either directly exhausted through the roof, or ducted exhaust to the side walls or the roof. No heat recovery was observed. Heated ambient air during the heating season is exhausted directly to the atmosphere.

The chlorine room is located on the ground floor and has its own ventilation system designed and installed by the chlorine consultant. The Chlorine Vestibule and Sulphur Dioxide Vestibule are two small rooms that have direct ventilation air supply.

Both motor control center-MCC rooms have no air conditioning systems, other than wall transfer grilles for ventilation and floor mounted electric cabinet heaters for heating, Photo M21. We were informed by operations and maintenance staff that these rooms do not get hot in the summer or cold in the winter. No humidity control was observed.

The Workshop Room includes one (1) draw-thru filter at the ceiling for airborne dust/fumes, but we were unable to determine the filter rating. There is also one (1) dust/fume collecting duct and fan, but no dust collection system is observed, so the exhaust air is discharged to the atmosphere. These appear to have been added at a later stage, Photo M22.

There are no mechanical ventilation or dehumidification on the second floor, even though the Filtration Room has several filtration pools. Mechanically unventilated areas on the second floor are highlighted in yellow on diagram M23.

Both the ground floor and the second floor are generally equipped with ceiling hung electric unit heaters (mostly circular) except for some locations. Most of them have been affected by moisture and corrosion is prevalent, Photo M24.

The second floor includes wall mounted fans and motorized dampers, they appear to be functional, but look to have reached the end of their service lives, Photo M25.

Score: Fair – 3

Short Term Recommendations:

- All maintenance work needs to be done periodically and recorded.
- Connect all electric heaters to a thermostat if not already connected.
- Clean and repair all existing unit heaters.
- Change all corroded or faulty electric unit heaters.
- Add a dust collector in the workshop.
- Add portable dehumidifier(s) to the Filter Control Room.
- Check all fans, repair, or replace them as needed.
- Check all wall motorized dampers/louvers, repair or replace if needed
- Inspect all fire dampers, and replace them as necessary.

Long Term Recommendations:

- New ventilation unit(s) are recommended to be added for the areas that don't have any ventilation with efficient energy recovery options.
- All ductwork, duct insulation, etc. is recommended to be replaced and renewed.
- Add centralized Building Automation System-BAS.
- Change the heating system to natural gas-fired. Existing electric heating equipment may remain for redundancy.
- Use demand based ventilation air based on indoor air quality.
- Monitor indoor air pollutants.
- Infiltration and duct leakage need to be reduced to acceptable values.
- Monitor and control humidity levels throughout the year.

2.1.5 Domestic Hot Water Heating - Plumbing

The domestic hot water system includes three (3) electric water heaters and one (1) recirculation pump. One of the heaters is scheduled for replacement. At the time of our visit, the new unit was already on site awaiting installation, Photo M26.

Two (2) are Ruud EGL120C-27, while the third is Giant 1129C-3-27.

Ruud brand water heaters appear to be from the original installation and appear to have exceeded their estimated service life expectancy. The existing Giant heater unit was manufactured in 2013.

No maintenance records were provided for our review; therefore, we are not sure whether the anode rods have ever been replaced, and the pressure relief valves have been properly maintained.

The recirculation pump is an Armstrong S-25 MF/AB with the manufacturing date code of 0217, Photo M27. The pump appears to be relatively new and in good condition.

The domestic heating pipes are insulated with 25mm (1”) aluminum foiled fiberglass insulation. No insulation jacketing was observed. Even though some corrosion is present, the pipes were observed to be functional.

There are about five (5) emergency eyewash and showers observed in the facility;

- One (1) eyewash and one (1) emergency shower next to the process-water water heater
- One (1) eyewash only beside AHU-1
- One (1) eyewash and one (1) emergency shower in Chlorine Storage room
- One (1) eyewash and one (1) emergency shower in Aqua Ammonia room
- One (1) eyewash and one (1) emergency shower in Sulphur Dioxide room
- One (1) eyewash only in the Laboratory room

These eyewash stations and the emergency showers need tempered water.

We did not observe an expansion tank in the domestic hot water system.

Score: Very Poor – 5

Short Term Recommendations:

- Remove and replace all the existing water heaters.
- Replace all the pressure relief valves.
- All maintenance work needs to be done periodically and recorded
- Repair all missing or broken pipe insulation.
- Add a new expansion tank.

Long Term Recommendations:

- Connect all emergency showers to the tempered water system if not already connected.
- Add new natural gas-fired water heaters. The electric water heaters, if replaced recently, may remain for redundancy.
- Review and optimize the existing tank configuration and capacity.

2.2 Electrical

2.2.1 Incoming Service, MCC1 and High Lift Pumps (Photo No, E1-E10)

The plant has two utility feeds with separate transformers and a tie-bus system within the main distribution switchboard, MCC1. MCC1 is original with plant construction (1984) and is equipped with a ground fault relay for each utility connection, and drawings indicate an ANSI47 (phase sequence + balance) devices, which were not observed on site. MCC1 does not include a surge protection device (SPD). The MCC is comprised of fused switches which provide basic overcurrent protection only for branch circuits. An electrical study was completed for the entire plant in 2012, which replaced fuses in an effort to improve coordination and reduce incident energy levels. Incident energy levels remain greater than 40 CAL/cm^2, which poses danger to personnel when working on the live equipment as PPE is not available to protect against the current incident energy levels. Arc flash and warning labels are present on some of the incoming sections. An external power monitoring system was installed recently in 2020 and is tied back to plant SCADA for monitoring purposes only. Fused switches, contactors and motor starters in the switchboard have been failing in recent years and replacement parts are expensive with long lead times. This MCC feeds the entire station and house the starters and feeders for high lift pumps #1, #3 and #4.

2.2.1.1 High Lift Pump 1&4

The 250HP High lift Pump #1 motor is powered and controlled by an autotransformer starter with PFC capacitor bank in MCC1. It also has a backup diesel drive that was installed with original building construction. The diesel drive is operational and is tested monthly. High lift pump 1 protection includes basic overcurrent and thermal overload and does not include pump monitoring protection systems that are standard with modern installations of similar size motors, which monitor and protect the motor from issues such as overtemperatures, leaks, over/under voltage, phase reversal and current unbalance.

There was space allocated on the lower level for a second dual drive high lift pump (#4) that has not been installed to date.

2.2.1.2 High Lift Pump 2&3

High lift pumps 2 and 3 are 300HP electrically operated only (no dual drive as with high lift pump 1) with autotransformer starters complete with PFC capacitor banks in MCC1. The capacitor bank that serves high lift pump 3 failed and was replaced recently. The pump motors are original to plant construction (1984) and have been disassembled, cleaned, and had the windings replaced within the past 15 years with new bearings. High Lift pumps 2 and 3 protection systems include basic overcurrent and thermal overload and does not include pump monitoring protection systems that are standard with modern installations of similar size motors, which monitor and protect the motor from issues such as overtemperatures, leaks, over/under voltage, phase reversal and current unbalance.

Score: Poor – 4
See section 2.2.4 for recommendations.

2.2.2 MCC2 (Photo No, E11-E13)

The MCC2 main bus is fed via 2 feeders, 1 coming from each incoming service sides of MCC1, and a tie bus. The main bus does not have surge protection, device protection or local power monitoring. A kirk key interlock system was in the process of being installed during the time of assessment as a result of an ESA review. MCC2 feeds back wash, sludge and decant pumps along with power panels for general plant building loads (heating, lighting etc.) all with fused switches. The majority of MCC2 was installed with original plant construction (1984) with one new section added within the last 5 years that feeds the Soda Ash system. MCC2 has 2 across the line 100HP starters with basic overcurrent and overload protection for the backwash pumps, which run once a day for 40 minutes to complete a backwash cycle. The backwash pumps are currently not protected from issues such as overtemperatures, leaks, over/under voltage, phase reversal and current unbalance. There are 2 speed starters for the sludge pumps, with basic overcurrent and overload protection. It was noted by staff that the high-level speed was the only one used. 2 speed, 2 winding motors are difficult to maintain and replace as compared to single winding motors on VFDs.

Score: Poor – 4
See section 2.2.4 for recommendations.

2.2.3 MCC3, MCC ‘E’, and Low Lift Pumps (Photo No, E14-E18)

2.2.3.1 MCC3 & MCC ‘E’

MCC3 and MCC ‘E’ are installed next to each other on the main floor of the WTP next to the low lift pumps and are original to plant construction (1984). Neither MCC has surge protection on the main bus nor local power monitoring. The MCC3 main bus is fed from MCC1 and feeds Low lift pumps 1, 2 and 3 with associated valves and inline blenders. The MCC 'E' main bus is fed from MCC1 and an emergency generator via an automatic transfer switch. MCC 'E' provides power to Low Lift Pump 4, FLOC agitators, station emergency lighting and some building HVAC equipment.

2.2.3.2 Low Lift Pumps 1, 2, 3 and 4.

Low lift pumps 1 (30HP), 2 (60HP) and 3 (60HP) are fed from MCC3 via an across the line starter. Low lift pump 4 (60HP) is fed from MCC 'E' via an autotransformer soft starter. Capacitor bank power factor correction is installed for pumps 2, 3, and 4, but is not included for pump 1. All pumps have basic overcurrent and overload protection and are not protected from issues such as overtemperatures, leaks, over/under voltage, phase reversal and current unbalance.

Score: Poor – 4
See section 2.2.4 for recommendations.

2.2.4 Recommendations and Proposed Design Philosophy

Given the vintage of the equipment and size of the facility, overall replacement of major electrical distribution is recommended. The following conceptual phased approach may be used to address budget constraints:

2.2.4.1 Phase 1: Incoming Service Switchboard and Backup Power Provisions

- Replace MCC1 with a new switchboard of similar rated capacity, including:
  - Dual utility feeders and automated tie bus for 2n+1 redundancy distribution.
  - LSIG Electronic trip main circuit breakers.
  - Ground fault, surge and advanced power protection.
  - Incoming utility connection power monitoring with SCADA integration.
  - Front end active power factor correction.
  - Solid state soft starters or VFDs with power filters and advanced pump motor monitoring and protection and SCADA integration for the high lift pumps.
  - Transfer switch and provisions for a temporary/portable and future permanent automated standby generator connection.
  - LSI electronic trip circuit breakers for branch circuits.
- Replace High Lift Pump motors with inverter duty rated, high efficiency motors.
- Investigate the installation of new High Lift Pump #4 to assist with upgrade implementation and minimizing station downtime during installation.

2.2.4.2 Phase 2: Permanent Generator Installation

- Install new modular outdoor standby generator system and connect to new MCC1 with automatic transfer scheme, sized to accommodate entire station load.
- Remove existing diesel motors on high lift pumps.
- Remove existing emergency generator feeding MCC'E', if new permanent generator and transfer switches are emergency rated as per CSA 282.

2.2.4.3 Phase 3: MCC2, MCC3 + MCC'E' Replacements

- Replace MCC2 with a new MCC of similar rated capacity, including:
  - Electronic trip circuit breakers.
  - Local power monitoring with SCADA integration.

- Surge protection devices for main bus and distribution panels.
    - Solid state soft starters or VFDs with power filters and advanced pump motor monitoring and protection and SCADA integration for the backwash pumps.
- Replace Backwash Pump and sludge pump motors with inverter duty rated, high efficiency motors.
- Replace MCC3 and MCC 'E" with a new combined MCC with a similar combined capacity rating, including:
    - Electronic trip circuit breakers.
    - Local power monitoring with SCADA integration.
    - Surge protection devices for main bus and distribution panels.
    - Solid state soft starters or VFDs with power filters and advanced pump motor monitoring and protection and SCADA integration for the low lift pumps.
    - Emergency rated inverter and battery bank sized to serve life safety loads, such as emergency lighting. This is only warranted if installed station permanent generator is rated for standby and not CSA 282 emergency rated.
- Disconnect and remove existing emergency generator feeding MCC'E'.
- Replace Low lift Pump motors with inverter duty rated, high efficiency motors.
- Modify power distribution for building HVAC to integrate gas fired units, as applicable.

3. Gros Cap Intake Station

3.1 Mechanical

The existing building was constructed in 1983, all the existing mechanical systems appear to be of the original construction.

No maintenance records were provided for our review, and therefore the following comments are based on the visible existing conditions observed during our review.

We understand that natural gas is expected to be available at the site this year. The fuel-oil tank is going to be decommissioned and removed at the end of this year and replaced with a new outdoor tank.

There are two (2) electric unit heaters in the Generator Room, three (3) in the Main Control Panel Room, six (6) in the Pump Room, and three (3) in the Storage Room. The Entry Room has one (1) semi-recessed electric force flow heater, Photo M28.

The facility includes two (2) fan with dedicated cooling coils. Each cooling coil is controlled by a 2-way motorized control valve. Untreated water from Lake Superior is circulated through the coils. The water temperature ranges between 0^{o}C and 20^{o}C depending on the time of the year. The cooling capacity is significantly impacted by the water supply temperature.

The cooling coils are cast iron coils, and the fans are axial fans, Photo M29. One unit serves the Generator Room's combustion air and the engine cooling, while the other is for the Pump Room's heating loads.

The cooling coils are equipped with a 65 mm Ø (2-1/2" Ø) pipes and Honeywell 2-way valves. Even though these fan/coil units appear to be functional, they have exceeded their estimated life expectancy and need to be replaced with higher efficiency equipment.

All motorized wall damper/louvers appear to be functional, Photo M30. The Pump Room includes two (2) destratification fans, one of them is functional.

We did not observe dehumidification or ventilation systems. The facility staff did not highlight a humidity issue in this facility.

A Building Automation System (BAS) was not observed.

Except for the one (1) fire damper between the Fuel Tank Room and its corridor, there were no other fire dampers observed during our visit.

The Electrical MCC Room, the Generator Room, and the Pump Room are all connected through wall openings (in addition to the doors), and the cooling system is designed in a way that the air moves from one room to another, Figure M31. The arrows indicate the manner in which the air moves as part of the existing system in case of temperature increase in either the Pump Room or the Electrical Room.

The chlorine room is used as a storage room, as reported by facility staff.

Score: Poor – 4

Short Term Recommendations:

- All maintenance work needs to be done periodically and recorded.
- Replace all corroded or dysfunctional electric heaters.
- Check all fans, repair, or replace as necessary.
- Check all wall motorized dampers/louvers, repair, or replace as necessary.
- Check all fire dampers and replace as necessary.

Long Term Recommendations:

- Isolate the rooms and prevent unrestricted air movement between them. Create fire separation between fire zones.
- Remove the existing cooling system and add a new ventilation and cooling system.
- Add a dehumidification system to the Pump Room.
- Add centralized Building Automation System (BAS).
- Change the heating system to natural gas-fired. Existing electric heating coil and electric heaters may remain for redundancy.
- More stable, closed loop, temperature and flow contolled cooling system design is recommended.
- Separate the generator’s combustion and cooling air from the ambient air.
- Monitor and control humidity throughout the year.

3.2 Electrical

3.2.1 Incoming Service, Switchboard and Generator (Photo No, E19-E22, E26)

Gros Cap Pumping Station is fed from a 12.5kV 3 phase service from PUC electrical utility into station owned outdoor 15kV switch gear and a 12.5kV to 600V 1500kVA pad mounted transformer with Primary metering. Provisions were made for a second pad mounted transformer and power feed to provide redundancy but has not been installed to date. The 12.5kV switchgear and transformer are not utility owned which presents added challenges with maintenance and replacement of high voltage equipment for PUC water operations.

Recently, the original main delta-wye 1500kVA transformer has failed and was replaced with a temporary wye-wye 1000kVA unit as a temporary measure by PUC.

The exterior pad mount transformer is connected to an interior 2000A main distribution switchboard via bus ducts. Bus ducts are susceptible to short circuit faults compared to the use of insulated feeder cables. The main distribution switchboard main bus has circuit breakers for electrical protection. The switchboard main bus does not currently include protection from ground faults, surges, and other power quality issues such as over/under voltage, negative sequence, loss of phase, etc. that could shorten the life spans of, and cause damage to, station equipment. Head end power factor correction equipment nor power monitoring with SCADA integration are installed on site. Most sections of the switchboard are missing CSA arc flash labels. There is a lack of harmonic mitigation in the system with the absence of harmonic filters for the existing large motor starters and it has been conveyed by PUC staff that harmonic issues exist with the current temporary wye-wye utility transformer installation.

A 750kW, 600V, 3 phase, emergency diesel generator was installed as part of original station construction (1983) and has failed during fall 2020. A portable generator has been installed as a temporary measure by PUC. Provisions for a 2nd interior generator of similar ratings were included in the design and it has not been installed to date. A new transfer switch for the existing emergency generator has been installed within the last 5 years.

Score: Very Poor – 5
See section 3.2.4 for recommendations.

3.2.2 MCC1 (Photo No, E23-E24)

MCC1 is a 600A, 600V MCC that is original to building construction (1983). MCC1 is fed from a circuit breaker in the main switchboard via cabling and provides power to all station loads outside of the main raw water pumps, including valves, instrumentation, lighting and building HVAC. MCC1 main bus does not currently include surge protection.

Score: Poor – 4
See section 3.2.4 for recommendations.

3.2.3 MCC2 and Raw Water Pumps 1-4 (Photo No, E25, E27)

MCC2 is a 2500A, 600V MCC that is original to building construction (1983). MCC2 is fed from the main switchboard via busduct and provides power to Raw water pumps 1 (200HP), 2 (200HP), 3 (400HP) and 4 (400HP). Original solid-state reduced voltage starters for pumps 3 and 4 have failed and had retrofit soft starter replacements implemented in 2016 and 2020, respectively. Power factor correction is not implemented with these pumps.

Score: Poor – 4
See section 3.2.4 for recommendations.

3.2.4 Recommendations and Proposed Design Philosophy

Given the vintage of the equipment and size of the facility, overall replacement of major electrical distribution is recommended. The following conceptual phased approach may be used to address construction budget constraints:

3.2.4.1 Phase 1: Incoming Utility Service, Main Switchboard and Backup Power Provisions

- Install 2 new utility connections with utility owned 600V secondary transformers, each with integrated load-break switches.
- Remove existing main distribution switchboard and replace with a new switchboard of similar rated capacity, including:
  - Dual utility feeders and automated tie bus for 2n+1 redundancy distribution.
  - LSIG Electronic trip main circuit breakers.
  - Ground fault, surge and advanced power protection.
  - Incoming utility connection power monitoring with SCADA integration.
  - Front end active power factor correction.
  - Automatic transfer switch and provisions permanent automated standby generator connection.

  - LSI electronic trip circuit breakers for branch circuits.
- Replace bus ducts (incoming and feeder) with parallel multi conductor cables.
- Install new modular outdoor standby generator system and connect to new MCC1 with automatic transfer scheme, sized to accommodate entire station load.

3.2.4.2 Phase 2: MCC1 and MCC2 and Raw Water Pump replacements

- Replace MCC1 with a new MCC of similar rated capacity, including:
  - Electronic trip circuit breakers.
  - Local power monitoring with SCADA integration.
  - Surge protection devices for main bus and distribution panels.
- Replace MCC2 with a new MCC with a similar rated capacity, including:
  - Local power monitoring with SCADA integration.
  - Surge protection devices for main bus.
  - Solid state soft starters or VFDs with power filters and advanced pump motor monitoring and protection and SCADA integration for the raw water pumps.
- Replace raw water pump motors with inverter duty rated, high efficiency motors.
- Modify power distribution for building HVAC to integrate gas fired units, as applicable.

4. Shannon Well

4.1 Mechanical

The existing building was constructed in 1972, some of the existing mechanical systems appear to be of the original construction, Figure M32.

No maintenance records were provided for our review; therefore, the following comments are based on existing conditions observed during our review.

We understand that natural gas is available in this area.

This station does not include a means of mechanical ventilation. Ventilation is being provided by infiltration. Only roof fan exhausts were observed.

There is one (1) electric unit heater in the Blended Phosphate Room, one (1) in the Pump Room and one (1) in the Chlorine Room. They are functional, but we were unable to determine their manufacturing date. They appear to have been installed at a later stage, to replace the original heaters, Photo M33.

Thermostats are mechanical type thermostats and do not include energy-saving/occupancy-controlled setpoints.

The Corridor cabinet electric heater appears to be from the original construction and operational, but it has exceeded its estimated service life expectancy, Photo M34. This unit should be removed and replaced.

The Blended Phosphate Room includes one (1) roof exhaust fan with a gravity damper. They appear to be from the original construction and operational; but they have exceeded their estimated service life expectancy, Photo M35.

There's also a roof opening and a wall grille in the Blended Phosphate Room. It appears that the roof opening originally would have had a gravity relief damper, but is no longer present, or was never been installed. The wall grille has been capped, while the roof opening is continually open, Photo M36.

The Chlorine Room includes a roof exhaust fan and a wall mounted motorized damper/louver. Both appear to be functioning without issues. We were unable to see the fan but based on the appearance of the ductwork and the wall louver, they are from the original construction and have exceeded their estimated service life expectancy, Photo M37.

The Chlorine Room is supplied with a portable dehumidifier to reduce both humidity levels and water-chlorine interaction. The portable humidifiers generally do not last long; they are replaced every year or two, as reported by the facility staff, Photo M38.

The well pump room includes two (2) portable air conditioning (AC) units and one (1) portable dehumidifier, Photo M39. These units do not last long either, as they need to be replaced every year or two, as reported by the facility staff. The main heat sources are the vertical turbine motor, the variable frequency drive (VFD), and its harmonic filter. The heat gain from this equipment results in elevated temperatures in the cooling season, which results in the need for air conditioning. There is one (1) roof exhaust fan and one (1) large wall louver with a motorized damper. The roof fan is out of order, while the wall louver has been capped, Photo M40.

Score: Poor– 4

Short Term Recommendations:

- All maintenance work needs to be done periodically and recorded.
- Replace the corridor cabinet electric heater.
- Replace the Pump Room roof exhaust fan. Check all other fans, repair, or replace as necessary.
- Inspect all wall motorized dampers/louvers, repair, or replace them if necessary.
- All thermostats are recommended to be converted to the energy-saving type.

Long Term Recommendations:

- Redesign of these rooms to ensure improved ventilation, air conditioning, and dehumidification.
- Add centralized Building Automation System (BAS).
- Investigate changing the heating system to natural gas-fired. The existing electric heating equipment may remain for redundancy.
- Ensure humidity is monitored and controlled throughout the year.

4.2 Electrical

4.2.1 MCC1 and Main Well Pump (Photo No, E28-E31)

MCC1 is rated at 600A, 600V, 3 phase, and is original with building construction (1972). The MCC is equipped with a main breaker and a phase relay for protection. The main bus does not currently have surge protection. A new electrical metering system was installed in 2020 to monitor station electrical usage through SCADA. The original main well pump and associated starter were both replaced approximately 2 years ago and now the main well pump runs on a VFD with additional harmonic filtering (located exterior to the MCC). There are currently no provisions for a back up power supply at this facility.

Score: Poor– 4

Short Term Recommendations:

- Replace MCC and integrate new VFD with power factor correction and harmonic filtering within MCC.
- Install portable generator connection and manual transfer switch to provide backup power provisions for the station.

Long Term Recommendations:

- Install permanent generator and ATS for automated backup power provisions at the station.

4.2.2 Chlorine Booster Pumps 1+2 (Photo No, E32-E33)

As reported by staff, these pumps operate at full power with output flow limited by valves to suit the flow requirements. This puts additional strain on the motor that can be reduced via implementing VFD control on the motor.

Score: Fair– 3

Short Term Recommendations:

- None

Long Term Recommendations:

- Replace pump motors and install new VFD control through SCADA to achieve required flow rates.

5. Steelton Well

5.1 Mechanical

5.1.1 Main House

The existing building was constructed in 1914, Figure M41.

No maintenance records were provided for our review, and therefore the following comments are based on the existing conditions observed during our review.

We understand that natural gas is available in this area.

This building does not include any means of mechanical ventilation.

The Pump Room includes one (1) electric unit heater, one (1) electric forced flow heater, and one (1) portable electric heater, Photo M42. The electric unit heater and the electric forced flow heater appear to have been installed recently.

The electric baseboard heaters in both the Chlorine Room and the Blended Phosphate Room are corroded, and in need of replacement, Photo M43.

The Pump Room and the Chlorine Room include one (1) portable dehumidifier in each, Photo M44.

The old pump room is decommissioned, but the pipes are still being used. There is no heating in this room, and so the piping is heat traced, Photo M45.

5.1.2 Well House

The existing building was constructed in 1964.

No maintenance records were provided for our review, and therefore the following comments are based on existing conditions observed during our review.

We understand that natural gas is available in this area.

The Well House does not include any means of mechanical ventilation. We observed one (1) roof exhaust fan, and one (1) door grille. The ventilation is being provided by infiltration. The roof exhaust fan is not provided with a gravity damper. The Well House includes one (1) portable air conditioning (AC) unit. The main heat sources are the vertical turbine motor, VFD drive, and its harmonic filter. The door is usually kept open during the summer, Photo M46.

The semi-recessed electric forced flow heater in the Well Building appears to be operational and in good condition, Photo-M47.

Score: Poor– 4

Short Term Recommendations:

- All maintenance work needs to be done periodically and recorded.
- Replace the baseboard heaters in the Pump House.

Long Term Recommendations:

- Design ventilation, air conditioning, and dehumidification solutions.
- Add centralized Building Automation System (BAS).
- Investigate changing the heating system to natural gas-fired. Existing electric heating equipment may remain for redundancy purposes.
- Monitor and control relative humidity levels throughout the year.

5.2 Electrical

5.2.1 Incoming Electrical Services and Distribution (Photo No, E34-E36, E39)

Steelton Well is split between two buildings and each have their own utility service connection. The Main house (original construction, 1914) has a 120/240V 1 phase service that is distributed via a 200A, 40 circuit distribution panel, which was installed after original building construction, and feeds all station loads outside of the 2 booster pumps and the well house pump. 120/240 is also brought from the main house into the well house to feed lighting and other auxiliary loads.

The Well house (constructed in 1964) has a 600V, 3 phase service fed via a 150kVA utility pad mounted transformer located on the exterior roadside of the Well house. Inside the well house there is a 200A 600V main disconnect switch, meter base and line reactor, before distributing to the main well pump and booster pumps (in the main house) via splitters and disconnect switches. The 600V service has a power monitoring system that was installed in 2020 and does not have surge protection installed.

Score: Poor– 4
Short Term Recommendations:

- Remove 120/240V service and modify/replace the 600V service distribution with power monitoring and surge protection such that all equipment at the station is fed from a single source.
- Investigate service size upgrade with 600V distribution modifications.
- Provide portable generator connection and manual transfer switch to feed the station.

Long Term Recommendations:

- Install new 600V service connection and incoming MCC/distribution equipment to replace the 2 utility connections and scattered distribution equipment.
- Install permanent standby generator and automatic transfer switch to feed the station.

5.2.2 Well Pump (Photo No, E37-E38)

The 125HP well pump has been replaced since original construction and operates by a VFD and backup across the line contactor starter via disconnect switches and a manual transfer switch. VFD operation is preferred with across the line acting as standby.

Score: Fair – 3
Short Term Recommendations:

- Feed pumps from a new unified power distribution system as per incoming service recommendations.

Long Term Recommendations:

- None

5.2.3 Chlorine Booster Pumps 1+2 (Photo No, E39-E40)

As reported by staff, these pumps operate at full power with output flow limited by valves to suit the flow requirements. This puts additional strain on the motor that can be reduced via implementing VFD control on the motor.

Score: Fair– 3
Short Term Recommendations:

- Feed pumps from a new unified power distribution system as per incoming service recommendation via a 600V feeder from well house and a 600V-120V/208V dry type transformer and distribution panels inside the main house.

Long Term Recommendations:

- Replace pump motors and install new VFD control through SCADA to achieve required flow rates.

6. Lorna Well

6.1 Mechanical

The existing building was constructed in 1979. Some of the existing mechanical systems appear to be from the original construction, Figure M48.

This station is not typically in use but remains available to address high system demands or in emergency circumstances only.

No maintenance records were provided for our review, and therefore the following comments are based on the existing conditions observed during our review.

We understand that natural gas is available in this area.

This station does not include a means of mechanical ventilation. Ventilation is being provided by infiltration. Only roof exhaust fans were observed.

There is one (1) electrical unit heater in the Pump Room, one (1) in the Chlorine Room, and one (1) in the Corridor. They are all functional, and appear to have been installed at a later stage to replace the original heaters, Photo M49. The Blended Phosphate Room includes one (1) electric baseboard heater, which appears to have been installed recently, Photo M50.

Thermostats are of the mechanical type and do not include energy-saving/occupancy-controlled setpoints, Photo M51.

The Blended Phosphate Room includes one (1) roof exhaust fan with a gravity damper. This appears to be from the original construction and is operational, but it has exceeded its estimated service life expectancy, Photo M52.

There are also one (1) roof opening and one (1) wall grille in the Blended Phosphate Room. It appears that the roof opening originally had a gravity relief damper, but no longer exists, meaning that it is always open, while the wall grille has been capped, Photo M53.

The Chlorine Room includes one (1) ducted type roof exhaust fan and a roof opening. We were unable to see the fan, but based on the appearance of the ductwork, it appears to be from the original construction, and has exceeded its estimated service life expectancy, Photo M54.

There is also a wall grill which is capped, and no longer in use. The exhaust air from the Chlorine Gas Room needs to be discharged to the atmosphere through the roof.

There is one (1) portable dehumidifier in the Chlorine Room to reduce the relative humidity levels and the resulting chlorine-water interaction. The portable dehumidifiers generally do not last long and are replaced every year or two, as reported by the facility staff, Photo M55.

There are two (2) well pumps, two (2) motor starters in the Pump Room, similar to the Shannon Station. One of the pumps is a submersible type.

The Pump Room includes two (2) big motorized dampers/louvers, but only one of them is functioning. There is also one (1) roof fan with a gravity damper. We were unable to see its operation but based on visible conditions, they are from the original construction and have exceeded their service life expectancy, Photo M56. This room also includes one (1) portable dehumidifier, Photo M57.

Score: Poor– 4

Short Term Recommendations:

- All maintenance work needs to be done periodically and recorded.
- Repair or replace the motorized damper/louver in the Pump Room.
- Check all wall motorized dampers/louvers, repair, or replace as necessary.
- All thermostats are recommended to be converted to the energy-saving type.

Long Term Recommendations (Note: the long term recommendations may not be warranted if the PUC plans to replace this source of water supply):

- Design the ventilation, air conditioning, and dehumidification systems.
- Add centralized Building Automation System (BAS).
- Investigate changing the heating system to natural gas-fired. Existing electric heating equipment may remain for redundancy.
- Humidity must be monitored and controlled throughout the year.

6.2 Electrical

6.2.1 MCC1 and Well Pumps (Photo No, E41-E43)

6.2.1.1 MCC1 and incoming service.

The electrical service at Lorna Well is fed from an exterior pad mounted utility transformer into MCC1. MCC1 is rated for 600A, 600V and is original with building construction (1978). The Main breaker had failed and was replaced in 2019. MCC1 feeds all station loads including 2 Well Pumps, with the 2nd well pump installed after original well construction. The incoming service has a power monitoring system that was installed in 2020 and does not have surge protection installed. No provisions for back up power are present at the station.

6.2.1.2 Well Pumps 1 and 2

Well Pump 1 (150HP) was installed with original building construction and is running with original across the line motor starter in MCC1. Well Pump 2 (125HP) is a submersible pump that was installed with a solid-state soft starter c/w across the line bypass that engages when pump is up to speed.

Score: Poor– 4

Short Term Recommendations:

- Install new MCC with integrated soft starters or VFDs for both well pumps.
- Replace motor for well pump 1.
- Provide portable generator connection and manual transfer switch to feed the station.

Long Term Recommendations (Note: the long term recommendations may not be warranted if the PUC plans to replace this source of water supply):

- Replace motor for well pump 2.
- Install permanent standby generator and automatic transfer switch to feed the station.

6.2.2 Chlorine Booster Pumps 1+2 (Photo No, E44)

As reported by staff, these pumps operate at full power with output flow limited by valves to suit the flow requirements. This puts additional strain on the motor that can be reduced via implementing VFD control on the motor.

Score: Fair– 3
Short Term Recommendations:

- None

Long Term Recommendations (Note: the long term recommendations may not be warranted if the PUC plans to replace this source of water supply):

- Replace pump motors and install new VFD control through SCADA to achieve required flow rates.

7. PZ2 Booster Station

7.1 Mechanical

The existing building was constructed in 1963, and the mechanical systems appear to be from the original construction, Figure M58. The building roof was scheduled to be replaced in 2020.

No maintenance records were provided for our review, and therefore the following comments are based on the existing conditions observed during our review.

We understand that natural gas is available in this area.

There are two (2) diesel engine powered pumps in the facility. When the diesel pumps start running, ventilation air enters the room through two (2) wall motorized dampers/louvers, Photo M59, for combustion and ventilation purposes. This also results in unconditioned air, entering the building. These dampers/louvers are no longer functioning due to the flood that occurred in 2015.

We were informed by facility staff that the diesel pumps will be replaced with electrical ones this year. Outdoor generators will also be added.

This station does not include a means of mechanical ventilation. Ventilation is being provided by infiltration. Two (2) roof exhaust fans with gravity dampers and manually opening windows were observed, Photo M60. We were unable to determine their condition or the manufacturing date, but they will be replaced with the roof this year, as reported by facility staff.

The building includes two (2) electric unit heaters with two (2) thermostats. These unit heaters appear to be newer than the original installation, but the thermostats are of the mechanical type and outdated, Photo M61.

Score: Poor– 4

Short Term Recommendations:

- All maintenance work needs to be done periodically and recorded.
- Repair or replace the motorized damper/louver.
- All thermostats are recommended to be converted to the energy saving type.

Long Term Recommendations:

- Redesign rooms for improved ventilation, air conditioning, and dehumidification.
- Add centralized Building Automation System (BAS).

- Investigate changing the heating system to natural gas-fired. Existing electric heating equipment may remain for redundancy.
- Monitor and control relative humidity throughout the year.

7.2 Electrical

PZ2 Booster station has a planned electrical upgrade to be completed in 2020. The electrical systems at the station are outside the scope of this report.

8. Goulais Well

8.1 Mechanical

The existing building was constructed in 1969, with a few updates in 1989, Figure M62. All the existing mechanical systems appear to be from the original construction with some changes over the years.

No maintenance records were provided for our review, and therefore the following comments are based on existing conditions observed during our review.

We understand that natural gas is available in this area.

This station does not include a means of mechanical ventilation. Ventilation is being provided by natural infiltration. Only roof fan exhausts were observed.

There is one (1) electric unit heater in the Blended Phosphate Room, one (1) in the Pump Room, and one (1) in the Chlorine Room. They are functional, but we were unable to determine their manufacture date. They appear to be installed later to replace the original heaters, Photo-M63.

Thermostats are mechanical type thermostats and do not include energy-saving/occupancy-controlled setpoints, Photo M64.

The Blended Phosphate Room includes one (1) wall-mounted axial fan, which appears to have been installed recently, Photo M65.

The Chlorine Room includes one (1) ducted type roof exhaust fan and one (1) large wall louver. This louver appears to have been replaced with a window, Photo M66. The roof exhaust fan was replaced in 2019 as reported by the facility staff.

There is one (1) portable dehumidifier in the Chlorine Room to reduce relative humidity levels and the water-chlorine interaction. The portable dehumidifiers generally do not last long; they are replaced every one or two years, as reported by the facility staff, Photo M67.

The Pump Room includes two (2) portable air conditioning (AC) units, Photo M68. These units also do not last that long, and need to be replaced every year or two, as reported by facility staff. The main heat sources are the main vertical turbine motor, the variable frequency drive (VFD), and its harmonic filter. The heat gain from this equipment generates results in elevated ambient conditions in the cooling season and requires air conditioning.

There are is a roof exhaust fan and large wall louver. The roof exhaust fan was replaced in 2019 as reported by the facility staff. The wall louver is capped, Photo M69.

Make-up air needs to be provided as all the wall louvers in this station are capped.

Score: Poor– 4

Short Term Recommendations:

- All maintenance work needs to be done periodically and recorded.
- Thermostats are recommended to be converted to the energy saving type.
- Provide make-up air

Long Term Recommendations:

- Redesign rooms for improved ventilation, air conditioning, and dehumidification.
- Add centralized Building Automation System (BAS).
- Investigate changing the heating system to natural gas-fired. Existing electric heating equipment may remain for redundancy.
- Humidity must be monitored and controlled throughout the year.

8.2 Electrical

Goulais Well had an electrical upgrade installed earlier in 2020. The electrical systems at the station are outside the scope of this report.

APPENDIX A – Facility Major Electrical Equipment Information

Facility	Equipment	Voltage (V)	Capacity	Horsepower (HP)
Water Treatment Plant	MCC1	600	1200A	-
	High Lift Pump 1	600	-	250
	High Lift Pump 2	600	-	300
	High Lift Pump 3	600	-	300
	MCC2	600	600A	-
	Backwash Pump 1	600	-	100
	Backwash Pump 2	600	-	100
	MCC3	600	600A	
	MCC 'E'	600	600A	-
	Low Lift Pump 1	600		30
	Low Lift Pump 2	600		60
	Low Lift Pump 3	600		60
	Low Lift Pump 4	600		60
	Generator	600	200kVA	-
Gros Cap Intake Station	MV Switchboard	13800	600A	-
	LV Switchboard	600	2000A	-
	MCC1	600	600A	-
	MCC2	600	2500A	-
	Raw Water Pump 1	600	-	200
	Raw Water Pump 2	600	-	200
	Raw Water Pump 3	600	-	400
	Raw Water Pump 4	600	-	400
	Generator	600	750kVA	-
Shannon Well	MCC1	600	600A	-
	Main Well Pump	600		150
	Cl Booster Pump 1	600	-	3
	Cl Booster Pump 2	600	-	3
Steelton Well	600V Main Distribution Switch	600	200A	-
	Main Well Pump	600	-	125
	Cl Booster Pump 1	600	-	3
	Cl Booster Pump 2	600	-	3
	120/240V Distribution Panel	240	200A	-
Lorna Well	MCC1	600	600A	-
	Well Pump 1	600	-	150
	Well Pump 2	600	-	125
	Cl Booster Pump 1	600	-	3
	Cl Booster Pump 2	**600**	**-**	**3**

APPENDIX B – Recommendation Cost Estimates

Facility	Section	Recommendation	Estimated Construction Cost	Estimated Soft Costs (+20%)	Total Costs
Water Treatment Plant	2.1.2	Ground Floor Offices - HVAC Short Term	$ 83,990.00	$ 16,798.00	$ 100,788.00
	2.1.2	Ground Floor Offices - HVAC Long Term	$ 415,060.00	$ 83,012.00	$ 498,072.00
	2.1.3	Process Side Rooms - HVAC Short Term	$ 120,810.00	$ 24,162.00	$ 144,972.00
	2.1.3	Process Side Rooms - HVAC Long Term	$ 773,220.00	$ 154,644.00	$ 927,864.00
	2.1.4	Other Rooms and Spaces - HVAC Short Term	$ 186,940.00	$ 37,388.00	$ 224,328.00
	2.1.4	Other Rooms and Spaces - HVAC Long Term	$ 685,770.00	$ 137,154.00	$ 822,924.00
	2.1.5	Domestic Hot Water Heating - Plumbing Short Term	$ 39,130.00	$ 7,826.00	$ 46,956.00
	2.1.5	Domestic Hot Water Heating - Plumbing Long Term	$ 6,430.00	$ 1,286.00	$ 7,716.00
	2.2.4.1	Phase 1: Incoming Service Switchboard and Backup Power Provisions	$ 870,000.00	$ 174,000.00	$ 1,044,000.00
	2.2.4.2	Phase 2: Permanent Generator Installation	$ 500,000.00	$ 100,000.00	$ 600,000.00
	2.2.4.3	Phase 3: MCC2, MCC3 + MCC'E' Replacements	$ 620,000.00	$ 124,000.00	$ 744,000.00
	ALL	**TOTAL SHORT TERM COSTS**			$ 1,561,044.00
	ALL	**TOTAL LONG TERM COSTS**			$ 3,600,576.00
Gros Cap Intake Station	3.1	Mechanical Short Term	$ 33,450.00	$ 6,690.00	$ 40,140.00
	3.1	Mechanical Long Term	$ 253,940.00	$ 50,788.00	$ 304,728.00
	3.2.4.1	Phase 1: Incoming Utility Service, Main Switchboard and Backup Power Provisions	$ 660,000.00	$ 132,000.00	$ 792,000.00
	3.2.4.2	Phase 2: MCC1 and MCC2 and Raw Water Pump replacements	$ 750,000.00	$ 150,000.00	$ 900,000.00
	ALL	**TOTAL SHORT TERM COSTS**			$ 832,140.00
	ALL	**TOTAL LONG TERM COSTS**			$ 1,204,728.00
Shannon Well	4.1	Mechanical Short Term	$ 28,760.00	$ 5,752.00	$ 34,512.00
	4.1	Mechanical Long Term	$ 32,890.00	$ 6,578.00	$ 39,468.00
	4.2.1	MCC1 and Main Well Pump Short Term	$ 105,000.00	$ 21,000.00	$ 126,000.00
	4.2.1	MCC1 and Main Well Pump Long Term	$ 150,000.00	$ 30,000.00	$ 180,000.00
	4.2.2	Chlorine Booster Pumps Short Term	$ -	$ -	$ -
	4.2.2	Chlorine Booster Pumps Long Term	$ 1,500.00	$ 300.00	$ 1,800.00
	ALL	**TOTAL SHORT TERM COSTS**			$ 160,512.00
	ALL	**TOTAL LONG TERM COSTS**			$ 221,268.00
Steelton Well	5.1	Mechanical Short Term	$ 15,440.00	$ 3,088.00	$ 18,528.00
	5.1	Mechanical Long Term	$ 21,580.00	$ 4,316.00	$ 25,896.00
	5.2.1	Incoming Service Short Term	$ 55,000.00	$ 11,000.00	$ 66,000.00
	5.2.1	Incoming Service Long Term	$ 160,000.00	$ 32,000.00	$ 192,000.00
	5.2.2	Well Pump Short Term	$ 3,000.00	$ 600.00	$ 3,600.00

	5.2.2	Well Pump Long Term	$ -	$ -	$ -
	5.2.3	Chlorine Pumps Short Term	$ 20,000.00	$ 4,000.00	$ 24,000.00
	5.2.3	Chlorine Pumps Long Term	$ 15,000.00	$ 3,000.00	$ 18,000.00
	ALL	**TOTAL SHORT TERM COSTS**			$ 93,600.00
	ALL	**TOTAL LONG TERM COSTS**			$ 210,000.00
Lorna Well	6.1	Mechanical Short Term	$ 23,440.00	$ 4,688.00	$ 28,128.00
	6.1	Mechanical Long Term	$ 23,330.00	$ 4,666.00	$ 27,996.00
	6.2.1	MCC and Well Pumps Short Term	$ 240,000.00	$ 48,000.00	$ 288,000.00
	6.2.1	MCC and Well Pumps Long Term	$ 220,000.00	$ 44,000.00	$ 264,000.00
	6.2.2	Chlorine Pumps Short Term	$ -	$ -	$ -
	6.2.2	Chlorine Pumps Long Term	$ 15,000.00	$ 3,000.00	$ 18,000.00
	ALL	**TOTAL SHORT TERM COSTS**			**$ 316,128.00**
	ALL	**TOTAL LONG TERM COSTS**			**$ 309,996.00**
PZ2 Booster Station	7.1	Mechanical Short Term	$ 18,090.00	$ 3,618.00	$ 21,708.00
	7.1	Mechanical Long Term	$ 89,910.00	$ 17,982.00	$ 107,892.00
Goulais Well	8.1	Mechanical Short Term	$ 17,490.00	$ 3,498.00	$ 20,988.00
	8.1	**Mechanical Long Term**	**$ 19,810.00**	$ 3,962.00	$ 23,772.00

Assumptions

The following are assumptions that went into the development of the above cost estimates:

General:

- Costs above are Class D level estimates (+/- 30%).
- Costs do not include HST.
- Construction costs include the following factors based on project location:
    - Overhead: +10%
    - Mark-up: +5%
    - Supervision: +15%
    - Labor rate: $75/hour
    - Material Adjustment +10%
    - Labor Adjustment +30%

Mechanical:

- 2.1.2: Ground floor HVAC, AHU-2 replaced with gas fired heating, electrical cooling packaged units, assumed similar capacity as existing AHU-2, 6500cfm.
- 2.1.3: Process side HVAC, AHU-1 replaced with gas fired heating, electrical cooling packaged units, assumed similar capacity as existing AHU-1, 11000cfm.
- 2.1.4: Other rooms and space HVAC, assumed new ventilation system will be added.
- All of space pump stations and wells were assumed the gas-fired heating unit would be added, the quantities based on the GFA.
- New BAS assumed required for all of space, pump stations and wells.

Electrical:

- 2.2.4.1 Switchboard, 600V, 1200A, (dual utility feeders and tie bus). Control panel including PLC panel connection, SCADA integration, reprograming and start-up and Arc flash study.
- New high lift pump motors (2(300HP), 1(250HP)).
- 2.2.4.2 1000KVA outdoor diesel generator.
- 2.2.4.3 New MCC (MCC3+MCCE), 600A, 600V, and MCC2, 600V, 600A
- New Backwash pump motors (2(100HP)
- New low lift pump motors (2(60HP),1(30HP))
- 3.2.4.1 Dual feeders with tie bus 2n+1, new LV switchboards 600V, 2000A.
- 1000KVA outdoor diesel generator
- 3.2.4.2 MCC1, MCC2, 600V, (600A,2500A), and new raw water pump motors(2(400HP),2(200HP))
- 4.2.1 MCC1 600V, 600A
- 4.2.1 300KVA indoor diesel generator
- 4.2.2 New Booster pump motors (2(3HP)) with new VFDs
- 5.2.1 Main distribution board (2(200A))
- 5.2.1 Diesel Generator 200kVA
- 5.2.3 New Booster pump motors (2(3HP)) with new VFDs
- 6.2.1 MCC1, 600V, 600A
- 6.2.1 New Booster pump motors (2(3HP)) with new VFDs

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M1	9/1/2020

Direction Photo Taken

WTP - Ground Level Floor Plan

Description

Ground floor AHU-2 serving areas

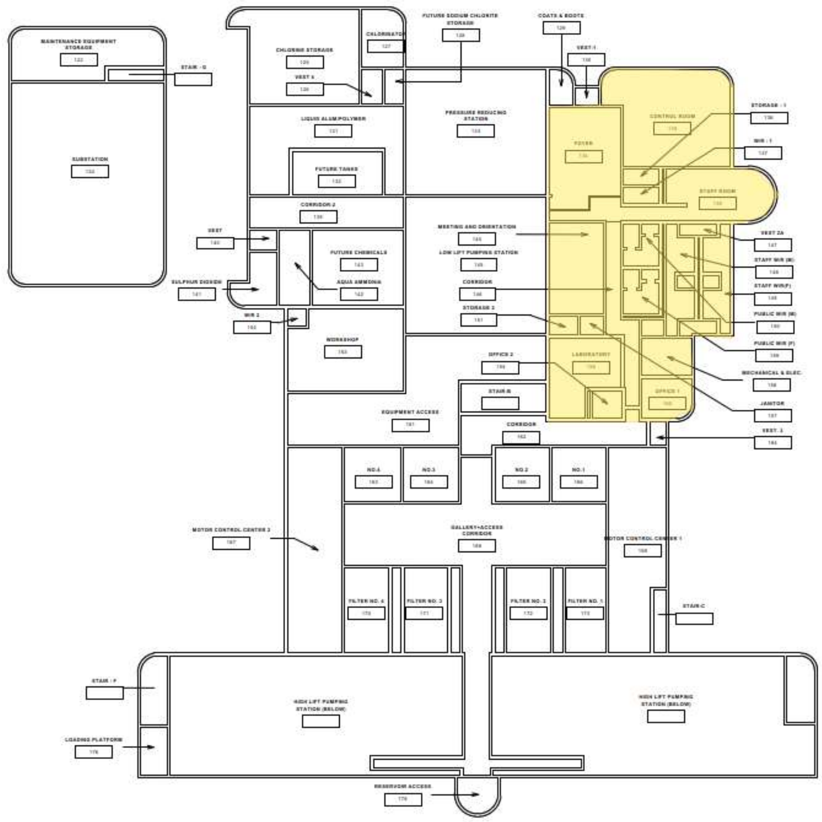


Photo No.	Date
M2	9/1/2020

Direction Photo Taken

WTP - AHU2

Description

AHU-2 and its nameplate

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M3	9/1/2020
Direction Photo Taken	
WTP - AHU2	
Description	

Photo No.	Date
M4	9/1/2020
Direction Photo Taken	
WTP - AHU2	
Description	
Patches and possible leak locations	

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M5	9/1/2020
Direction Photo Taken	
WTP - Control Room	
Description	
The Control Room portable dehumidifier and previous removed ducted dehumidifier location	

Photo No.	Date
M6	9/1/2020
Direction Photo Taken	
WTP - Control Room & Staff Room	
Description	
In-floor electric heaters	

AECOM Imagine it. Delivered.

MECHANICAL PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M7	9/1/2020

Direction Photo Taken

WTP - Control Room

Description

Room thermostats

Photo No.	Date
M8	9/1/2020

Direction Photo Taken

WTP - WC and Entrance

Description

Electric cabinet heaters and electric force flow heaters

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M9	9/1/2020
Direction Photo Taken	
WTP - AHU2 Room	
Description	
AHU-2 return air transfer grill above the door	

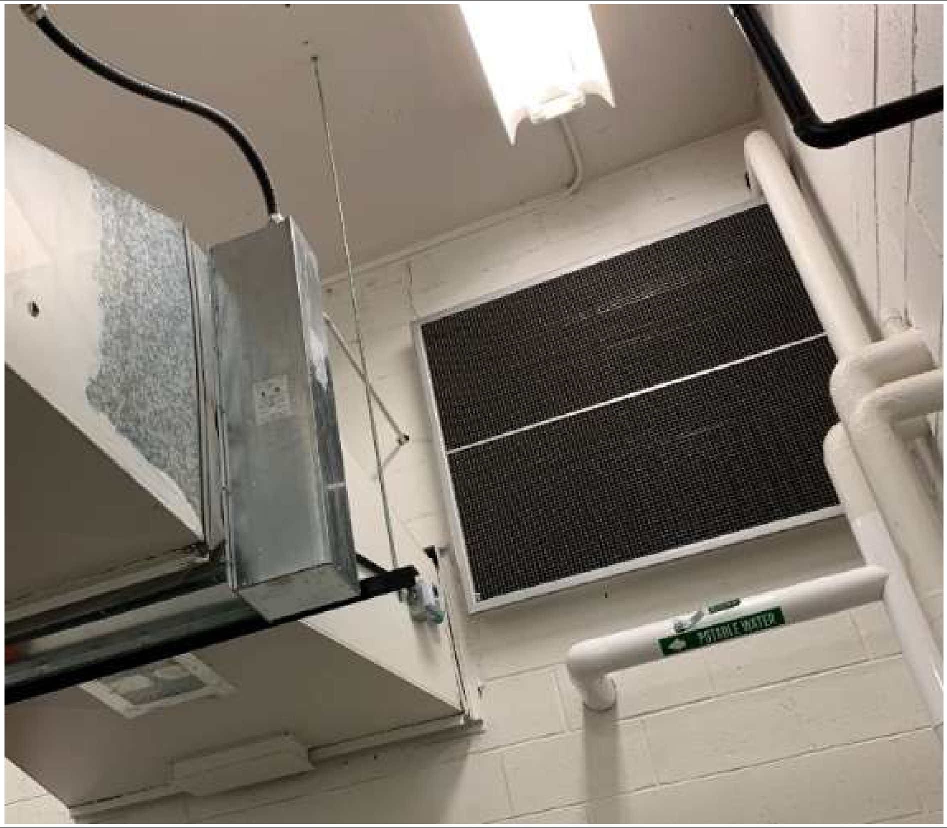


Photo No.	Date
M10	9/1/2020
Direction Photo Taken	
WTP - AHU1	
Description	
AHU-1 and its nameplate	

Photo No.	Date
M11	9/1/2020
Direction Photo Taken	
WTP - AHU1	
Description	
AHU-1 cooling coil pipe connection	

Photo No.	Date
M12	9/1/2020
Direction Photo Taken	
WTP - AHU1	
Description	
AHU-1 dehumidifier, its name plate and ducted type reactivation filter/ electric heater	

MECHANICAL PHOTOGRAPHIC LOG

AECOM Imagine it. Delivered.

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M13	9/1/2020

Direction Photo Taken

WTP – Basement Floor Plan

Description

AHU-1 basement floor serving areas

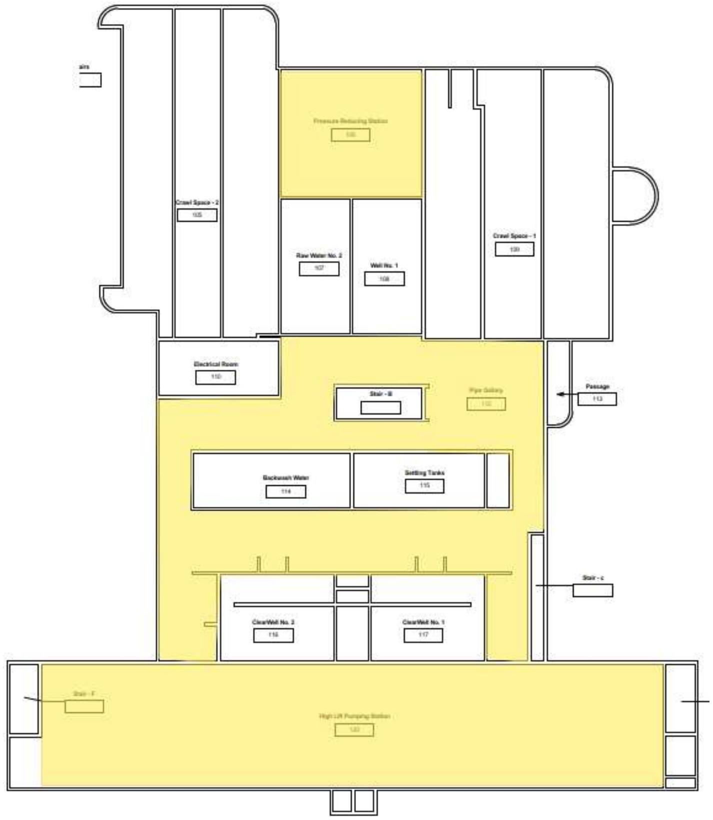


Photo No.	Date
M14	9/1/2020

Direction Photo Taken

WTP-AHU1&High Lift S.

Description

Duct patch at the dehumidifier inlet and round supply ducts in the High Lift Station

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M15	9/1/2020

Direction Photo Taken

WTP-AHU1&High Lift S.

Description

Return air inlet at the AHU-1 and return air grills in the High Lift Station

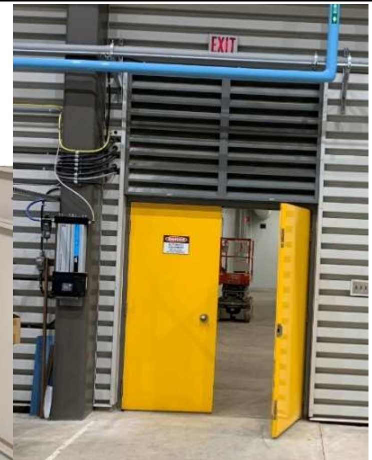


Photo No.	Date
M16	9/1/2020

Direction Photo Taken

WTP - High Lift Station

Description

Diesel Pump motorized dampers/louvers on the High Lift Station’s wall

AECOM Imagine it. Delivered.

MECHANICAL PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M17	9/1/2020

Direction Photo Taken

WTP-Reservoir Access

Description

Cabinet electric heater

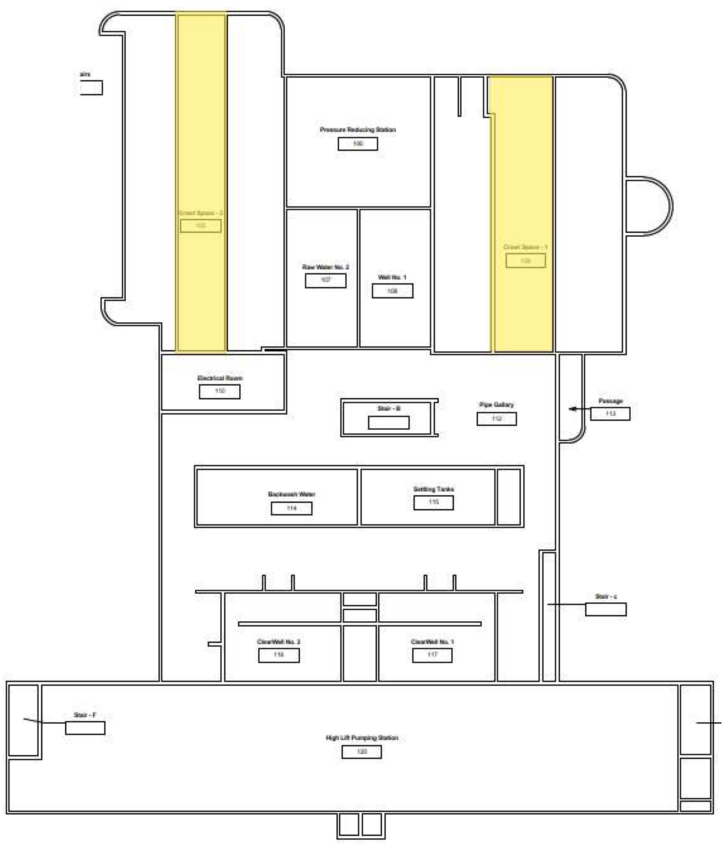
Photo No.	Date
M18	9/1/2020

Direction Photo Taken

WTP - Basement Floor Plan

Description

Basement floor mechanically unventilated areas

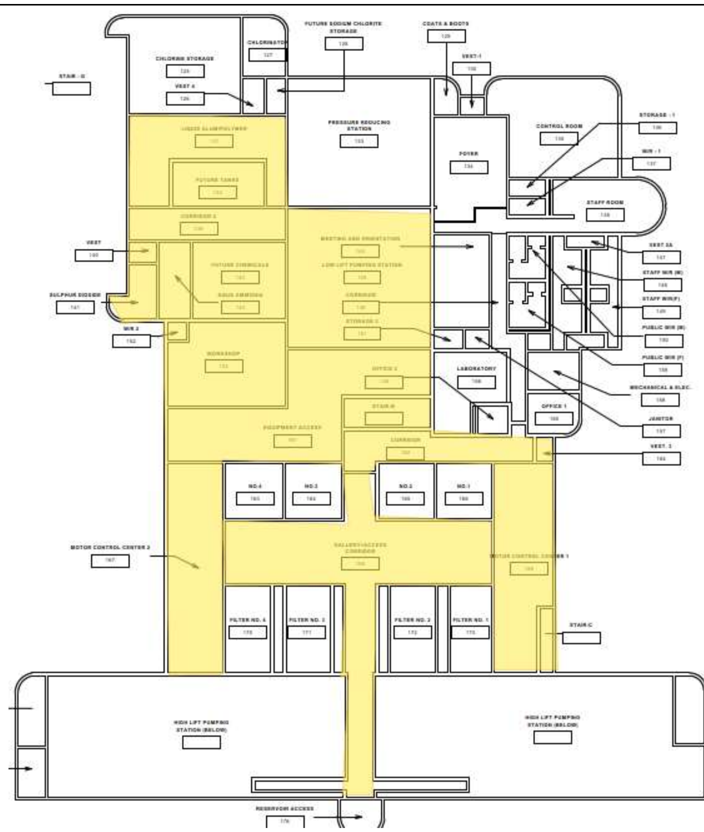


MECHANICAL PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M19	9/1/2020
Direction Photo Taken	
WTP- Crawl Spaces	
Description	
Crawl spaces, right (top) and left (bottom)	

Photo No.	Date
M20	9/1/2020
Direction Photo Taken	
WTP- Ground Floor Plan	
Description	
Ground floor mechanically unventilated areas	



MECHANICAL PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M21	9/1/2020

Direction Photo Taken

WTP - MCC rooms

Description

MCC rooms

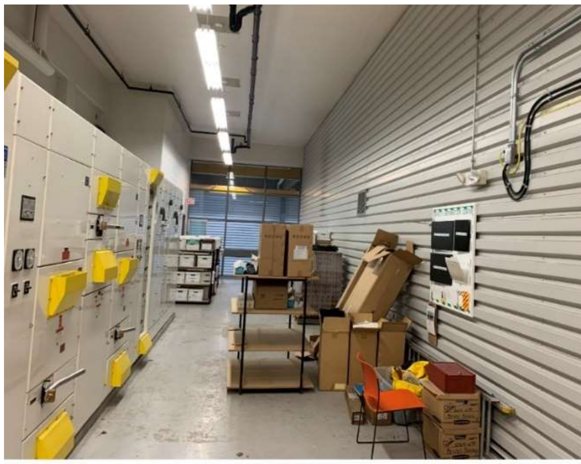


Photo No.	Date
M22	9/1/2020

Direction Photo Taken

WTP - Workshop

Description

Inline filter (top) and dust/fume collector (bottom)

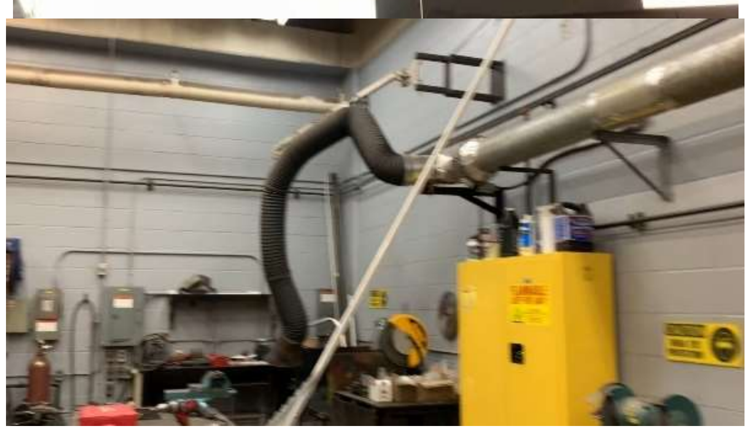


Photo No.	Date
M23	9/1/2020

Direction Photo Taken

WTP - Second Floor Plan

Description

Second floor mechanically unventilated areas

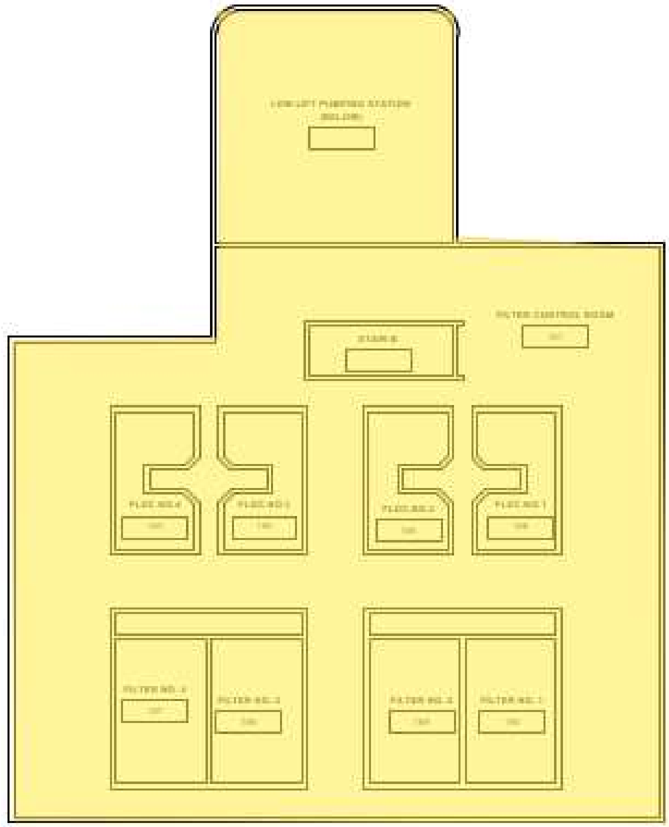


Photo No.	Date
M24	9/1/2020

Direction Photo Taken

WTP-Filter Control Room

Description

Circular electric unit heaters

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M25	9/1/2020
Direction Photo Taken	
WTP-Filter Control Room	
Description	
Wall mounted fan and motorized damper	

Photo No.	Date
M26	9/1/2020
Direction Photo Taken	
WTP - AHU1 Room	
Description	
Domestic hot water heaters	

MECHANICAL PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M27	9/1/2020

Direction Photo Taken

WTP - AHU1 Room

Description

Domestic hot water heating system recirculation pump

Photo No.	Date
M28	9/1/2020

Direction Photo Taken

Gros Cap – Entrance & MCC Room

Description

Electric unit heater and electric force flow heater

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M29	9/1/2020
Direction Photo Taken	
Gros Cap – Generator Room	
Description	
Cooling coil and fan	

Photo No.	Date
M30	9/1/2020
Direction Photo Taken	
Gros Cap–Generator R.	
Description	
Motorized damper/louver	

MECHANICAL PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M31	9/1/2020

Direction Photo Taken

Gros Cap-Floor Plan

Description

Floor plan and air movement route

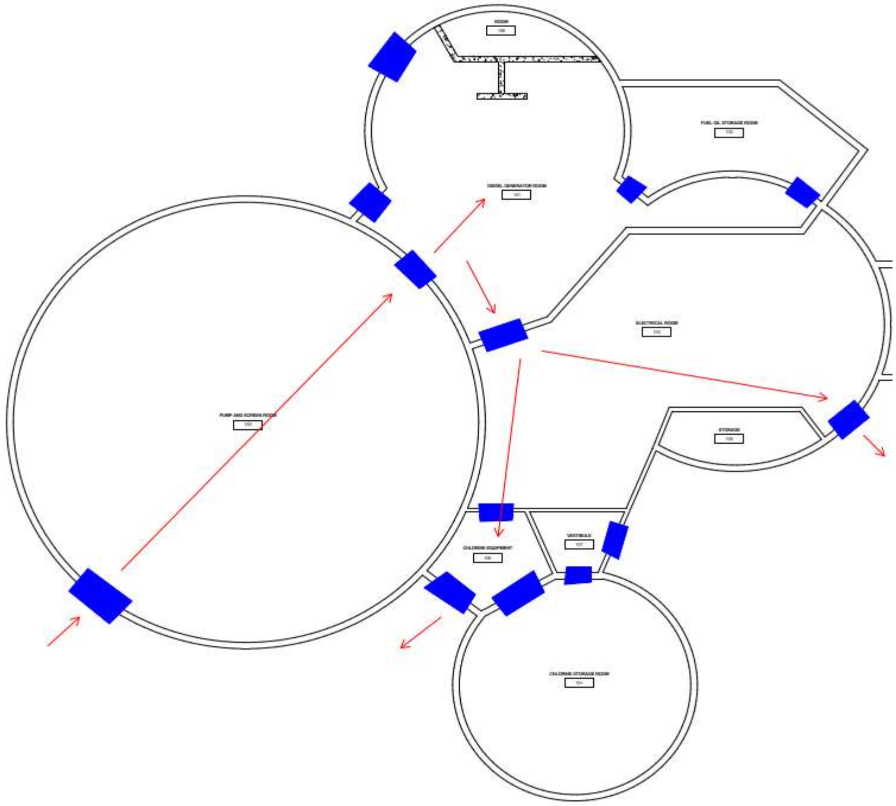


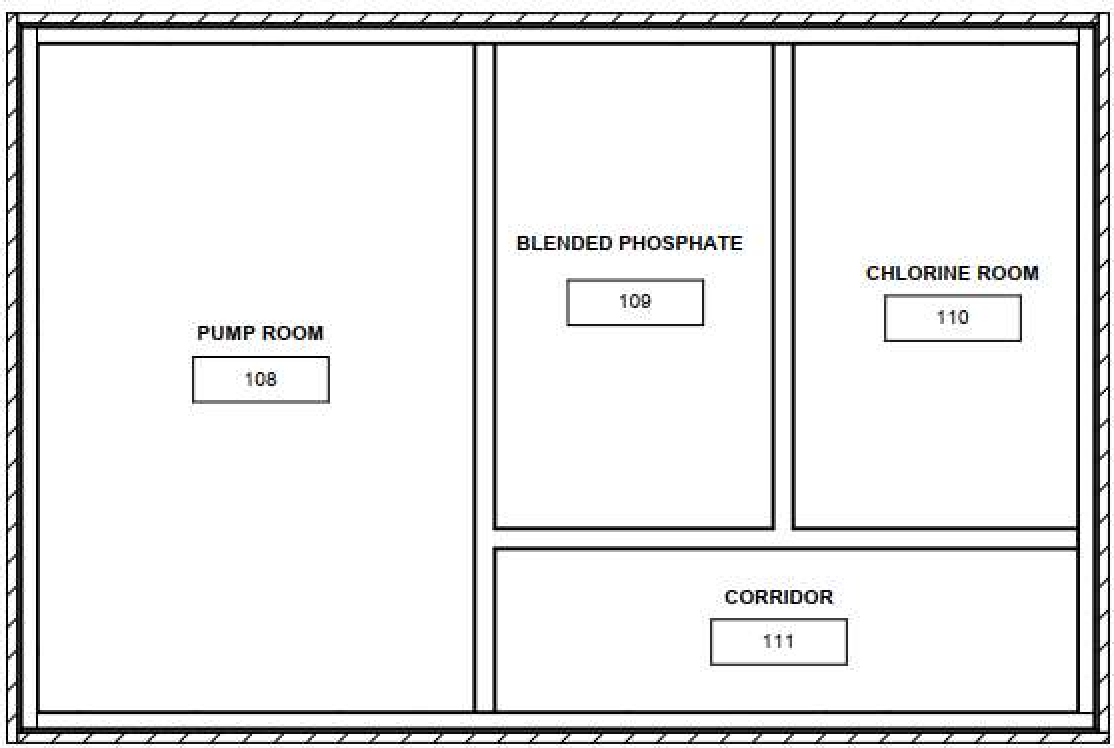
Photo No.	Date
M32	9/2/2020

Direction Photo Taken

Shannon Well

Description

Floor plan



Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M33	9/2/2020
Direction Photo Taken	
Shannon Well	
Description	
Electric unit heaters, Blended Phosphate Room (top-left), Pump Room (bottom), Chlorine Room (top-right)	

Photo No.	Date
M34	9/2/2020
Direction Photo Taken	
Shannon Well	
Description	
Corridor electric cabinet heater	

AECOM Imagine it. Delivered.

MECHANICAL PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M35	9/2/2020
Direction Photo Taken	
Shannon Well	
Description	
Blended Phosphate Room roof exhaust fan inlet and its gravity damper	

Photo No.	Date
M36	9/2/2020
Direction Photo Taken	
Shannon Well	
Description	
Blended Phosphate Room roof opening and capped wall grill	

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

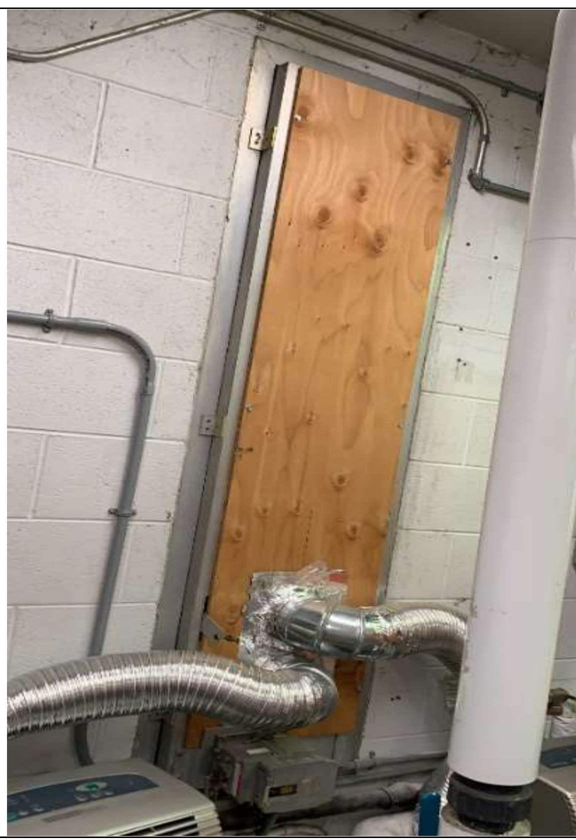
Photo No.	Date
M37	9/2/2020
Direction Photo Taken	
Shannon Well	
Description	
Chlorine Room wall motorized damper	

Photo No.	Date
M38	9/2/2020
Direction Photo Taken	
Shannon Well	
Description	
Chlorine Room portable dehumidifier	

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M39	9/2/2020
Direction Photo Taken	
Shannon Well	
Description	
Pump Room portable dehumidifier (left) and portable air conditioning units (right)	

Photo No.	Date
M40	9/2/2020
Direction Photo Taken	
Shannon Well	
Description	
Pump Room motorized damper/louver	



MECHANICAL PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M41	9/2/2020
Direction Photo Taken	
Steelton Well	
Description	
Floor plan	

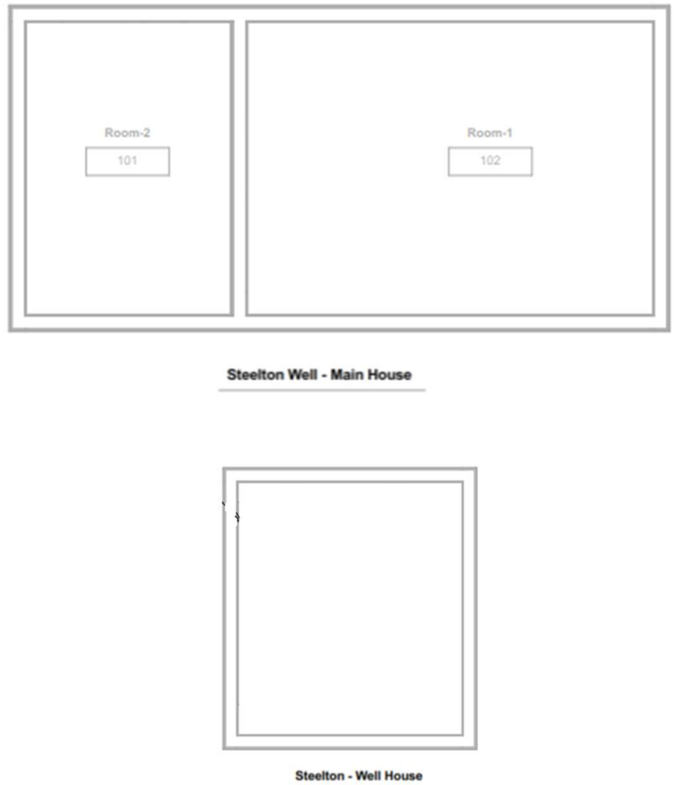


Photo No.	Date
M42	9/1/2020
Direction Photo Taken	
Steelton Main House	
Description	
Main House electric forced flow heater (left), electric unit heater (middle) and portable electric heater (right)	

AECOM Imagine it. Delivered.

MECHANICAL PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M43	9/1/2020
Direction Photo Taken	
Steelton Main House	
Description	
Blended Phosphate Room electric baseboard heater (top) and Chlorine Room electric baseboard heater (bottom)	

Photo No.	Date
M44	9/1/2020
Direction Photo Taken	
Steelton Main House	
Description	
Chlorine Room and Booster Pump Room portable dehumidifiers	

MECHANICAL PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M45	9/1/2020
Direction Photo Taken	
Steelton Main House	
Description	
Old Pump Room (decommissioned)	

Photo No.	Date
M46	9/1/2020
Direction Photo Taken	
Steelton Well House	
Description	
Well Building door grill (left), air conditioning unit (middle) and roof exhaust fan (right)	

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M47	9/1/2020
Direction Photo Taken	
Steelton Well House	
Description	
Well Building electric force flow heater	

Photo No.	Date
M48	9/2/2020
Direction Photo Taken	
Lorna Well	
Description	
Floor plan	

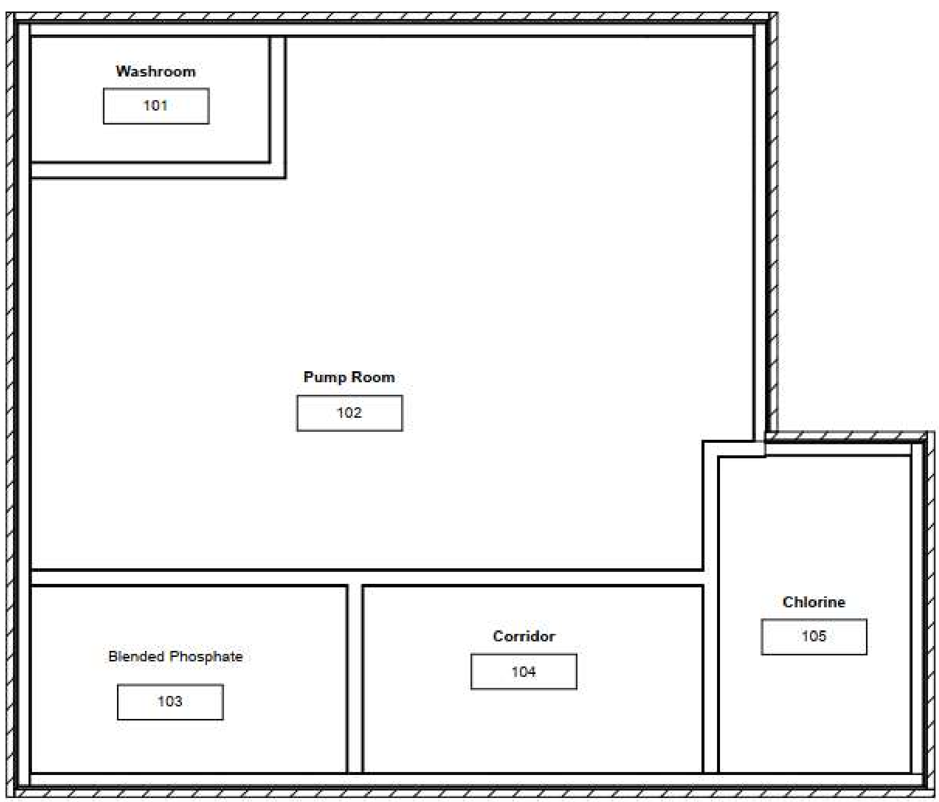


Photo No.	Date
M49	9/2/2020

Direction Photo Taken

Lorna Well

Description

Pump Room electric unit heater (top-left), Chlorine Room electric unit heater (top-right) and Corridor electric unit heater (bottom)

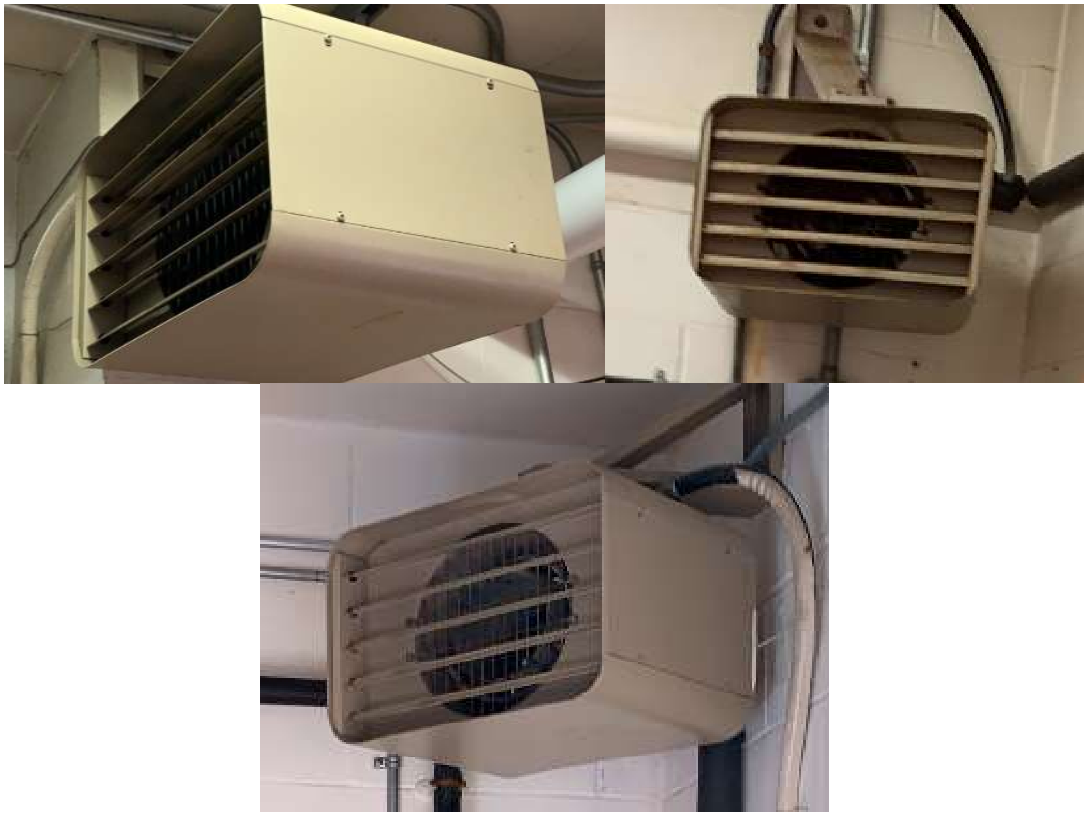


Photo No.	Date
M50	9/2/2020

Direction Photo Taken

Lorna Well

Description

Blended Phosphate Room electric baseboard heater

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M51	9/2/2020

Direction Photo Taken

Lorna Well

Description

Wall thermostat

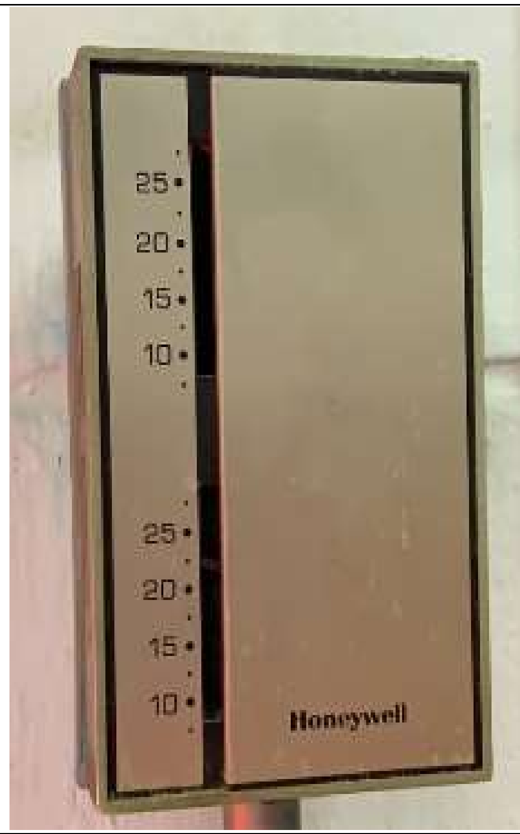


Photo No.	Date
M52	9/2/2020

Direction Photo Taken

Lorna Well

Description

Blended Phosphate Room roof exhaust fan and gravity damper

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M53	9/2/2020

Direction Photo Taken

Lorna Well

Description

Blended Phosphate Room roof opening (left) and capped wall grill (right)

Photo No.	Date
M54	9/2/2020

Direction Photo Taken

Lorna Well

Description

Chlorine Room roof opening

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M55	9/2/2020

Direction Photo Taken

Lorna Well

Description

Chlorine Room portable dehumidifier

Photo No.	Date
M56	9/2/2020

Direction Photo Taken

Lorna Well

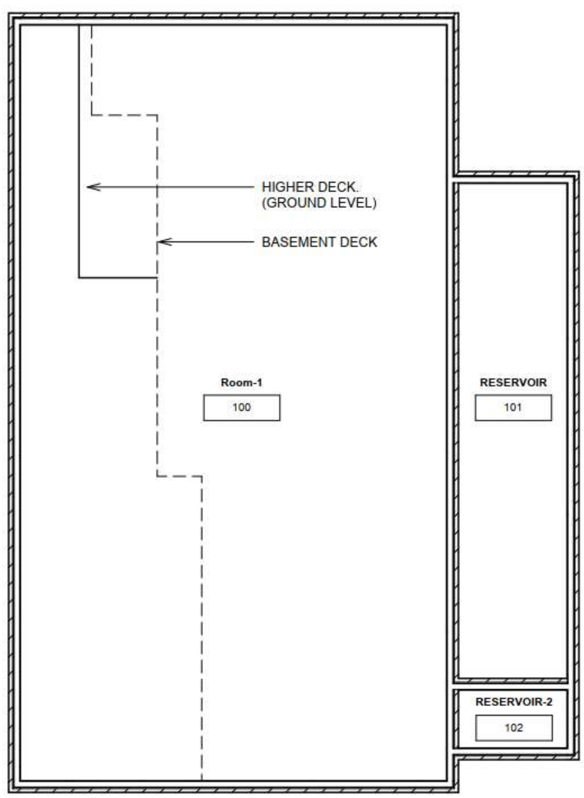
Description

Pump Room motorized dampers/louvers (left and middle) and roof exhaust fan with gravity damper (right)

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M57	9/2/2020
Direction Photo Taken	
Lorna Well	
Description	
Pump Room portable dehumidifier	

Photo No.	Date
M58	9/2/2020
Direction Photo Taken	
PZ2 Booster Station	
Description	
Floor plan	



Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M59	9/2/2020

Direction Photo Taken

PZ2 Booster Station

Description

Diesel pump fresh air intake motorized dampers/louvers (left and right)

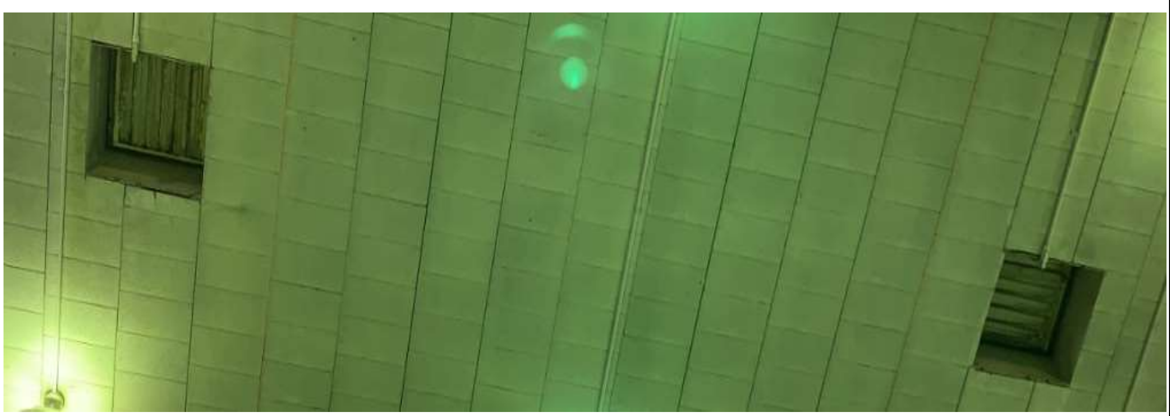
Photo No.	Date
M60	9/2/2020

Direction Photo Taken

PZ2 Booster Station

Description

Roof exhaust fans and gravity dampers



Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M61	9/2/2020
Direction Photo Taken	
PZ2 Booster Station	
Description	
Electric unit heaters (top-left and top-right) and wall thermostat (bottom)	

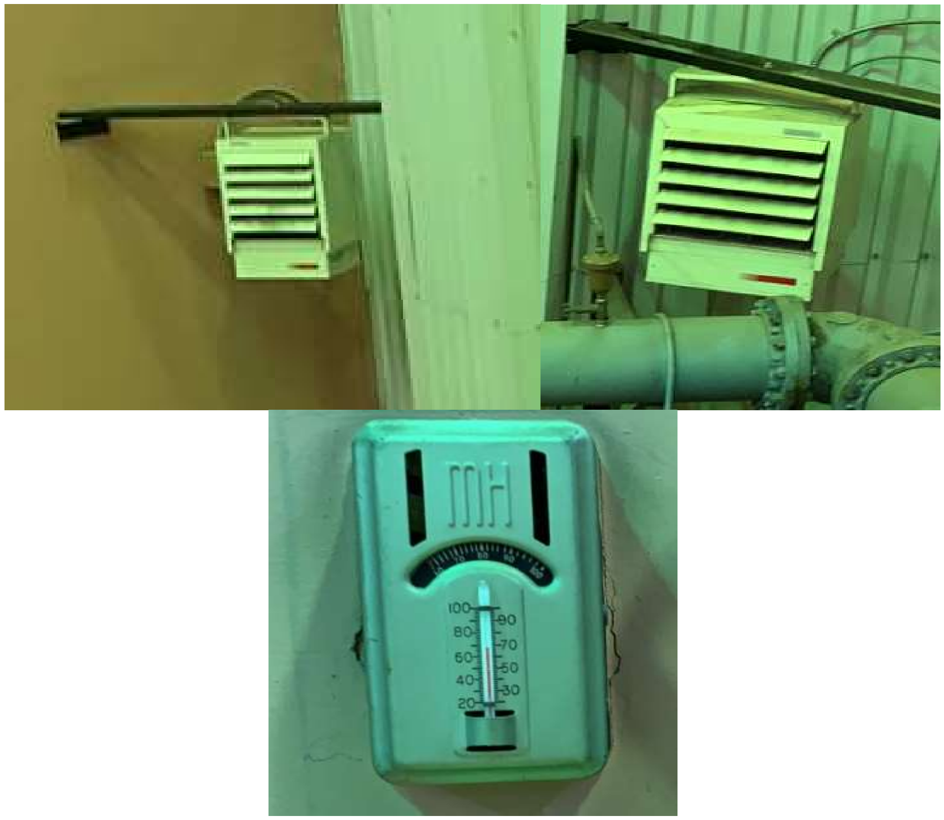
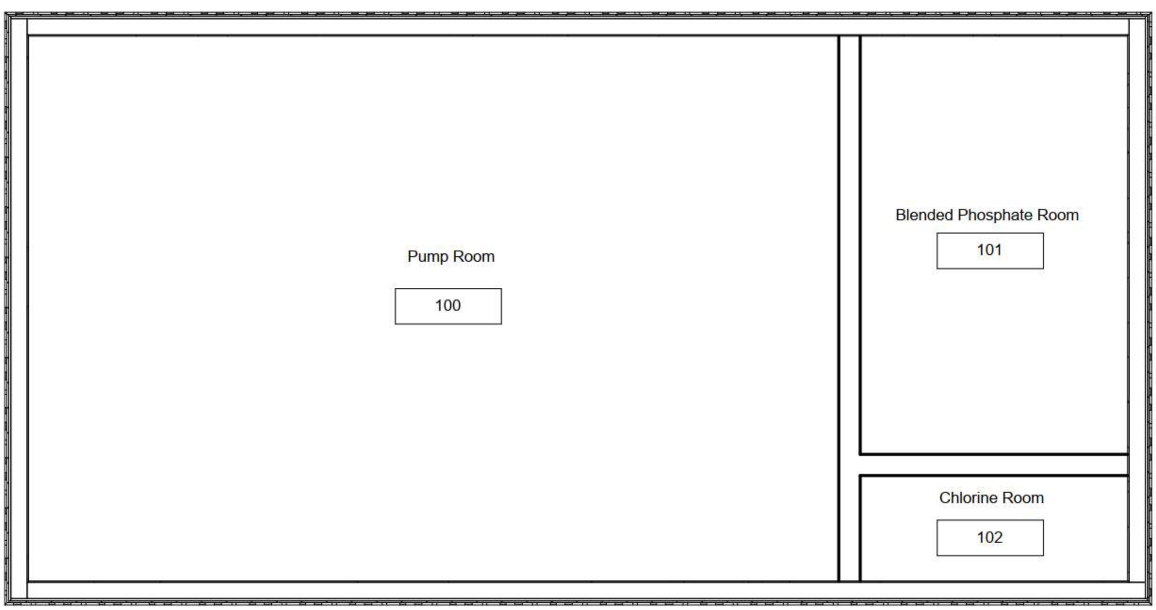


Photo No.	Date
M62	9/1/2020
Direction Photo Taken	
Goulias Well	
Description	
Floor plan	



MECHANICAL PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M63	9/1/2020

Direction Photo Taken

Goulias Well

Description

Blended Phosphate Room electric unit heater (top-left), Pump Room electric unit heater (top-right) and Chlorine Room electric unit heater (bottom)



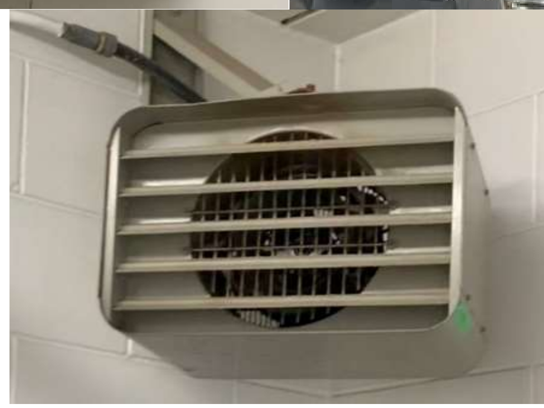


Photo No.	Date
M64	9/1/2020

Direction Photo Taken

Goulias Well

Description

Wall thermostats

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M65	9/2/2020

Direction Photo Taken

Goulias Well

Description

Blended Phosphate Room wall mounted axial exhaust fan

Photo No.	Date
M66	9/1/2020

Direction Photo Taken

Goulias Well

Description

Chlorine Room roof exhaust fan duct connection (left) and original wall louver location (right)

Photo No.	Date
M67	9/1/2020

Direction Photo Taken

Goulias Well

Description

Chlorine Room portable dehumidifier

Photo No.	Date
M68	9/1/2020

Direction Photo Taken

Goulias Well

Description

Pump Room portable air conditioning units

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
M69	9/1/2020

Direction Photo Taken

Goulias Well

Description

Pump Room wall louver (taken from outside – top-left, taken from inside – top-right) and roof exhaust fan with gravity damper (bottom)

ELECTRICAL PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
E1	9/1/2020

Direction Photo Taken

WTP - Ground Level Floor Plan

Description

WTP Ground Floor Electrical Infrastructure

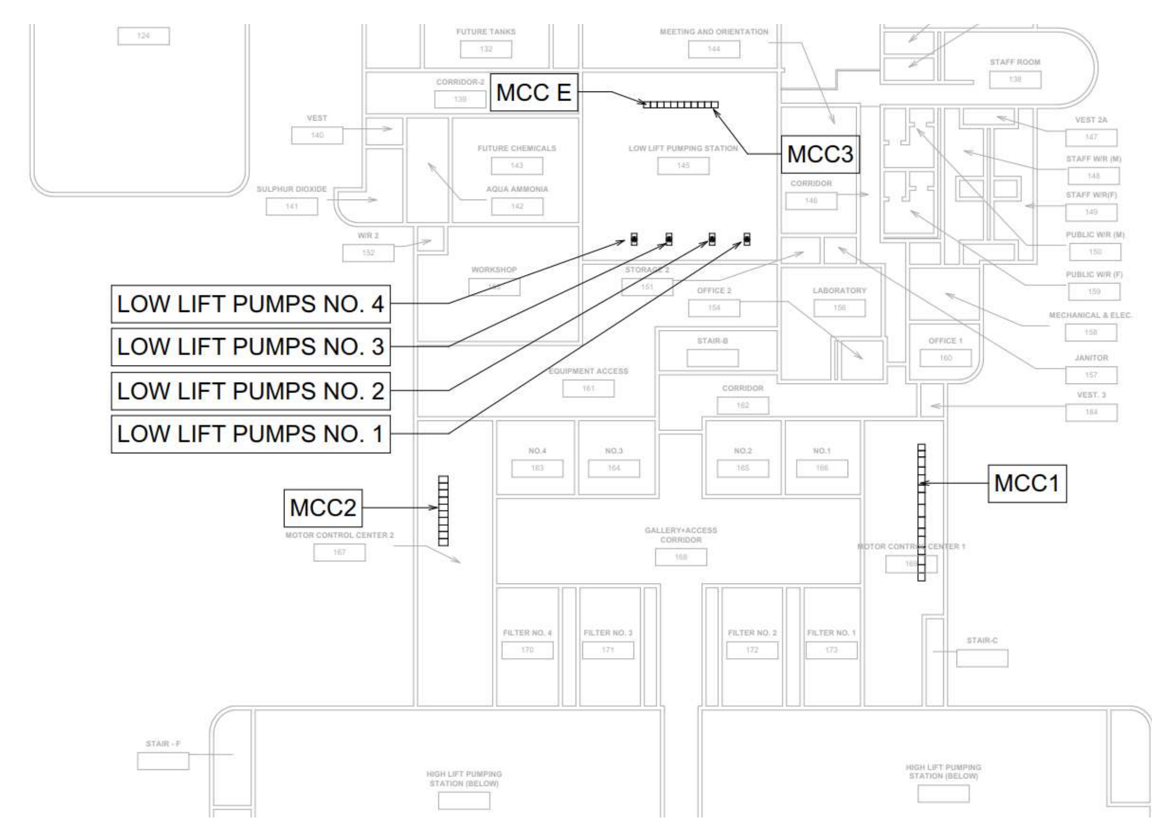


Photo No.	Date
E2	9/1/2020

Direction Photo Taken

WTP-MCC1

Description

MCC1 Lineup 1

ELECTRICAL PHOTOGRAPHIC LOG

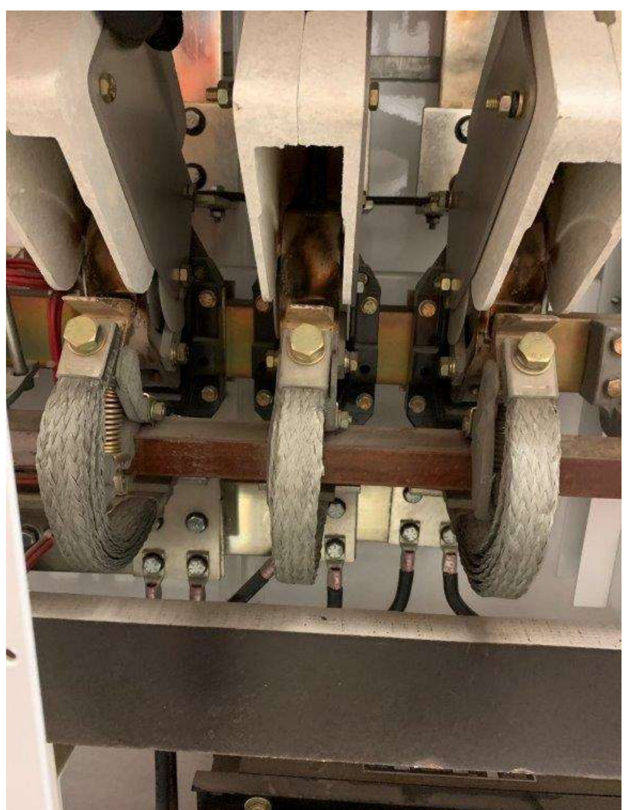
Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
E3	9/1/2020
Direction Photo Taken	
WTP-MCC1	
Description	
MCC Lineup 2	

Photo No.	Date
E4	9/1/2020
Direction Photo Taken	
WTP - MCC1	
Description	
MCC1 Name Plates	

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date	
E5	9/1/2020	
Direction Photo Taken		
WTP – MCC1		
Description		
High Lift Pump 3 Starter		

Photo No.	Date	
E6	9/1/2020	
Direction Photo Taken		
WTP – MCC1		
Description		
High Lift Pump 3 Contactors		

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
E7	9/1/2020

Direction Photo Taken

WTP - Lower Level Floor Plan

Description

WTP Lower Floor Electrical Infrastructure

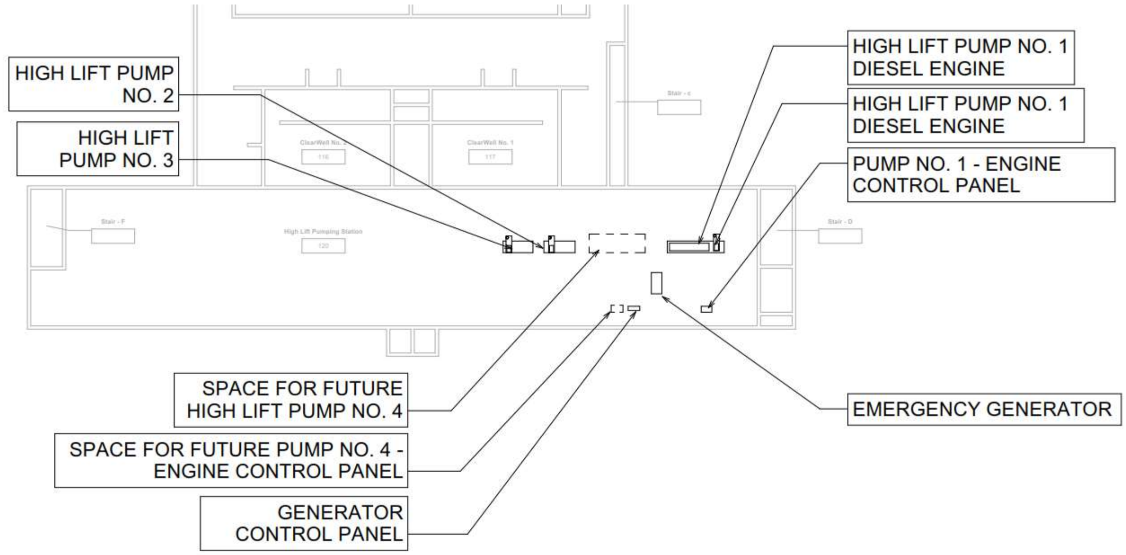


Photo No.	Date
E8	9/1/2020

Direction Photo Taken

WTP – Lower Level

Description

Dual Drive High lift Pump # 1 and Generator (from above)

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
E9	9/1/2020

Direction Photo Taken

WTP – Lower Level

Description

High lift pumps 3 and 4 and space for High lift pump 2 (from above)

Photo No.	Date
E10	9/1/2020

Direction Photo Taken

WTP – Lower Level

Description

HLP#3 Nameplate

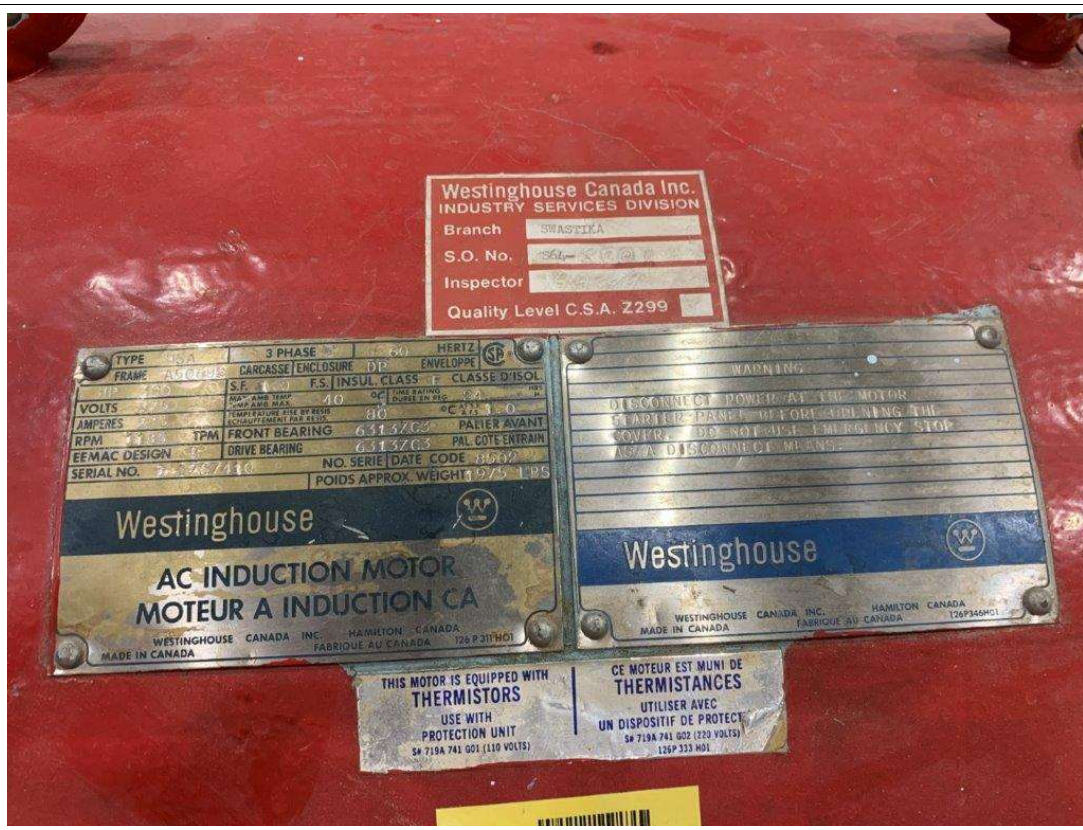


Photo No.	Date
E11	9/1/2020
Direction Photo Taken	
WTP – MCC2	
Description	
MCC2 Lineup	

Photo No.	Date
E12	9/1/2020
Direction Photo Taken	
WTP – MCC2	
Description	
MCC2 Nameplates	

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
E13	9/1/2020

Direction Photo Taken

WTP – MCC2

Description

MCC2 added Allen Bradley Soda Ash section and nameplate

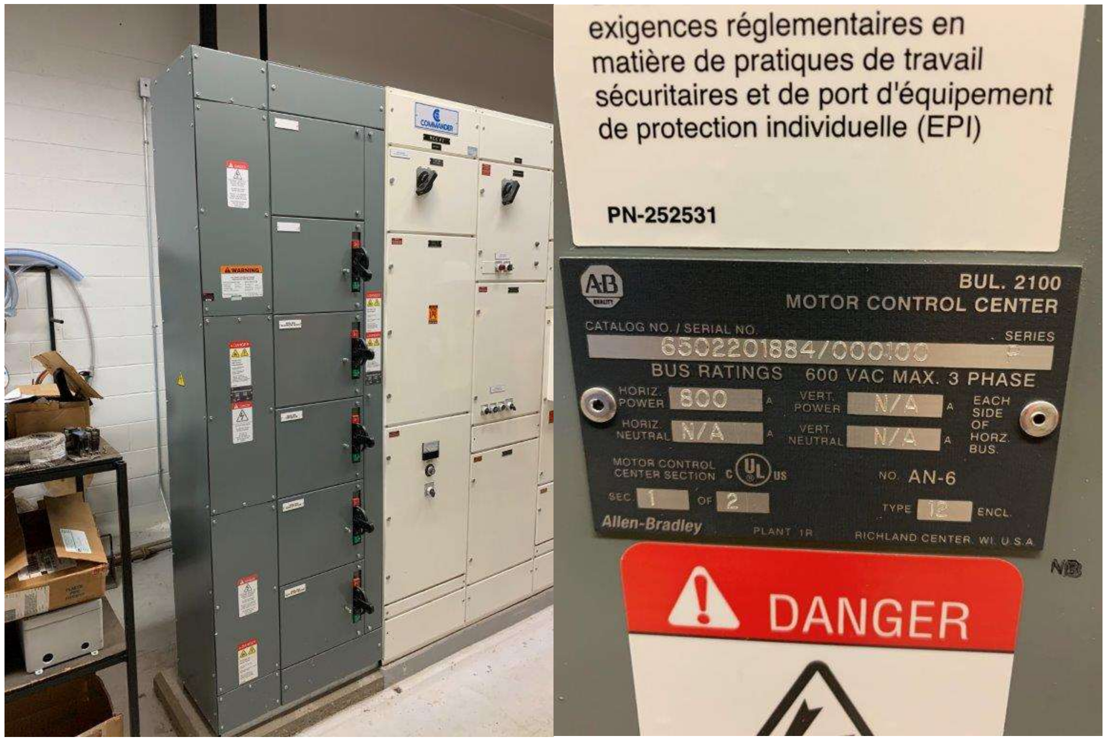


Photo No.	Date
E14	9/1/2020

Direction Photo Taken

WTP – MCC3

Description

MCC3 Lineup

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
E15	9/1/2020
Direction Photo Taken	
WTP – MCC3	
Description	
MCC3 Nameplates	

Photo No.	Date
E16	9/1/2020
Direction Photo Taken	
WTP – MCC 'E'	
Description	
MCC 'E' Lineup	

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No. E17

Date 9/1/2020

Direction Photo Taken

WTP- MCC 'E'

Description

MCC 'E' Nameplate + Automatic Transfer Switch

Photo No. E18

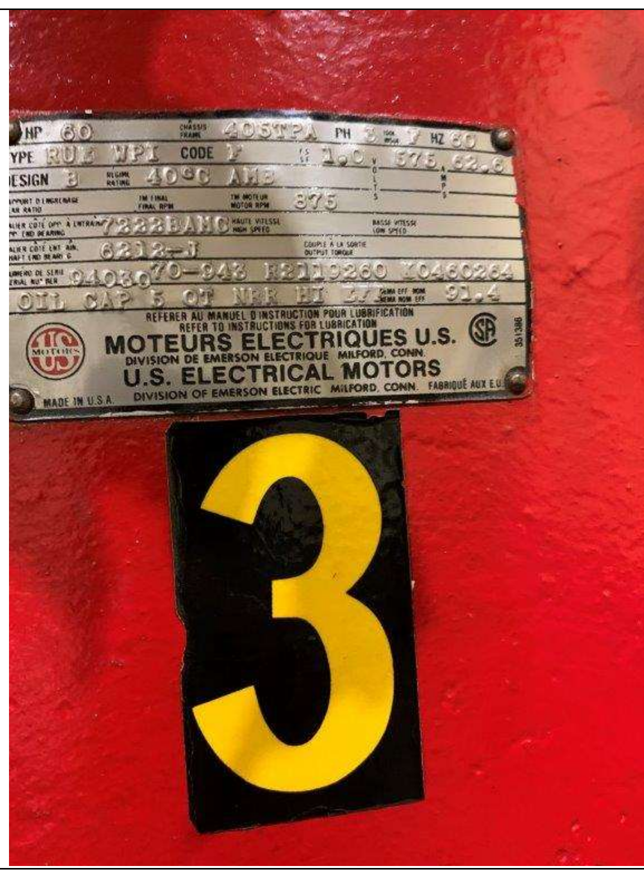
Date 9/1/2020

Direction Photo Taken

WTP – Low Lift Pump

Description

Low Lift Pump Motor 3 Nameplate



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ELECTRICAL PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
E19	9/1/2020

Direction Photo Taken

Gros Cap – Floor Plan

Description

Gros Cap Ground Level Electrical Infrastructure

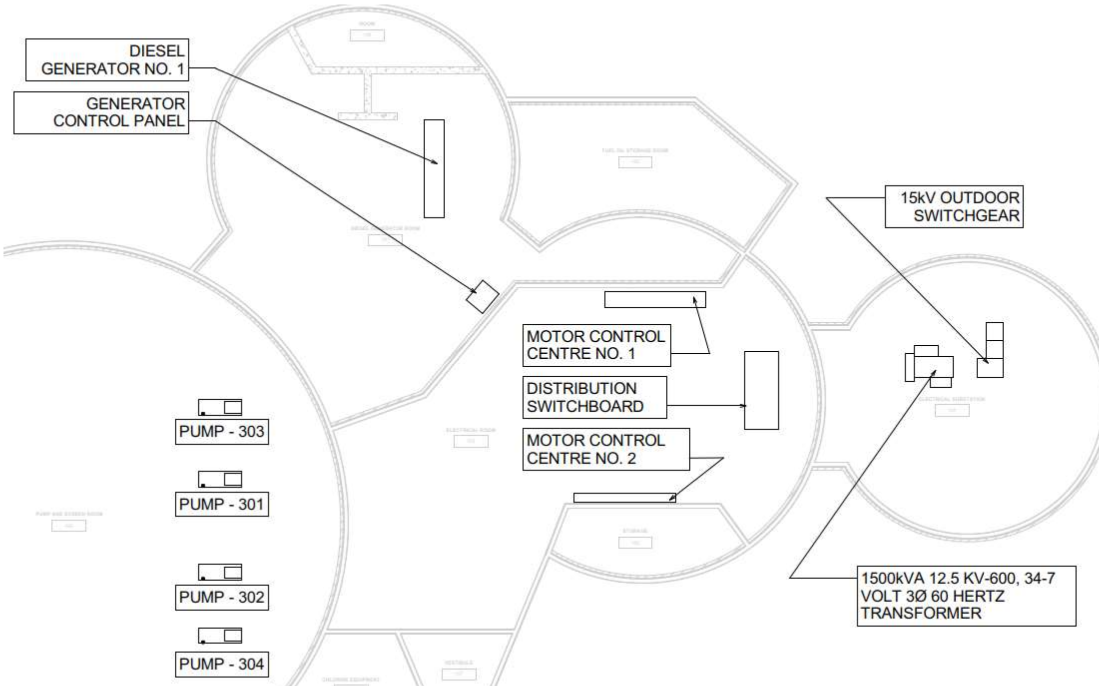

Photo No.	Date
E20	9/1/2020

Direction Photo Taken

Gros Cap - Exterior

Description

Incoming Switchgear and Transformer

ELECTRICAL PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
E21	9/1/2020

Direction Photo Taken

Gros Cap - Exterior

Description

Incoming Switchgear and Transformer Nameplates

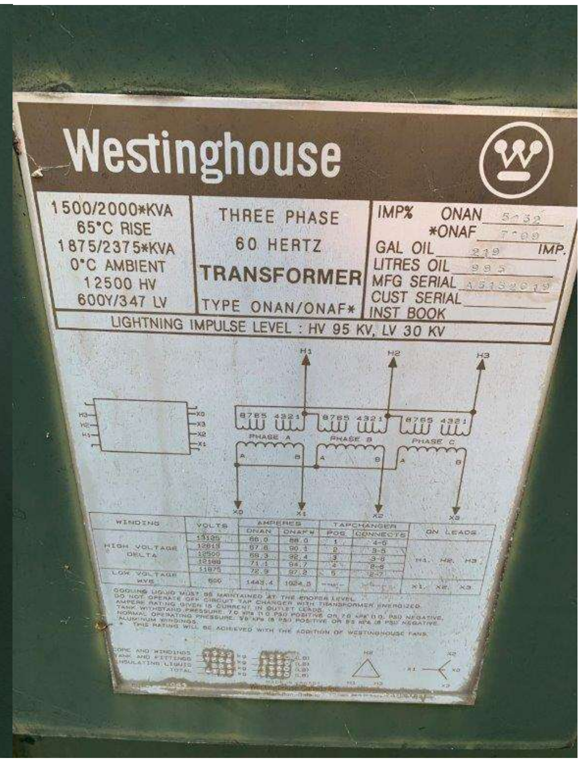

Photo No.	Date
E22	9/1/2020

Direction Photo Taken

Gros Cap – Electrical Room

Description

Main incoming switchboard lineup

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
E23	9/1/2020

Direction Photo Taken

Gros Cap – Electrical Room

Description

MCC1 Lineup

Photo No.	Date
E24	9/1/2020

Direction Photo Taken

Gros Cap – Electrical Room

Description

MCC1 Nameplate

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
E25	9/1/2020

Direction Photo Taken

Gros Cap – Electrical Room

Description

MCC2 Lineup

Photo No.	Date
E26	9/1/2020

Direction Photo Taken

Gros Cap – Generator Room

Description

Diesel Generator and Control Panel

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
E27	9/1/2020

Direction Photo Taken

Gros Cap – Pump Room

Description

Raw water pump and nameplate

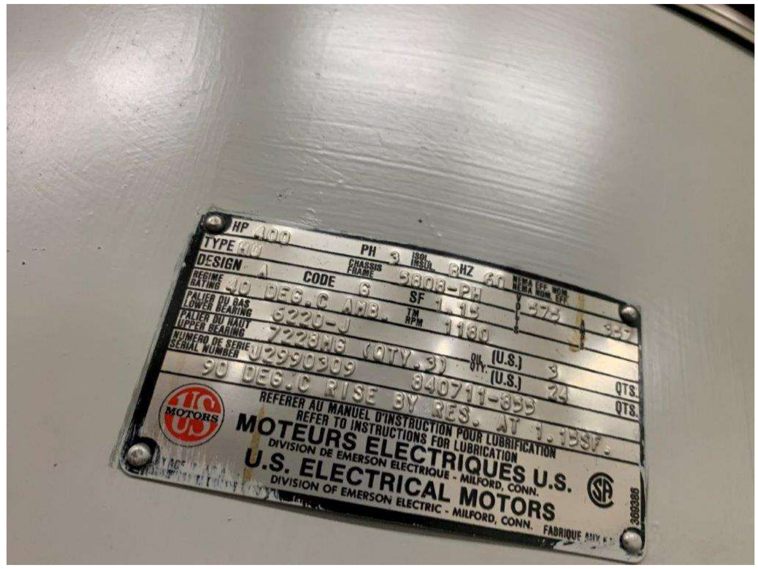

Photo No.	Date
E28	9/2/2020

Direction Photo Taken

Shannon Well

Description

Floor Plan Electrical Infrastructure

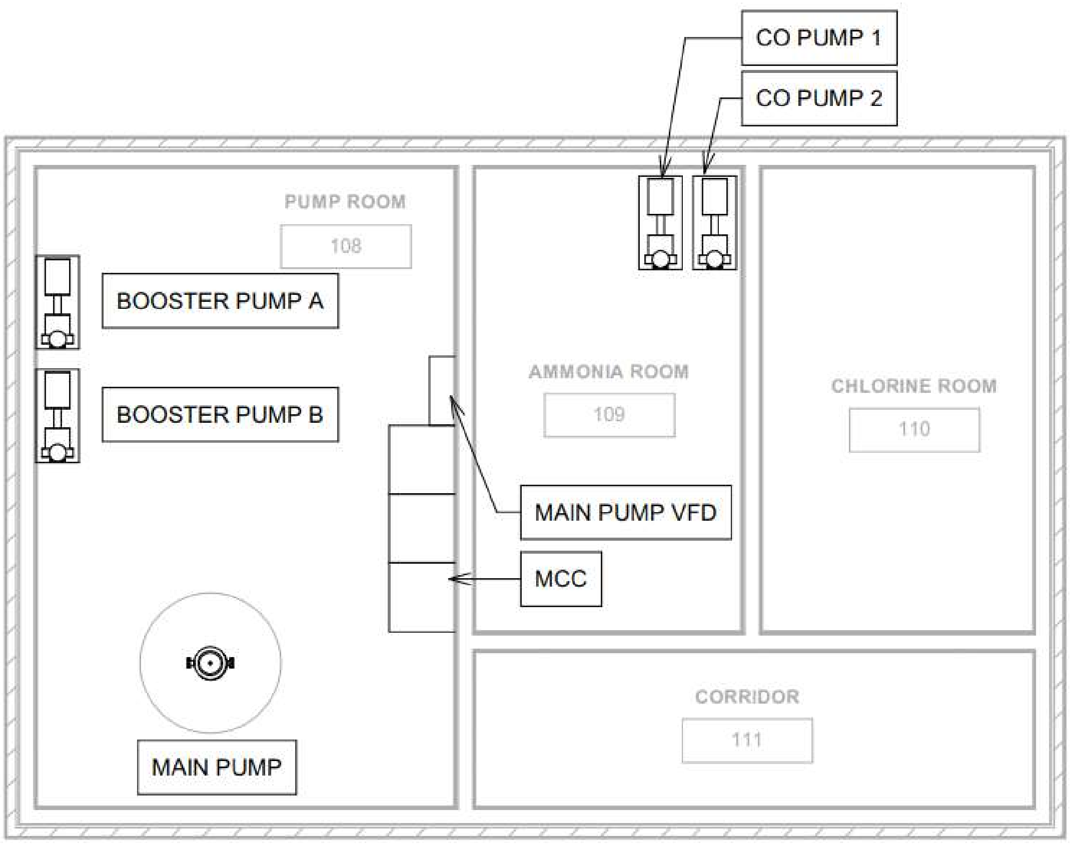

Photo No.	Date
E29	9/2/2020

Direction Photo Taken

Shannon Well

Description

MCC1 Lineup + Main Pump VFD

Photo No.	Date
E30	9/2/2020

Direction Photo Taken

Shannon Well

Description

Power monitor and SCADA Control Panel

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ELECTRICAL PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
E31	9/2/2020

Direction Photo Taken

Shannon Well

Description

Well Pump Motor + Nameplate

Photo No.	Date
E32	9/2/2020

Direction Photo Taken

Shannon Well

Description

Chlorine Booster Pumps 1 + 2 and name plate

ELECTRICAL PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
E33	9/2/2020

Direction Photo Taken

Shannon Well

Description

CO2 Booster Pumps 1+2 and nameplate

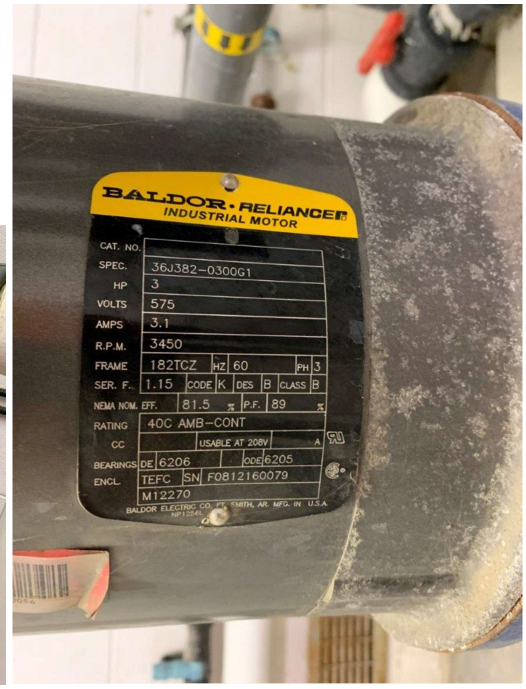


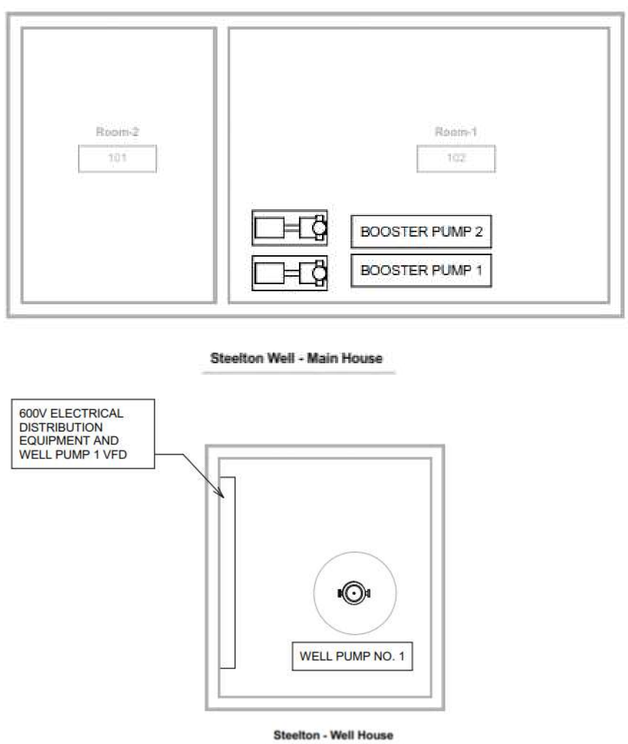
Photo No.	Date
E34	9/1/2020

Direction Photo Taken

Steelton Well

Description

Steelton Well Main house and Well house electrical infrastructure layouts



Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
E35	9/1/2020

Direction Photo Taken

Steelton Well

Description

Well House and pad mounted utility transformer for 600V service and incoming overhead 120/208V service to main house.

Photo No.	Date
E36	9/1/2020

Direction Photo Taken

Steelton Well

Description

Well House Electrical distribution equipment

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ELECTRICAL PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
E37	9/1/2020

Direction Photo Taken

Shannon Well

Description

Well Pump and nameplate

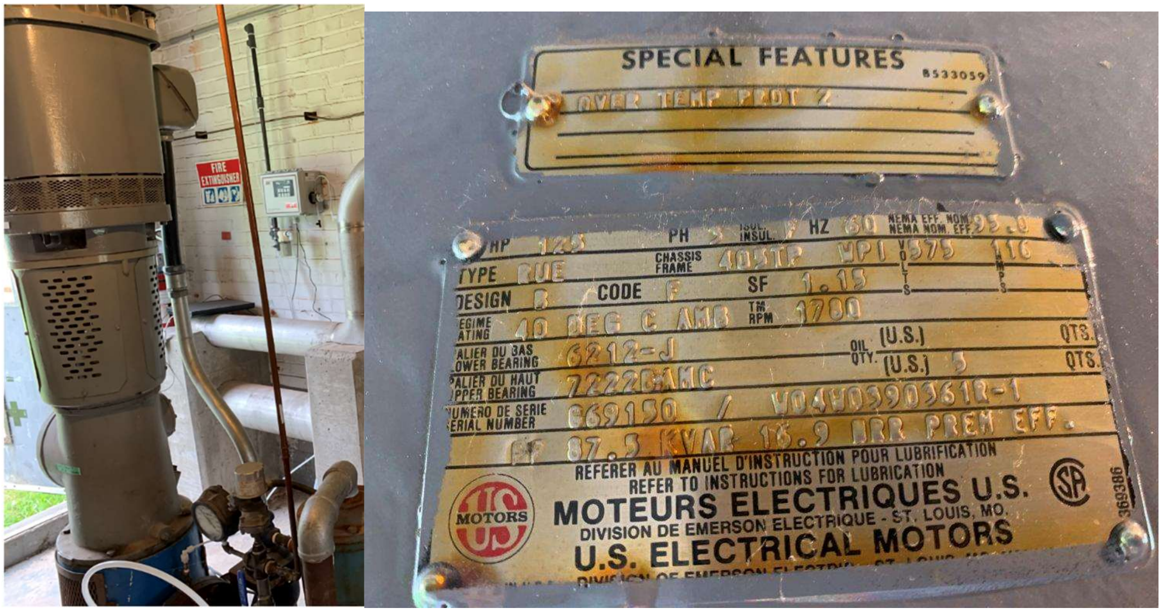


Photo No.	Date
E38	9/1/2020

Direction Photo Taken

Steelton Well

Description

Well House Pump VFD and Pump supply transfer switch.

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
E39	9/2/2020

Direction Photo Taken

Steelton Well

Description

Main house 120/240V distribution panel and 600V splitter and disconnect switches for Booster pumps

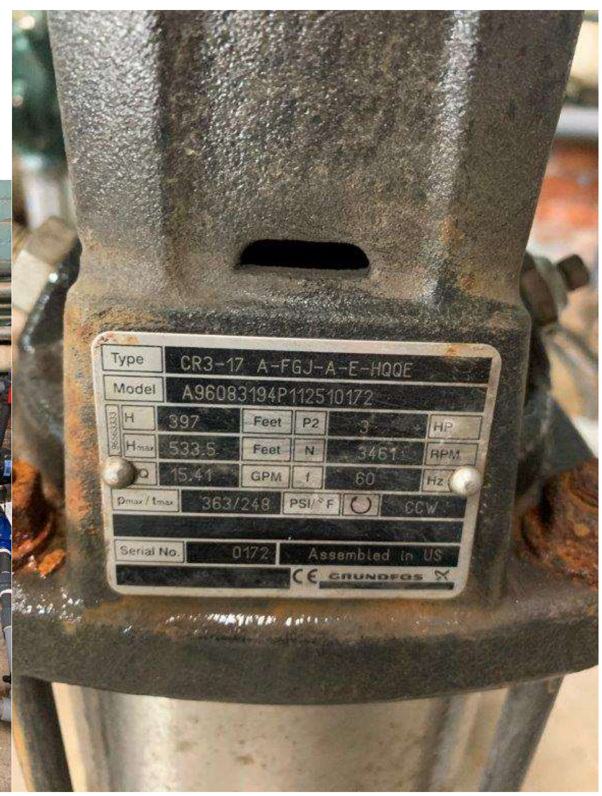
Photo No.	Date
E40	9/1/2020

Direction Photo Taken

Steelton Well

Description

Main house Booster pumps 1 + 2 and nameplate



ELECTRICAL PHOTOGRAPHIC LOG		
Client Name: PUC Water Treatment Facilities	**Site Location** Sault Ste Marie	**Project No.** 60636362

Photo No.	Date
E41	9/1/2020
Direction Photo Taken	
Lorna Well	
Description	
Lorna Well Electrical Infrastructure Plan	

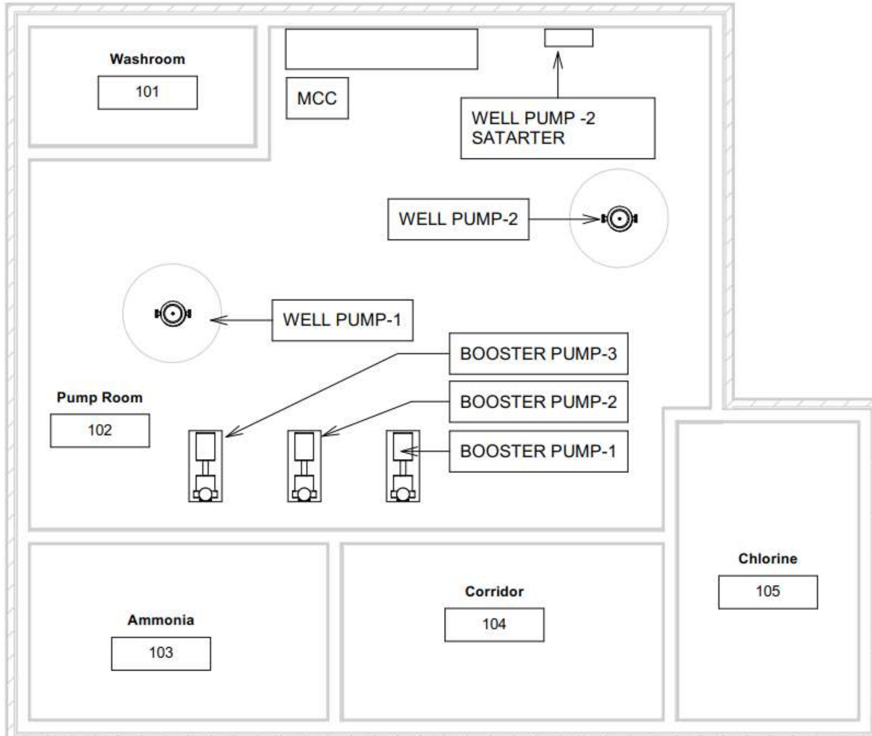


Photo No.	Date
E42	9/1/2020
Direction Photo Taken	
Lorna Well	
Description	
MCC1 Lineup	

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ELECTRICAL PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
PUC Water Treatment Facilities	Sault Ste Marie	60636362

Photo No.	Date
E43	9/1/2020

Direction Photo Taken

Lorna Well

Description

Well Pump 1 and nameplate

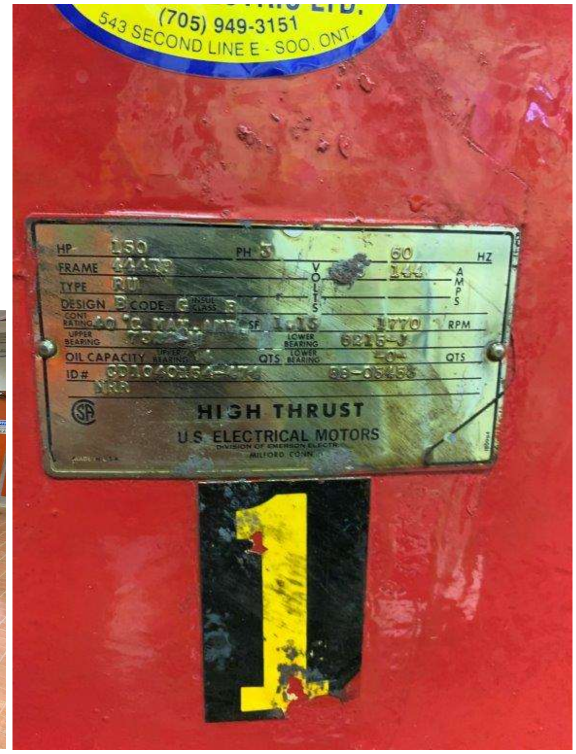

Photo No.	Date
E44	9/1/2020

Direction Photo Taken

Lorna Well

Description

Chlorine Booster Pumps

Appendix D

TM4 - Levels of Service

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Public Utilities Commission of the City of Sault Ste. Marie

Drinking Water System Asset Management Plan

Technical Memo #4 – Levels of Service

Prepared by:

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Prepared for:

PUC Services Inc.
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Sault Ste. Marie, ON P6A 6P2

Date: July 2023

Project #: 60596267

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Revision History

Rev #	Date	Revised By:	Revision Description
0	October 19, 2019	SS,KK	Initial Draft
1	May 17, 2020	SS, KK, MS	Internal review and draft submission
2	October 01, 2020	KK	Internal review based on PUC Comments
3	October 14, 2020	RT, CL	Internal QA/QC
4	December 08, 2020	RT, KK	Review of Final Report
5	July 11, 2023	KK	Final Report

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Orlan Euale, P.Eng.
Senior Water Distribution Engineer
PUC Services Inc.
500 Second Line E,
Sault Ste. Marie, ON P6A 6P2

July 12, 2023

Project #
60596267

Dear Orlan:

Subject: Drinking Water System Asset Management Plan
Technical Memo #4 – Levels of Service

Please, find enclosed our Final Report on Levels of Service for the drinking water system at Sault Ste. Marie.

We trust the enclosed meets your approval. Should you have any questions or require further information about our submission, please do not hesitate to contact us.

Sincerely,
AECOM Canada Ltd.

Khalid Kaddoura, PhD, P.Eng, PMP, IAM Cert., M.ASCE, M.CSCE
Asset Management Specialist
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khalid.kaddoura@aecom.com

Encl.
cc:

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AECOM: 2015-04-13

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Asset Management Lead

Table of Contents

List of Figures

List of Tables

Appendices

1. Project Overview

PUC Services Inc. ("PUC") is a utility services company operating as a wholly owned private company of the Corporation of the City of Sault Ste. Marie. PUC operates a drinking water system and an electrical distribution system under service contracts between PUC and its clients. The City of Sault Ste. Marie (herein referred to as "the City") has a population of 73,368 and is projected to experience an increase in population of 9,900 by 2036 (as reported to Council in 2019). To service this population, PUC maintains a drinking water system dating back to 1916. Today, PUC supplies drinking water from both surface water and groundwater using a combination of surface water intakes and pumps, a surface water treatment plant, 6 wells, two reservoirs, and 445 kilometres of watermains .

PUC is charged with maintaining and renewing a diverse portfolio of mixed vintage infrastructure within the bounds of available funding levels. At the same time, PUC strives to enable development in a municipality that has experienced minimal growth in recent years. With a variety of water sources, PUC desires to align its future investments in drinking water sources, treatment facilities, storage, and conveyance with growth projections while ensuring that a high quality of drinking water is provided. As well, PUC recognizes the challenges in drinking water distribution. Unlike wastewater and/or stormwater collection systems, pressurized watermains are often operationally and cost prohibitive to inspect, resulting in many municipalities possessing limited condition information, and in many cases managing them in a reactive fashion.

With the inception of Ontario Regulation 588/17, PUC faces an upcoming series of regulatory requirements for asset management systems that align with ongoing PUC and City initiatives to update the Financial Plan, develop a Drinking Water Master Plan, and update the City's Official Plan. Recognizing the alignment of these goals with asset management, PUC has engaged AECOM to develop a Drinking Water System Asset Management Plan. The project deliverables will provide PUC with a roadmap for establishing its asset management system and include:

1. A review of asset data and data management practices to evaluate requirements for the proposed asset management system.
2. The creation of an Asset Management Policy to serve as the top-down guidance document that defines the components of the asset management system.
3. An analysis of the State of the Infrastructure using a combination of desktop and field assessments to develop risk profiles and identify further condition assessment activities for large assets.
4. Development of PUC's current and proposed Levels of Service.
5. The consolidation of plans and projects required to achieve the objectives of the asset management system into an Asset Management Strategy.
6. The development of a Financial Strategy to evaluate the requirements for sustainably funding the asset management system, to propose funding models for meeting the needs of the system, and to support the update of PUC's Financial Plan.

1.1 This Report

This Technical Memo encompasses the development of the Levels of Service Framework for PUCs Water Treatment Plant and water Distribution System. The goals of this report are as follows:

1. Establish an understanding of Levels of Service;
2. Review current regulatory requirements and best practices for management of water treatment plants;

3. Define the current Levels of Service provided by PUC (at a utility level not at a customer level);
4. Define the desired Levels of Service by incorporating industry best practices and regulatory requirements;
5. Set the stage for defining desired maintenance activity levels; and
6. Establish performance measures that can be used to monitor progress and achievement.

This memo summarises the results of this task; namely to outline PUCs current and desired levels of service.

2. Defining Levels of Service

2.1 What Are Levels of Service?

Typically, the term Level of Service (LoS) is used to describe the quantification of benefits that a municipal customer receives from municipal services based on the perspective of the customer. The term "services" is specifically used here, because most customers will have little or no interest in individual assets. They instead focus on the service outcomes they receive from the infrastructure. By defining the LoS, a customer can expect, PUC can then define specific activities they can engage in to provide or meet the desired service.

By making a commitment to a given LoS, PUC is also implicitly committing to employ a given amount of PUC's resources to actualizing this LoS. The level of funding and resources used in managing water linear assets should be directly tied to the defined LoS. Defining LoS and subsequent activity targets are excellent communication tools for establishing funding levels, as customers and asset owners gain an understanding of how customer service can be related to use of government resources. Trade-offs can then be made as performance or spending becomes unpalatable. When resources are limited, LoS can be established as a compromise between the minimum and desired LoS, with the understanding that additional funding and/or resources could be required to improve the agreed upon LoS.

In theory, PUC could identify various LoS (minimum, existing, higher etc.) and determine the cost of providing each of these LoS. PUC could then have an informed discussion with residents and business owners to determine their desired LoS and their willingness to pay for the desired LoS. This discussion is particularly important when considering water network funding needs.

In defining PUC's LoS, the underlying goal is to identify gaps between the current and desired LoS, and quantify the changes needed to actualize PUC's goals; including the required changes in lifecycle activities or performance and the associated cost.

2.2 The Context of Water Network Management

LoS are an important part of the asset management (AM) business cycle as they determine the expected requirements of assets. LoS are generally separated into the following levels (**Figure 1**).

- **Utility LoS** describe the organizational mission, vision and corporate goals and objectives, as reflected in the direction provided by elected officials and the municipal administration. The Utility LoS generally set the tone for the LoS that stakeholders want and are willing / able to support financially. These goals and objectives should reflect the values of the stakeholders but may be directed by certain legislative / regulatory requirements.
- **Customer LoS** describe in plain language that is understandable by most stakeholders the service that individual stakeholders and users can expect.

As such, LoS should be connected through the entire organization and, ultimately, to each individual asset and activity that contributes to providing the service. They should be a set of tools to help an organization guide customer expectations about service and price, while at the same time, provide an organization with facts and numbers to help guide mission and business outcomes

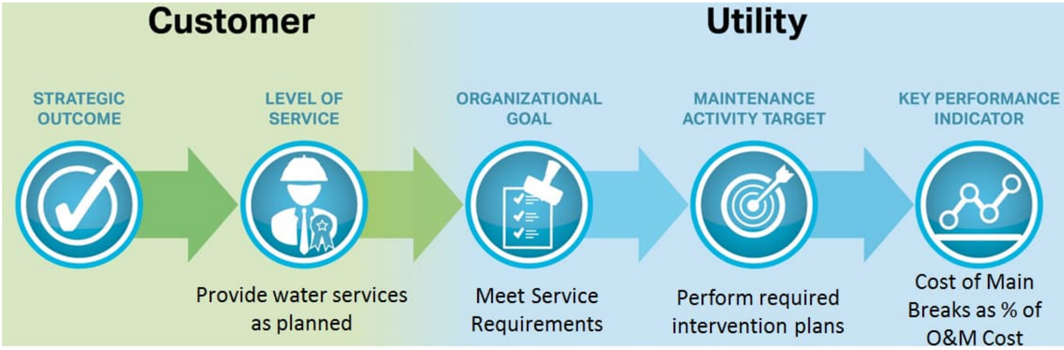

Figure 1: The Link Between Activities, KPIs, and "Customer Related LoS" – An Example

To study these targets, certain performance measures have been identified which align with the methodology presented in AECOM's National Water and Wastewater Benchmarking Initiative (NWWBI, see www.nationalbenchmarking.ca). The following section introduces the methodology.

2.3 Methodology and Approach

2.3.1 The National Water and Wastewater Benchmarking Initiative

Through the National Water and Wastewater Benchmarking Initiative (NWWBI), AECOM and participating municipalities have identified a generic goal model for municipal services. The goal model sets the framework for identifying a municipality's LoS for water services (**Figure 2**).

Figure 2: National Wastewater Benchmarking Initiative Goal Model for Utility Management

Using the approach of defining an overall goal, understanding the underlying sub-goals and how one would measure the achievement of a sub-goal, the development of a utility level LoS framework can be taken from broad overall goals down to the specific measures of performance that will drive achievement. **Table 1** provides a listing of the sub-goals and measures to be employed in developing the water utility's LoS framework for each water network service area. Many of the performance measures are applicable to both facilities and linear assets. Where the performance measure is considered for the asset, "Y" is used. In case a performance measure is not used for facilities or linear assets, "N" is used.

The definition and formulas for these measures can be found in **Appendix A**. The majority of the performance measures values were supplied by PUC.

Table 1: Goals, Sub-goals and Performance Measures

Sub-Goal	Performance Measure	Facilities	Linear Assets
Goal 1 - Provide Reliable Service and Infrastructure			
Reliable Treatment & Distribution System	Do design criteria comply with the Design Guidelines for, A) FACILITIES: Drinking Water Systems by Ontario Ministry of the Environment? B) LINEAR: AWWA minimum requirements?	Y	Y
	Are design standards and specifications documented?	Y	Y
	Are design criteria, standards and specifications reviewed on a regular basis to ensure compliance with applicable standards and guidelines?	Y	Y
	Number of distribution systems failures per 100 km per year?	N	Y
	% of Main Length Replaced or Relined	N	Y
	Is a risk assessment plan in place to identify the risks to providing safe and reliable service? If yes, Is the risk model used to proactively manage asset lifecycle?	Y	Y
Proactive Maintenance Management	Is a condition assessment plan in place to monitor and gather data on the various assets at the plant (Structural, Process Mechanical, HVAC, I&C, Electrical)? Is a condition assessment plan in place to monitor and gather data on the various assets (transmission mains, distribution mains, services, etc.)?	Y	Y
	% of Valves Cycled	N	Y
	% of Hydrants Inspected or Winterized	N	Y
	Preventative maintenance program developed (valve, water main, hydrant, leak detection)	Y	Y
Asset Renewal and Replacement	Capital Budget requirements identified through annual review of performance indicators and risk analysis?	Y	Y
	Amount spent on Capital Reinvestment / Replacement Value?	Y	Y
Emergencies are responded to with defined procedures	Do operators maintain an inventory of spare parts matched to the specifications of the assets?	Y	Y
	Are emergency response times defined?	Y	Y
	Are Contingency plans defined and rehearsed for typical failures as well as critical assets?	Y	Y
	How many hours were spent in reactive maintenance?	Y	Y
	Number of emergency service connection repairs (# Service Connection Repairs & Replacements / # of Service Connections	N	Y
	Does the Municipality maintain agreements with contractors for the standard operating procedure in response to unplanned outages?	Y	Y
Goal 2 - Ensure Adequate Capacity			
Demand Side Management	# of Days the Plant Operated > 90% and > 100% of Capacity	Y	N
	Does the available flow meet the minimum demand requirement?	Y	Y
	Are the acceptable pressure requirements maintained? What is the Average Operating Pressure?	N	Y
	Does the municipality have a Master Plan? Does the municipality conduct master planning exercises?	Y	Y
Goal 3 - Meet Service Requirements with Economic Efficiency			
Municipality meets service requirements	Facilities: Quality of water monitored at each treatment step or does the quality of water at outlet meet the regulatory limits defined in O. Reg. 169/03: ONTARIO DRINKING WATER QUALITY STANDARDS? Distribution: Quality of water monitored as specified in O. Reg. 170/03 for Large Municipal Residential System?	Y	Y
Service requirements are achieved with	Total Cost to Provide Water / Population Served	Y	Y
	Breakdown of O&M Cost / ML Treated (F) & / km Length (DS)	Y	Y
	Cost of Water Quality Monitoring / Population Served	Y	Y

Sub-Goal	Performance Measure	Facilities	Linear Assets
Economic Efficiency	Cost of Chemical per ML Treated	Y	N
	(O&M Cost + Capital Reinvestment Cost) / ML Treated	Y	N
	Cost of Main Breaks Repairs as % of Total O&M Cost	N	Y
	Cost of Fire Hydrant O&M/# of Fire Hydrants	N	Y
	Is there co-ordination between PUC and the City for Capital municipal work (roads, water, sewers)	N	Y
Deliver Value to the Stakeholders	Volume of Non-Revenue Water in L/Connection/Day	N	Y
	Revenue Generated by Customer Billing / Cost of Treated Water	Y	Y
Goal 4 -Protect the Environment			
Service requirements are moderated using conservation measures	% of Water Wasted During Treatment Process	Y	N
	% of Backwash Waste Treated	Y	N
	Breakdown of GHG Emissions from Energy Consumed in the Operation of the Treatment Plant	Y	N
	Water conservation targets	Y	N
	Program in the community to promote the reduction of water use through education and the use of water efficient fixtures. *Or* Program in the community to convey how safe it is to drink tap water and more environmentally friendly compared bottled water.	Y	Y
	Cost of Water Conservation Program/Population Served	N	Y
	Average Residential Daily Consumption per Capita (L/Cap/D)	N	Y
	Peaking Factor (MDD/ADD)	N	Y
Leak Estimate in Water Systems	Infrastructure Leakage Index	N	Y
Goal 5 - Provide a Safe and Productive Workplace			
Safe Workplace	Are Health and Safety plans in place for SOPs?	Y	Y
	Are regulatory requirements for O&M achieved (OSHA)?	Y	Y
	Number of hours dedicated to safety training per year.	Y	Y
Productive Workplace	Breakdown of Unavailable O&M Hours / Total Paid O&M Hours	Y	Y
	# of O&M Accidents with Lost Time / 1,000 O&M Labour Hours	Y	Y
	Overtime hours paid as a result of emergency repairs	Y	Y
	Are activities defined and controlled using SOPs?	Y	Y
	Total Overtime Hours / Total Paid O&M Hours	Y	Y
Goal 6 - Protect Public Health and Safety			
Water quality achieves regulatory requirements for public health and safety	# of Boil Water Advisory Days	Y	N
	# of Total Coliform Occurrences in Treated Water	Y	N
	Average Value for Turbidity	Y	N
	Average Value for Treated Water Nitrates	Y	N
	Cumulative Length Cleaned as % of System Length per Year	N	Y
	Number of Water Quality Samplings (Distribution) exceeded Ontario Drinking Water Standard/Reg Requirements	N	Y
Goal 7 - Satisfied and Informed Customers			
Informed Customers	Are customer facing staff knowledgeable of the assets, common issues, and customer questions?	Y	Y
	Does the municipality educate the public through outreach efforts?	Y	Y
	Does Council endorse the Levels of Service proposed for O. Reg 588/17 compliance?	Y	Y
	Is the public aware of the Level of Service it receives?	Y	Y
Satisfied Customers	# of Water Quality Customer Complaints / 1,000 People Served	Y	Y
	# of Water Pressure Customer Complaints / 1,000 People Served	N	Y
	Target Response Times for Emergencies and Attainment	Y	Y
	Target Response Times for Non-Emergencies and Attainment	Y	Y

2.3.2 Workshops

Using the model framework developed through the NWWBI, AECOM drafted potential goals, sub-goals, and performance measures for PUC's water infrastructure system. These goals and sub goals were discussed with PUC staff in an arranged workshop.

3. Developing 'Minimum Levels of Service'

Minimum Levels of Service (LoS) describe the minimum achievement PUC must deliver through its water infrastructure management as directed by regulations, and directives from corporate leadership or Council members. There are several constraints and requirements that steer how PUC conducts water infrastructure management. Compliance with Provincial and Federal regulations is required to avoid fines, legal action, or loss of funding opportunities; meaning that compliance must always be ensured as the minimum. These realities inform the development of the minimum LoS that PUC recognizes it must accomplish. Only with this understanding can the use of resources be evaluated as focus shifts to seeking savings opportunities or delivering on a desired LoS beyond the minimum requirement. Minimum LoS provides the baseline for these discussions.

The following section includes some of the best practices, codes and regulations that are relevant to water systems which also supports presenting the performance measure results.

3.1 Regulations and Best Practices

3.1.1 Drinking Water Systems (Ontario Regulation 170/03)

This document provides insights into minimum requirements that each water distribution owner is required to follow to ensure safe drinking water is supplied and delivered to customers (Ontario, 2018)[1]. The document is divided into several schedules that are related to treatment equipment, sampling, operational checks, and testing. In general, the schedules outline:

- Expected sampling frequencies;
- Sampling locations;
- Microbiological sampling and chlorine residual requirements;
- Form of samples;
- Continuous monitoring and other testing requirements.

The minimum requirements in the schedules, in many cases, depends on the treatment methodologies adopted by each municipality. Therefore, comprehensive minimum thresholds based on the Regulation can be derived after studying the drinking water system as a whole (distribution system as well as treatment plants).

3.1.2 Ontario Drinking Water Quality Standards (Ontario Regulation 169/03)

This document lists the standards required to be attained to produce acceptable drinking water quality (Ontario, 2018)[2]. The act contains several schedules that define Microbiological Standards, Chemical Standards and Radiological Standards.

[1] Ontario. (2018). *DRINKING WATER SYSTEMS*. Retrieved from https://www.ontario.ca/laws/regulation/030170
[2] Ontario. (2018). *ONTARIO DRINKING WATER QUALITY STANDARDS*. Retrieved from https://www.ontario.ca/laws/regulation/030169

3.1.3 Drinking Water Testing Services (Ontario Regulation 248/03)

Under this regulation, PUC is required to perform tests in specific laboratories. Any laboratory that performs drinking water testing should have a license and accredited for the tests they conduct (Ontario, 2018)[3]. PUC should ensure laboratories used have the minimum requirements mentioned in the regulation.

3.1.4 Asset Management Planning for Municipal Infrastructure (Ontario Regulation 588/17)

In December 2017, the Province of Ontario passed a regulation titled, *Asset Management Planning for Municipal Infrastructure*, under the *Infrastructure for Jobs and Prosperity Act (2015),* to regulate asset management planning for municipalities. There are several key deadlines with requirements for asset management planning, including requirements for formalized LoS by July 1, 2025, accompanied by a financing strategy for funding the activities that achieve the LoS. **Table 2** provides the amended deadlines along with the regulatory requirements related to *Ontario Regulation 588/17*.

Table 2: Ontario Regulation 588/17 Deadlines

Deadline Date	Regulatory Requirement	Additional Information
July 1st 2019	All Municipalities are required to prepare their first **Strategic Asset Management Policy.**	The Strategic Asset Management Policy must be reviewed and, if necessary, updated at least every five (5) years.
July 1st 2022	All municipalities are required to have an **Asset Management Plan** for its entire **core municipal infrastructure.**	Assets under Core Municipal Infrastructure include water, wastewater, stormwater, roads, bridges and culverts.
July 1st 2024	All municipalities are required to have an asset management plan for infrastructure assets not included under their core assets.	Other assets not identified in the Core Assets above.
July 1st 2025	All Asset Management Plans **must include information about the levels of service that the municipality proposes to provide, the activities required to meet those levels of service, and a strategy to fund activities**	

3.1.5 Distribution Systems: Design Guidelines for Drinking-Water Systems

The chapter on Distribution Systems in the *Design Guidelines for Drinking-Water Systems* provides requirements to follow in designing a water distribution system that balances water quality and water network performance. The minimum and maximum requirements defined in the document shall be followed when designing new assets. During operation, any variations in specific parameters could indicate deficiencies in the water distribution system. **Table 3** provides some of the design/maintenance requirements for a distribution system along with some of the operational insights related to each item.

[3] Ontario. (2018). *Drinking Water Testing Services*. Retrieved from https://www.ontario.ca/laws/regulation/03024

Table 3: Design/Maintenance Requirements and Operational Indications

Item	Design	Operation
Maintaining Water Quality	Maximize turnover and minimize retention times and water age.	Owners should perform the minimum sampling requirements to ensure water quality is not deteriorated. Reported aesthetic parameters could be an indication of some material deterioration (i.e., red water may indicate internal corrosion in metallic pipelines).
Operating Pressure	Operating pressure to be designed for minimum of 20 psi and maximum 100 psi, as per the most recent standard published by the Ministry of Environment, Conservation and Parks (MECP). While this standard is the latest, existing system design may align with older standards and regulations.	The normal operating pressure in the distribution system shall be between 50 and 70 psi. However, pressures not within this range may be dictated by the system size and or topography. Water pressure complaints could be an alert of some water distribution operating pressure problems.
Transient Pressure	Watermains shall be designed to withstand operating pressure and induced transient pressure.	Pipelines that do not have a minimum capacity to withstand transient pressures could lead to failure in pipelines.
C-Factor	The design should consider the minimum AWWA requirements.	C-Factor could be an indication of deterioration. In Asbestos Cement pipelines, values that exceed the original C-Factors are indications of internal deterioration. In metallic pipelines, however, values that are less than the original values could be an indication of tuberculation in pipelines.
Material Selection	Some of the requirements when selecting pipe material are related to trench foundation, location, soil conditions, etc.	Unaccounted loads and improper bedding requirements could impose stresses that lead to failure. Soil condition is another crucial parameter. Corrosive soil could lead to excessive external deterioration and lead to pipeline failure.
Flushing	Flushing devices shall provide a minimum velocity of 0.8 m/s to flush watermains.	As the main aim of flushing is to maintain water quality and increase capacity of the distribution system, flushing at lower velocity rates would not attain the main objectives.
Corrosion	Where aggressive soil conditions are suspected, some analysis are required to be performed. Metallic material used shall be protected.	Corrosive soil will lead to deterioration of the external surface of unprotected metallic pipelines. Upon metallic pipeline failure and extraction of a sample coupon, external deterioration could indicate corrosive soil.

3.1.6 Procedure for Disinfection of Drinking Water in Ontario

This procedure is intended to provide systematic methodologies related to water disinfection and pre-disinfection that may be required for an effective disinfection process (Ontario, 2018d)[4]. The procedure contains requirements that are related to water treatment plants but also provides requirements for distribution systems. The specific provision in the regulation for the distribution system is as follows:

> *"all drinking water entering a distribution system that has been treated and is otherwise ready for consumption must contain a disinfectant residual that persists throughout the distribution system unless a point of entry treatment approach is used as permitted by the Regulation".*

Table 4 shows the benefits of providing secondary disinfection in water distribution systems along with the minimum and maximum parameter requirements. It should also be noted that disinfection of drinking water systems

[4] Ontario. (2018d). *Procedure for Disinfection of Drinking Water in Ontario*. Retrieved from https://www.ontario.ca/page/procedure-disinfection-drinking-water-ontario

is required after constructions or repairs. The disinfection process for watermains shall be in accordance with the *AWWA Standard for Disinfecting Water Mains (C651)*.

Table 4: Secondary Disinfection Benefits, Minimum and Maximum Requirements

Item	Benefits	Minimum	Maximum
Disinfectant Residual Maintenance (secondary disinfection)	Protect water from microbiological re-contamination reduce bacterial re-growth control biofilm formation Indicator of distribution system integrity	Free chlorine residual of 0.05 mg/L at pH 8.5 or lower or dioxide residual of 0.05 mg/L or where monochloramine is used, a combined chlorine residual of 0.25 mg/L	Chlorine residual <=4.0 mg/L, when measured as free chlorine <=3.0 mg/L when measured as combined chlorine

4. Levels of Service Framework – Workshop Results

This section provides the Levels of Service (LoS) framework for PUC's water treatment and distribution system. This section is structured to provide a detailed description of the current, minimum, and desired LoS for each goal using the methodology outlined in **Section 2.3**, consideration of regulatory requirements, and discussions during Workshop #2.

On October 10th, AECOM and PUC-SSM held a workshop to establish current practices taken by PUC and the goals and directives driving the future. AECOM received feedback on the potential goals, sub-goals, and performance measures for PUC's system. Through discussion with PUC, the framework was refined, and key issues were identified.

4.1 Goal #1 - Provide Reliable Service and Infrastructure

This goal describes the sub-goals required to be achieved and maintained to ensure that PUCs water treatment and distribution system is reliable and is attaining the objective in treating and distributing safe drinking water to customers.

This is measured using three sub-goals:

1. Reliable Distribution System
2. Proactive maintenance management
3. Emergencies responded to with defined procedures

4.1.1 Sub-Goal #1 - Reliable Treatment & Distribution System

Providing reliable infrastructure is a result of construction, rehabilitation, and repair of water infrastructure according to accepted standards and protocols. This sub-goal ensures that built infrastructure is based on accepted standards and requirements of the American Water Works Association (AWWA) and Drinking Water Systems by Ontario Ministry of the Environment. These standards set certain procedures and design requirements in more than 180 AWWA codes that are related to storage, treatment and distribution of all areas of water treatment and supply. As these standards are updated and developed regularly based on technology advancement, it is important to ensure that PUC is aware of the updated standards.

4.1.1.1 Facilities

- PUC has not developed a design criteria manual of their own and typically refers to the regulatory design guidelines. The treatment facilities design criteria comply with the design guidelines specified in the Drinking Water Systems by Ontario Ministry of the Environment and AWWA design guidelines.
- PUC has also documented design standards and specifications in the form of checklist for review.
- PUC annually reviews the documented design standards and specifications.

- PUC currently complies with the DWQMS requirements for performing a risk assessment to identify the risks to providing safe and reliable service. However, the DWQMS model is not used to proactively manage asset lifecycle.

To enhance the Levels of Service of this sub-goal, the facility intends to develop a risk model for proactively managing asset lifecycle through the current Asset Management Plan project.

4.1.1.2 Linear Assets

Design Criteria and Standards

Existing linear assets were designed based on the provincial regulations and standards (e.g. MECP) and following existing practices (e.g., AWWA). Currently, PUC does not have an internal design guideline, but the documented design specifications and standards are reviewed annually to conform with the latest industry and regulatory updates.

Watermain Break Failures

Based on historical data of watermain breaks at Sault Ste. Marie since (1984-2019), the average break rate per 100 km per year is approximately 20. The average age of watermains, which are 100 mm and larger and owned and operated by the City and PUC, is approximately 48 years.

Currently, PUC performs reactive interventions after failure events, and rehabilitation/replacement interventions are conducted according to water quality and capacity requirements. Although these interventions are related to service levels, replacements/protection of vulnerable ferrous pipelines could decrease failure rates in the future, especially in areas with corrosive soils. As part of the project, a risk-based condition assessment strategy will be developed in TM #5 to enhance future practices in condition assessment and/or intervention.

Length of Main Replaced and Relined

Interventions are performed based on quality and capacity requirements. Pipelines that have continuous quality issues and do not provide the required flow are replaced. These practices are not performed based on a risk-based approach. In general, the annual percentage of main length replaced or relined is approximately 0.23%.

PUC is interested in upgrading and enhancing existing infrastructure to avoid sudden collapses in high consequence areas. PUC uses a 75-year renewal cycle to enhance existing condition of watermains and will also consider a risk-based approach to identify and prioritize pipelines based on environmental, economic, operational, and social parameters. These practices could ensure effective funding in future interventions.

4.1.2 Sub-Goal #2 - Proactive Maintenance Management

4.1.2.1 Facilities

Currently, PUC does not follow a condition assessment plan to monitor the condition of its various assets at facilities. While Instrumentation & Control (I&C) assets are frequently calibrated and tested, the maintenance management strategy for most other assets is responsive with some assets run to failure. Any preventative maintenance performed is not recorded or measured. PUC desires to develop and document a preventative maintenance program including measuring achievements.

One indicator to determine the impact of a proactive maintenance program on service level to customers is to track the number of unplanned hours that treatment plants could not operate at rated capacity. PUC does not track these data but desires to do so in the future.

4.1.2.2 Linear Assets

Condition Assessment Plan

Currently, PUC does not follow an advanced condition assessment plan to assess the condition of watermains. However, leak detection is performed annually on one third of the network. Leak detection is performed by a third-party contractor as the utility has limited leak detection tools. The identified leaks are investigated and recorded as failures (available in GIS data). While leak detection is considered part of any maintenance strategy or a preliminary condition assessment technique, leak detection by itself does not provide robust structural evaluations of water pipelines and is typically used as a screening tool.

Break rates and historical conditions of the breaks are utilized as a proxy to assess the condition of pipelines. Unlike watermains, PUC follows a condition assessment plan to monitor the condition of hydrants and valves. Going forward, PUC will rely on a risk-based framework to prioritize condition assessment practices of watermains to better understand the condition of the pipelines.

Percentage of Valves Cycled

PUC has historically done the unidirectional flushing (UDF) on a three-year cycle (e.g. 1/3 of the City per year). Each year, through UDF, about 600 valves are exercised. Because the same UDF plans are followed each year, only valves that are part of the UDF plan are exercised. Annually, valve exercising (including UDF) includes some 5% (2020) to 20% (2019) of valves; however, because many are only exercised through UDF, some valves are not exercised on schedule. Valves on hydrant leads and water services do not get exercised. Approximately, 12% of PUC valves are cycled annually. The percentage of inoperable or leaking valves is approximately 7%.

Since valves are an integral component of the water system, AWWA recommends that each valve should be operated through a full cycle and returned to it's normal position on a schedule that is designed to prevent buildup tuberculation or other deposits that could render the valve inoperable or prevent a tight shut-off. While the valve exercising is suggested to be maximized on an annual basis (100%), PUC could establish a Valve Exercising Program which has some benefits as follows:

- Schedule - Establish valve exercising schedule that staff are able to follow
- Budget allocation - Since the number of valves and locations will be known, PUC will be able to anticipate the expected annual required budget.
- Prioritize valves - Valves are prioritized based on a risk model that could include many parameters including location in the water system (e.g. valves on a transmission main are prioritized when compared to distribution mains)
- Reduction of failure impacts - Reduce areas impacted by breaks and outages during failure events
- Accessibility - Improve accessibility of valves

Percentage of Hydrants Inspected or Winterized

PUC has a well-established inventory of hydrant assets with model and make attributes. In 2018, 50% of the hydrants were assessed and 100% of the hydrants were winterized. As per the data, the percentage of inoperable or leaking hydrants was approximately 0.2%. In 2020, the percentage of annual inspected hydrants increased to 100% of the hydrants.

PUC will continue inspecting all hydrants annually to align with the minimum regulations stated in O.Reg. 213/07. The following list includes some of the requirements but not limited to:

- Municipal and private hydrants shall be maintained in operating condition;
- Hydrants shall be maintained free of snow and ice accumulation;
- Hydrants shall be readily available and accessible for use at all times; and
- Hydrants shall be inspected annually and after each use .

4.1.3 Sub-Goal #3 - Asset Renewal and Replacement

PUC performs asset renewal to enhance levels of service and to ensure that quality drinking water is delivered to customers. PUC annually allocates funds to upgrade water infrastructure, which can then be compared to annual reinvestments as a measure of efficient funding and renewal. The capital budget (for asset replacement or rehabilitation) has been increasing upwards from $1M for the past 15 years. **Table 5** provides a summary of replacement values for surface water treatment facilities derived from *2018 Tech Memo Infrastructure Costs*. Also, **Table 6** summarizes the planned and actual investments for PUC water assets from 2016 to 2020.

Table 5: 2019 Infrastructure Replacement Value for Surface Water Treatment Facilities

2019 Infrastructure Replacement Value (1)	Estimated Cost
Raw Water Surface Supply	
60 ML/D firm cpy raw water pump station	$15,000,000
Marshall Rd Tanks 2 @ 3,393 m(2)	$13,260,000
Surface Water Treatment Plant	
WTP 75 ML/D low lift pumping station 1	$11,400,000
WTP 40 ML/D direct filtration plant 1	$42,000,000
WTP High 60 ML/D High Lift Pump Station	$9,000,000
WTP 15 ML Plant Reservoir	$11,250,000
TOTAL	**$101,910,000**

Notes: 1. Data Source: AECOM - 2018 Tech Memo Infrastructure Costs
2. Kresin Engineering, 2014 estimate plus 3% inflation

Table 6: PUC 2016 to 2020 Capital Report – Actual and Projected Costs

Item	2016	2017	2018	2019	Projected 2020	5-Year Average
Linear City Projects	$4,073,813	$1,669,209	$1,838,032	$2,444,553	$1,970,862	**$2,399,294**
Customer Demand	$209,136	$647,957	$533,705	$999,163	$821,433	**$642,279**
PUC Projects - Linear	$1,130,294	$120,378	$73,115	$387,039	$2,699,844	**$882,134**
Linear Total Costs	**$5,413,242**	**$2,437,544**	**$2,444,852**	**$3,830,755**	**$5,679,713**	**$3,961,221**
PUC Projects - Facilities	$747,419	$1,868,450	$1,657,350	$1,632,399	$2,375,284	**$1,656,180**
Total – Linear + Facilities	**$6,160,661**	**$4,305,994**	**$4,102,202**	**$5,463,154**	**$7,825,701**	**$5,571,542**

4.1.3.1 Facilities

From **Table 6**, of the $4.1 M in 2018's capital renewal and replacement projects, $1.7M was dedicated to water treatment facilities' interventions and engineering studies. PUC reported the total replacement value of the surface water facilities (treatment plant and raw water supply system) to be $101.9 M in 2019-dollar amount (Refer **Table 5**). The same value would be equivalent to $98.9 M in 2018-dollar amount (considering a 3% rate).

Therefore, the 2018 Capital Reinvestment / Replacement Value ratio would approximately be 1.68%. Considering a five-year average (2016 to 2020), the capital costs for facilities is roughly $1.7 M. When using the same replacement costs and the calculated five-year average cost, the Capital Reinvestment / Replacement Value ratio would relatively be the same.

4.1.3.2 Linear Assets

In 2018, PUC spent approximately $2.4 M for capital improvements in the linear water infrastructure (Refer **Table 6**). Considering this budget and a replacement value of watermains of approximately $650 M (*Technical Memorandum #3A – State of Infrastructure*), the performance measure ratio of Capital Reinvestment / Replacement Value for linear assets would approximately be 0.38%. However, if a five-year average (2016 to 2020) of the capital costs for linear assets ($4.0 M) and the same replacement cost are used, the ratio would increase to 0.62%.

PUC's average pipe age is approximately 48 years. PUC plans to enhancing capital planning to maintain minimum LoS as required. PUC will rely on a risk-based approach to maximize the benefits of each dollar spent in future budget allocations and will continue to coordinate with the City's reconstruction projects for better management of assets.

4.1.4 Sub-Goal #4 - Emergencies Responded to With Defined Procedures

4.1.4.1 Facilities and Linear Assets

Spare Parts & Third-Party Agreements

For linear assets, PUC maintains spare parts of valves, clamps, repair parts and several distribution pipe sizes. However, spare parts for transmission mains are limited. PUC will continue maintaining spare parts to respond to emergency needs. PUC verbally agreed with a number of service providers and contractors to respond to emergencies. PUC is confident that existing agreements are sufficient to maintain current service levels.

For facilities assets, PUC maintains spare parts for many critical assets but not for all assets. PUC will continue maintaining spare parts to respond to emergency needs. While essential services and supplies have been identified, no contracts or purchase orders have been executed with contractors.

Emergencies and Contingency Plans

Currently, PUC does not have a defined response time for linear failures but has a defined event-based decision model to decide on the extent of the failure. However, the operation team tries to respond to any reported break or asset failures immediately without delays.

Additionally, PUC has standard operating procedures (SOPs) to respond to breaks. However, no SOPs are available for responding to failures of facilities assets. PUC will continue their existing practices and ensure breaks and emergencies are responded to immediately. SOPs are reviewed and updated where required. PUC intends to develop SOPs for facilities assets to ensure emergencies are responded to within defined procedures.

Reactive Maintenance

Although this measure is not tracked, PUC stated that for distribution systems roughly 75% of its maintenance activities are reactive. Such a practice is normal when condition assessment planning and a risk-based framework are limited. Ultimately, a “fix it when it breaks” methodology will dominate maintenance practices.

The “fix it when it breaks” methodology treats all assets on almost a similar scale while they actually differ given their failure consequences. An asset that has a very high failure consequence would not only have economic impacts but also environmental, safety, operational, and social ones. These are considered some of the parameters when dealing with the consequence of failure in a risk-based approach. With a proactive maintenance framework, PUC could focus attention on assets that are critical to the system to avoid sudden failures and significant impacts to the service levels.

Further, it is recommended to establish a tracking system for this reactive maintenance which is part of this performance measure.

Service Connection Repairs

Many service connection repairs are due to third party damages. However, there are no records to track this metric definitively. PUC will consider tracking this performance measure in the future.

4.2 Goal #2 - Ensure Adequate Capacity

This goal measures available capacity of the water system. This goal is measured by the designed demand requirements.

4.2.1 Sub-Goal #1 – Designed Demand Requirements

4.2.1.1 Facilities

The licensed rated capacity of the WTP is 40,000 m^3/day. PUC has however undertaken studies to identify treatment train constraints with the goal of enhancing capacity by approximately 10%. A system head curve analysis estimated the plants high lift pumping capacity to be adequate to support the proposed increased plant capacity.

Potable water is also produced from four wells (two aquifers) with a total well pumping capacity of 24,200 m^3/day and a firm capacity reported at 9,100 m^3/day (assumes largest pump in each aquifer is out of service) (Refer **Table 7**). Therefore, the supply capacity that can be consistently delivered to the distribution system is 49,100 m^3/day (WTP Rated Capacity + Well Pumping Firm Capacity).

Two additional wells (Lorna Wells) also remain available for service during high demand periods and emergencies. However, Lorna well is not part of PUCs long-term water supply strategy and will be permanently decommissioned in the future due to certain water quality issues in the City’s east end. Considering the availability of the Lorna wells on a stand-by basis the system supply capacity is 62,900 m^3/day.

Table 7: Groundwater Well Capacities[5]

Component	Description	DWWP Pumping Capacity	PTTW
Central Basin/Aquifer			
Goulais Well			
- Goulais Well #1	1 pump @ 63.2 L/s	63.2 L/s (5.5 MLD)	6.6 MLD
- Goulais Well #2	1 pump @ 41.7 L/s	41.7 L/s (3.6 MLD)	3.4 MLD
Steelton Well			
- Steelton Well	1 pump @ 95 L/s	95 L/s (8.2 MLD)	8.2 MLD
Central Basin/Aquifer		105 L/s (Firm) * 9.1 MLD (Firm)	
East Basin/Aquifer			
Shannon Well			
- Shannon Well	1 pump @79.5 L/s	79.5 L/s (6.9 MLD)	7.0 MLD
Lorna Wells			
- Lorna Well #1	1 pump @ 80 L/s	80 L/s (6.9 MLD)	7.3 MLD
- Lorna Well #2	1 pump @ 80 L/s	80 L/s (6.9 MLD)	7.3 MLD
East Basin/Aquifer		**With Lorna Well:** 160 L/s / 13.8 MLD (Firm)* **Without Lorna Well**:** 0 L/s (Firm) * / 0 MLD (Firm)	

* Firm capacity is determined assuming largest pump in each aquifer is out of service
** Lorna wells have been excluded for the purposes of this study as the PUC plans to decommission these wells once adequate alternative production capacity is brought online.

During the LOS workshop, PUC stated that the maximum average daily demand is typically between 38 – 40 MLD. PUC also reported that water consumption at Sault Ste Marie has been declining in the recent past.

PUC performed an Existing Water Infrastructure Capacity Study that concluded that “the estimated maximum day production required to support the existing population is 49 MLD (rounded) indicating the existing production capacity is adequate to support the existing population”.

PUC also initiated a Drinking Water System Master Plan (“Master Plan”) focusing on water supply, storage and distribution system needs in the City of Sault Ste. Marie until 2036. Initial results of this study revealed that PUC’s serviced population is expected to increase from 66,031 in 2016 to 74,986 in 2036 requiring a future maximum day production of 56,000 m^3/day. The current supply capacity of 49,100 m^3/day (exclusive of the Lorna Wells) is adequate to meet the current requirements and the supply capacity including the Lorna Wells is 62,000 m^3/day which is adequate to meet future maximum day production requirements. The Lorna wells will continue to be available for service until a replacement or partial replacement supply or supplies are online.

PUC is currently considering performing a study to upgrade/optimize the water treatment plant to address the capacity constraint. PUC has been and continues to explore options to replace the Lorna wells.

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[5] *PUC Services Inc. - Existing Water Infrastructure Capacity (Final Draft), 2018*

4.2.1.2 Linear Assets

In some locations in the network, flow rates below the minimum desired fire flow requirements are observed. To improve existing flows, PUC is planning to renew and replace pipelines to enhance the supplied flow in some areas.

PUC has a typical operating pressure for the water system between 34 and 115 psi while MECP guidelines suggest a range between 50 and 70 psi. Pressures outside the desirable range are generally dictated by topography and system size.

Based on the information provided by PUC, the average pressure between the start and end was considered for each pipe segment to display the results in **Figure 3**. As per the figure, the majority of the pipelines are operating at a pressure that is within the 50 to 70 psi range. In specific, 30 km of the pipelines are operating at a pressure less than 50 psi and around 150 km of the pipelines are operating at a pressure higher than 70 psi. From the 150 km, only 2 km are operating at a pressure greater than 100 psi.

As higher pressures in deteriorated pipelines could result in a failure (depending on the residual factor of safety), monitoring the pressure in the system and the pipeline condition are recommended. Compared with the generic recommendations of the MECP, the majority of PUC's system is operating within the MECP guideline's pressure range (between 50 to 70 psi).

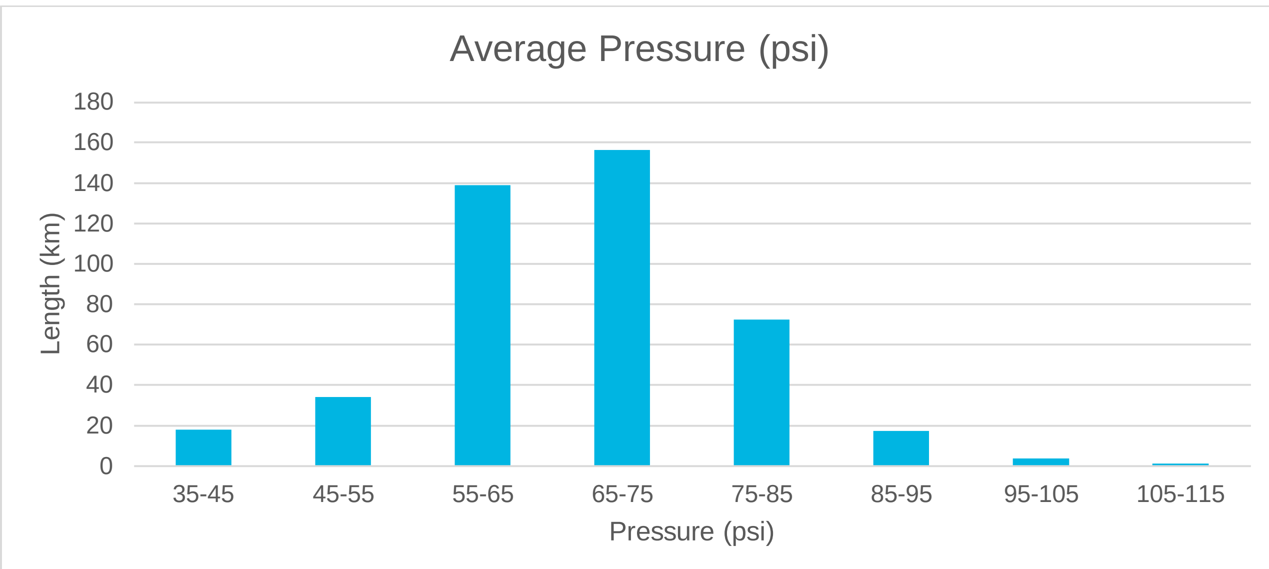

Figure 3:Average Pressure by Length

4.3 Goal 3 - Meet Service Requirements with Economic Efficiency

This goal measures the economic efficiency of the Municipality's water purification plant operations. It is measured by three sub-goals as follows:

1. PUC meets service requirements
2. Service requirements are achieved with economic efficiency
3. Deliver value to stakeholders

4.3.1 Sub-Goal #1 - PUC meets service requirements

4.3.1.1 Facilities and Linear Assets

PUC monitors water quality as required by regulations and all permit requirements are met based on O. Reg. 170/03, O. Reg. 169/03, and others.

Water quality monitoring is performed throughout the system. PUC has a program to manage lead services and has established a dead-end and corrosion program to reduce water quality issues.

4.3.2 Sub-Goal #2 - Service requirements are achieved with Economic Efficiency

The ratios and percentages arrived within this section are based on information supplied by PUC from the 2018 statement of operations and accumulated surpluses and is summarized in **Table 8**. PUC reported an approximate total O&M cost of $13.4 M for 2018 (Refer **Table 8**). The cost was broken down into the following categories: purification and pumping, transmission and distribution, hydrants, billing and collection, and general and administration. However, detailed information of the cost breakdowns was not available.

Table 8: Operational Expense Type and Value

Expense Type	2018 Budget
Purification and Pumping	$3,886,696
Transmission and Distribution	$4,212,547
Hydrants	$404,964
Billing and Collection	$1,219,605
General and Admin	$3,592,524
Total	**$13,316,336**

Total Cost to Provide Water / Population Served

PUC reported that the total per capita cost to provide water is approximately $234. All costs incurred in providing water to the customers are recovered. PUC will continue its practices in providing quality water to customers at 100% cost recovery.

Breakdown of Operations and Maintenance (O&M) Costs for Linear System

Given a total length of watermain of 442 km, operation costs of transmission and distributions mains ($4.2 M), and operation cost of hydrants ($488 K), the average O&M costs per km are calculated at approximately $11 K.

Breakdown of Operations and Maintenance (O&M) Costs for Treatment Facilities

PUC's operations expense is calculated assuming that only expenses under purification and pumping are applicable to treatment facilities. Given that 10,014 ML of water was treated in 2018, the O&M cost for facilities was determined to be $400 per ML treated.

While PUC currently tracks O&M cost data, it desires to begin tracking and reporting the breakdown of O&M costs by categories such as wages, staff training, equipment and materials, energy, chemicals, and contracted services to better understand the holistic expenses for treating water.

Cost of Water Quality Monitoring / Population Served

Currently, PUC does not track the cost of water quality monitoring per population served. However, PUC plans to track this performance measure in the future.

Cost of Repairs as % of Total O&M Cost

PUC owns 2,221 hydrants as part of the water distribution and transmission network. Using operating costs associated with hydrants (**Table 8**), the O&M cost of each hydrant is approximately $182.

In addition, approximately 12% of O&M costs are used to repair main breaks. Most of PUC watermain breaks are predominated by vulnerable ferrous pipelines and are observed in distribution mains.

Based on the asset management strategy that AECOM is developing, O&M costs due to reactive maintenance could reduce over time. PUC will utilize AECOM's prioritization framework to perform interventions.

Cost of Chemical per Treated Volume

PUC reported a chemical cost per treated volume of $23.55/ML for 2018.

4.3.3 Sub-Goal #3 – Deliver Value to Stakeholders

Revenue Generated by Customer Billing / Cost of Treated Water

PUC tracks this criterion. PUC experiences 100% cost recovery model for producing and treating water. The current ratio of this performance measure is 3.4, which is in the acceptable range. This ratio should always be monitored in order to ensure direct and indirect costs are recovered and potential enhancements to the systems are considered.

Volume of Non-Revenue Water in L/Connection/Day

PUC tracks the criterion. The estimated amount is 185.75 L/Connection/Day. While there is not a specific threshold, minimizing the non-revenue water is always recommended. One way of reducing this ratio is by considering a real-time monitoring leak detection system to detect and respond to any leaks in the system. In general, leaks are considered one of the most contributing factors in non-revenue water.

PUC will continue tracking and reporting this performance measure. Planned annual infrastructure renewals are expected to further reduce water losses within the distribution system. It is recommended to consider a smart monitoring system that could continuously detect and identify leaks in the water network.

4.4 Goal 4 – Protect the Environment

This goal describes the goals and measures PUC can take through water distribution management to protect the environment.

4.4.1 Sub-Goal #1 - Service requirements are moderated using conservation measures

Conservation Programs

There are no conservation programs currently in place, but by-laws are implemented for water use restriction when needed. PUC observed a decline in usage with pricing and installation of water-efficient fixtures. PUC is also developing a brochure to educate customers about water tap usage.

4.4.1.1 Facilities

% of Water Wasted During Treatment Process

PUC reported approximately 3.6% of water wasted during treatment processes. PUC also reported that backwash waste is typically not treated. PUC reported that at times the WTP plant makes up less than half of the production with the wells making up the rest which do not require backwashing.

Water Conservation Targets or GHG Emission Targets

PUC annually reports on energy consumption and corresponding greenhouse gas emissions from all treatment facilities and pump stations for the past five years. However, a breakdown of GHG emissions from energy consumed in the operation of the treatment plant is not available. PUC uses an online template provided by the ministry to enter the energy usage which then calculates the GHG emissions.

PUC does not have water conservation targets or GHG emission targets. Energy reduction initiatives are focused primarily on cost reduction. PUC created a five-year energy efficiency plan for the water treatment plant which involved performing audits. PUC is now in the process of re-writing the energy efficiency plan. Nonetheless, PUC has implemented many energy saving measures including installation of solar panels, VFD conversions, control valves, lighting upgrades and energy recovery turbine and generator installation. For instance, all production wells in regular use will be fitted with a VFD as of 2021 and the WTP is also being evaluated for a VFD conversion. PUC stated that energy efficiency is now a design criteria and plans to implement additional energy conservation measures in the future.

4.4.1.2 Linear Assets

Average Residential Daily Consumption per Capita (L/Cap/D)

PUC tracks this performance measure. In this study, the ratio was calculated using the residential sales from individually serviced, and individually metered residential premises. Multi-residential data was excluded as there would be one meter for each building. Based on the information provided by PUC and assuming an average population per household of 2.2, the ratio would be 200 L/Cap/D. PUC observed a decline of water consumption in the past years due to the different awareness initiatives being arranged by PUC staff to the customers.

Generally, the peaking factor[6] is 1.5 as per design criteria. The hourly peaking factor is not measured and tracked by PUC, but the maximum daily factor is tracked. Monitoring the hourly peaking factor could provide insights into daily consumption.

4.4.2 Leak Estimate in Water Systems

The infrastructure leakage index is a ratio of the current annual real losses (Real Losses) to the unavoidable annual real losses (UARL). The UARL is a theoretical reference value representing the technical low limit of leakage that could be achieved if all of today's best technology could be successfully applied.

The infrastructure leakage index is 3.5, as per the data supplied by PUC. In general, lower indices that are closer to zero are theoretically favourable; however, this requires significant budgets to ensure that Real Losses are mitigated. Currently, PUC conducts a leak detection program on one third of the system annually and respond to leaks detected - such a practice is essential in keeping sustainable infrastructure by reducing leaks of the treated water.

4.5 Goal 5 - Provide a Safe and Productive Workplace

PUC shall ensure that operation and maintenance activities of the water distribution system are performed using safe and productive practices and procedures.

This goal is measured by two sub-goals:

1. Safe Workplace
2. Productive Workplace

4.5.1 Sub-Goal #1 - Safe Workplace

Personnel performing work related to distribution systems and affecting water purification plant O&M shall be competent based on appropriate education, training, skills, test requirements, and experience as required by the governing regulatory agency. PUC should endeavour to evaluate procedures and processes used by workers with the intent of optimizing their operation.

PUC has health and safety (H&S) plans which are frequently reviewed. Each job function/role has defined training requirements based on a structured matrix. Additionally, PUC follows best practices and protocols related to safety to limit hazards in the workplace. The utility performs staff training based on their job description to increase safety awareness and equip staff with proper safety procedures. However, the number of training hours dedicated to safety training per year is only tracked for operators and not for all personnel attending training. To monitor safety programs for staff, it is recommended that PUC consider tracking this criterion for all dedicated training.

4.5.2 Sub-Goal #2 - Productive Workplace

PUC shall establish written maintenance procedures that document all functioning and maintenance activities required for the water purification system. PUC could measure accomplishment of this sub-goal by monitoring the following performance measures:

- Breakdown of Unavailable O&M Hours / Total Paid O&M Hours

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[6] *Peaking Factor is the ratio of maximum flow to average daily flow in the water system.*

- Number of O&M Accidents with Lost Time / 1,000 O&M Labour Hours
- Overtime hours paid as a result of emergency repairs
- Defined and Controlled SOPs
- Total Overtime Hours / Total Paid O&M Hours

Breakdown of Unavailable O&M Hours / Total Paid O&M Hours

Currently, the estimated percentage of unavailable hours is 22% and is based on sick, vacation, training, meetings, etc. (as per information supplied by PUC). The breakdown of the unavailable hours is currently not tracked and monitored. Thus, it is recommended to track and record unavailable O&M hours.

Number of O&M Accidents with Lost Time / 1,000 O&M Labour Hours

PUC tracks this metric for the operation team only and recorded zero accidents with lost time incidents. It is recommended to continue tracking this criterion but expand it to include other staff from different departments.

Overtime Hours Paid as a Result of Emergency Repairs

PUC estimates that its contribution of overtime hours paid as a result of emergency repairs is about 3,000 hours and is included in total values reported for labour and wages. It is recommended that PUC track this criterion based on actual overtime hours recorded to better define future labour budgeting and maintenance scheduling.

Defined and Controlled SOPs

PUC has several defined and controlled SOPs for several tasks but not all. Work instructions are available, but resources are not defined within the procedures. It is recommended to define instructions and resources and consider developing SOPs for all activities.

Total Overtime Hours / Total Paid O&M Hours

Overtime hours are dedicated to responding to emergencies in an effort to reduce failures or operational impacts. The current estimated ratio of overtime hours as a percentage of the total paid O&M is roughly 9%.

4.6 Goal 6 - Protect Public Health and Safety

4.6.1 Sub-Goal #1 - Water quality achieves regulatory requirements for public health and safety

4.6.1.1 Facilities

- **Boil Water Advisories**

  PUC reported ‘0’ boil water advisories in 2018. PUC desires to ensure water quality achieves regulatory requirements for public health and safety.

- **# of Total Coliform Occurrences in Treated Water**

  PUC reported 1 total coliform occurrence in 2019 and 3 in 2018. PUC desires to continue monitoring the treatment system to identify sources of coliform occurrences.

- **Average Value for Treated Water Nitrates**

  An average value of 0.355 mg/L was reported which is well within regulatory limits. PUC desires to ensure water quality achieves regulatory requirements for public health and safety.

- **Average Value for Turbidity**

  PUC maintained its filter in compliance with ministry requirements each month for the required limit for dual media filtration to achieve necessary filtration credits for primary disinfection. One turbidity exceedance issue was reported in 2018. PUC desires to continue monitoring turbidity and continue compliance with regulatory requirements.

4.6.1.2 Linear Assets

Cumulative Length Cleaned as % of System Length per Year

Currently, 33% of the system is annually cleaned using unidirectional flushing methodology. There is no swabbing program in place. It is recommended to increase the annual total length cleaned and to consider establishing a swabbing program, where applicable, as it is more effective than unidirectional flushing. Cleaning helps and enhances the hydraulics of the system (for example, cast iron pipelines that have excessive tuberculation could have implications on the flow of the water). The internal condition of the pipe may also impact implementing certain condition assessment tools in assessing water pipes. Pipes with excessive tuberculation, tethered assessment tools (e.g. Investigator+) may not be effective as the tool will not be able to advance inside the pipe.

Water Quality Sampling

Sodium test results exceeded limits in Shannon and Lorna Wells as per the Water Quality Report in 2018. Also, six lead samples exceeded limits as per the same report. PUC has established a lead service replacement program to reduce the impacts of lead in the water system. The utility will collect samples and test the water quality as per Ontario Regulation 170/03.

4.7 Goal 7 – Satisfied and Informed Customers

Under this goal, PUC wishes to ensure customers are satisfied with the service that the utility provides. This can be monitored by the measuring the following:

1. Informed Customers
2. Satisfied Customers

4.7.1 Sub-Goal #1 - Informed Customers

PUC ensures that customer-facing staff are aware of the water system to answer questions. However, there is no outreach program aimed at educating the public. Existing outreach programs are only related to significant operating/capital programs. Community engagement is partially achieved through organized educational tours to treatment plants.

4.7.2 Sub-Goal # 2 – Satisfied Customers

Number of Water Quality Customer Complaints / 1,000 People Served

PUC tracks and reports this performance measure through an internal system that codes, and tracks calls and complaints. The reported ratio is 1.36, but this ratio is not categorized per complaint or issue. Most of the water quality complaints are related to discoloration of water. This water discoloration is believed to result from ferrous pipelines in the distribution network. PUC has been addressing this issue through mitigation efforts, cleaning, and intervention programs that aims to enhance existing infrastructure

In some jurisdictions, non/semi-structural lining for ferrous pipelines has been deployed to enhance the quality of water. However, this type of lining is dependent on many factors including the structural integrity of the pipes.

Number of Water Pressure Customer Complaints / 1,000 People Served

Currently, PUC does not track this performance measure. Since pressure is one of the most important criteria for customer satisfaction, it is recommended to track pressure complaints and ensure that the complaints are resolved in a timely manner.

Target Response Times for Emergencies, Non-Emergencies and Attainment

PUC does not track the target response time for non-emergencies. However, for emergencies, PUC believes that the operation team reports to the location within 30 minutes. As these metrics are not actually monitored, it is recommended to track and report this performance measure to control response times after establishing a baseline. Depending on the emergency and its extent, PUC may baseline a response time at 60 minutes and update this time based on actual records.

4.8 LoS Summary

Table 9 summarizes current and desired LoS for PUC alongside recommendations.

Table 9: LoS Summary

Sub-Goal	Performance Measure	Facilities	Linear Assets	Existing	Desired	Category	Recommendation
Goal 1 - Provide Reliable Service and Infrastructure							
Reliable Treatment & Distribution System	Do design criteria comply with the Design Guidelines for, A) FACILITIES: Drinking Water Systems by Ontario Ministry of the Environment? B) LINEAR: AWWA minimum requirements?	Y	Y	PUC designs new linear assets as per AWWA and local standards. However, some parts of the linear assets are out of date. PUC does not have an internal standard that is specific to Sault Ste. Marie topography. PUC's design criteria for drinking water systems complies with the design guidelines for drinking water systems by Ontario Ministry of Environment. The majority of the pipes are operating at 50 to 70 psi.	PUC will continue implementing best practices' minimum requirements in designing linear assets and drinking water systems. PUC will aim to maintain an operating pressure that satisfy the customers expectations.	Provisional Requirements and Best Practices	Follow best practices and requirements set by AWWA and comply with Ontario government requirements. It is recommended to establish an internal design standard that is based on best practices and is aligned with the strategic objectives of PUC.
	Are design standards and specifications documented?	Y	Y	PUC maintains and documents specifications and design standards. Some design criteria exceeded best practices' minimum requirements.	PUC will continue maintaining and documenting specifications and design standards.	Provisional Requirements and Best Practices	Continue maintaining and documenting design standards.
	Are design criteria, standards and specifications reviewed on a regular basis to ensure compliance with applicable standards and guidelines?	Y	Y	PUC reviews the design standards annually to align with any updates in best practices.	PUC will continue reviewing design standards and specifications to align with any best practices' updates.	Provisional Requirements and Best Practices	Continue the review of the utilized practices on an annual basis.
	Number of distribution systems failures per 100 km per year?	N	Y	Currently, PUC is experiencing 19.87 failures per 100 km per year. This is considered one of the highest rates compared to other locations in Ontario. Such a difference would be related to topography, weather, operations, etc. The majority of the failures are occurring in ferrous distribution mains and mostly cast-iron pipelines. This type of material's failures was observed in many locations across North America.	PUC is interested in upgrading and enhancing existing infrastructure to avoid sudden collapses in high consequence areas. PUC uses a 75-year renewal cycle to enhance existing condition of watermains and will also consider a risk-based approach to identify and prioritize pipelines based on environmental, economic, operational, and social parameters. These practices could ensure effective funding in future interventions.	Planning and O&M	It is recommended to replace vulnerable cohorts and especially ferrous types (installed post 1950s). It is recommended to follow a risk-based approach to balance the two risk parameters (likelihood of failure [LoF] and consequence of failure [CoF]) to prioritize interventions. Part of the planning is to conduct field condition assessment in order to decide on the near-optimum intervention decisions. It is also recommended to coordinate with the City for any reconstruction projects.
	% of Main Length Replaced or Relined	N	Y	Currently, 0.23% of the mains total length is replaced or relined. Existing interventions consider the fire flow minimum requirements and historical failures the mains.	PUC will continue renewing existing infrastructure and based on the annual allocated budget, PUC will increase the interventions' length and ensure a 75-year renewal cycle.	Planning and O&M	It is recommended to follow a risk-based approach to perform future interventions while also considering the existing 75-year renewal cycle.
	Is a risk assessment plan in place to identify the risks to providing safe and reliable service? If yes, Is the risk model used to proactively manage asset lifecycle?	Y	Y	PUC does not follow a defined risk-based model which includes the LoF and the CoF.	PUC will prioritize future interventions based on a risk-based approach. PUC retained AECOM to develop a prioritization model that would aid PUC in the decision-making process.	Planning and O&M	PUC is recommended to follow a risk-based approach in future interventions. It is also recommended to update the LoF outputs based on any future interventions or any field condition assessment results. Based on the desktop model, transmission mains' LoF is not critical (no failure breaks). As field condition assessment would be prioritized for these types of pipes, it is necessary to update the assessed pipe' LoF accordingly. It is also recommended to update the CoF model based on any future strategic objective updates. Such an update would not necessarily be related to attributes or attribute values but can be reflected in the attribute weights' distribution (economic, environmental, social, and operational).
Proactive Maintenance Management	Is a condition assessment plan in place to monitor and gather data on the various assets at the plant (Structural, Process Mechanical, HVAC, I&C, Electrical)? Is a condition assessment plan in place to monitor and gather data on the various assets (transmission mains, distribution mains, services, etc.)?	Y	Y	PUC does not maintain a comprehensive condition assessment plan for linear system and drinking water system. PUC hires vendors to utilize acoustic detection of leaks on one-third of distribution system annually. PUC did not assess transmission mains.	PUC will be utilizing a risk-based approach to assess existing linear and non-linear infrastructure.	Planning and O&M	It is recommended to prioritize condition assessment to evaluate transmission mains as the failure consequences of such asset are extremely catastrophic. It is also recommended to conduct field condition assessment on some distribution mains where the risk margin is significant, and that field condition assessment is justifiable.
	% of Valves Cycled.	N	Y	Currently, about 12% of valves are cycled annually. PUC does not have a well-established database to track activities and failures in valves.	PUC will continue cycling valves and is looking toward increasing the number of cycled valves.	O&M	It is recommended to increase the current percentage to reduce the probability of unexpected failures in water valves. AWWA recommends that each valve should be operated through a full cycle and returned to its normal position on a schedule that is designed to prevent buildup tuberculation or other deposits that could render the valve

Sub-Goal	Performance Measure	Facilities	Linear Assets	Existing	Desired	Category	Recommendation
							inoperable or prevent a tight shut-off. While the valve exercising is suggested to be maximized on an annual basis (100%), PUC could establish a Valve Exercising Program
	% of Hydrants Inspected or Winterized	N	Y	In 2018, 50% of the hydrants are inspected and 100% are winterized. In 2020, 100% of the hydrants were inspected.	PUC will continue inspecting all hydrants (100%) on an annual basis. PUC will consider the service interruptions' number of days as a measure of performance.	O&M	It is recommended to maintain the efforts in inspecting 100% of the hydrants' inventory each year.
	Preventative maintenance program developed (valve, water main, hydrant, leak detection).	Y	Y	The preventive maintenance program is based on regular inspections. Maintenance of instrumentation assets is performed on a regular basis. However preventative maintenance program is not documented. Leak detection program is in place and approximately one third of the system is inspected annually.	PUC will continue performing preventative maintenance activities to enhance water infrastructure. PUC to document a preventative maintenance program.	O&M	Continue preventative maintenance and prioritize maintenance activities based on a risk-based approach.
Asset Renewal and Replacement	Capital Budget requirements identified through annual review of performance indicators and risk analysis?	Y	Y	The Capital Budget started at $1M and increased in the past 15 years. Approximately, 60% of the capital budget is allocated for the distribution system.	PUC will continue allocating budgets to enhance existing infrastructure. Currently, the incremental increase varies but is roughly $1M/year.	Planning	Allocate budgets and rely on decision-support systems to aid in the decision making of interventions to conclude near-optimum minimum costs.
	Amount spent on Capital Reinvestment / Replacement Value?	Y	Y	The 2018 capital cost is approximately $4.1 M for linear system and water treatment plant renewal and upgrades. Based on the replacement costs, capital reinvestment / replacement ratio is: *Linear (2018) = ~0.38%* *Facilities (2018) = ~1.68%* *Five-year average (2016-2020) Linear = ~0.6%* *Five-year average (2016-2020) Facilities = ~1.7%*	PUC aims to enhance and renew existing infrastructure to increase the levels of service. These renewals would require budgets and therefore, this rate is expected to increase.	Planning and O&M	Continue renewing existing infrastructure to maintain minimum expected levels of service. PUC will rely on a risk-based approach to maximize the benefits of each dollar spent in future budget allocations as well as co-ordinating with the City's reconstruction projects for better management of assets.
Emergencies are responded to with defined procedures	Do operators maintain an inventory of spare parts matched to the specifications of the assets?	Y	Y	PUC maintains an inventory of spare parts for most critical assets at facilities. PUC maintain spare parts for valves, clamps, and some small pipe sizes.	PUC will maintain spare parts for water assets to respond to reactive maintenance.	O&M	Maintain spare parts and update the inventory according to future usages and purchases. Maintain spare parts for assets identified as critical during the consequence of failure (CoF) exercise.
	Are emergency response times defined?	Y	Y	PUC does not have predefined response times for emergency repairs. However, PUC ensures that repairs are performed immediately. PUC has an event-based decision-making process to decide on the extent of the failure.	PUC will continue responding to emergencies to reduce disruptions.	O&M	Define emergency response times based on location, pipe size, and other factors that would impact the operations' team response to failure.
	Are Contingency plans defined and rehearsed for typical failures as well as critical assets?	Y	Y	PUC maintains emergency response plans and emergency preparedness plan. PUC also has high-level SOPs like loss of supply or loss of power. Some emergency events are practiced. PUC has main break repair procedures and high-level SOPs. PUC has some repair procedures in the event of a pipeline break. All existing plans are generic and not detailed.	PUC will maintain its best practices in responding to critical assets and develop detailed SOPs.	Planning and O&M	It is recommended to establish contingency plans and detailed SOPs to facilitate the decision-making process during failure events.
	How many hours were spent in reactive maintenance?	Y	Y	PUC does not track the reactive maintenance activities.	PUC is planning to track the time required for future reactive maintenance activities.	Planning	It is recommended to track the reactive maintenance activities.
	Number of emergency service connection repairs (# Service Connection Repairs & Replacements / # of Service Connections	N	Y	Nearly daily curb box repairs due to third party damages. Currently, the ratio is 0.56%.	PUC will continue responding to emergencies.	Planning and O&M	Continue responding to emergencies. It is recommended to increase public/contractors' awareness to decrease third party damages of utilities and fixtures.
	Does the Municipality maintain agreements with contractors for the standard operating procedure in response to unplanned outages?	Y	Y	PUC has informal agreements with contractors, and it is believed that they are responsive when required.	PUC will maintain the established agreements with contractors	Planning	It is recommended to establish formal agreements with contractors to avoid unexpected issues in the future.

Sub-Goal	Performance Measure	Facilities	Linear Assets	Existing	Desired	Category	Recommendation
Goal 2 - Ensure Adequate Capacity							
Designed Demand Requirements	# of Days the Plant Operated > 90% and > 100% of Capacity.	Y	N	The number of days the plant operated at > 90% and > 100% of Capacity is low.	PUC will continue operating at optimal capacity.	Planning	Continue the established programs.
	Does the available flow meet the minimum demand requirement?	Y	Y	Some locations in the network experience lower flow rates than the minimum fire flow requirements.	PUC is planning to renew and replace pipelines to enhance the supplied flow.	Planning and Provisional Requirements and Best Practices	It is recommended to ensure that the supplied flow is based on the minimum fire flow requirements.
	Are the acceptable pressure requirements maintained? What is the Average Operating Pressure?	N	Y	PUC has a typical operating pressure for the water system between 34 and 115 psi.	PUC will continue providing minimum operating pressure requirements.	O&M and Provisional Requirements and Best Practices	Industry recent guidelines consider a range between 50 and 70 psi for water pipelines. While the existing MECP regulations consider this range, pressures outside this range are dictated by topography and system size. In addition, the existing system was designed in accordance to older provincial standards where operational requirements may have been changed. As higher pressures in deteriorated pipelines could result in a failure (depending on the residual factor of safety), monitoring the pressure in the system and the pipeline condition are recommended. Compared with the generic recommendations of the MECP, the majority of PUC's system is operating between 50 to 70 psi.
	Does the municipality have a Master Plan? Does the municipality conduct master planning exercises?	Y	Y	PUC co-ordinates and participates with the City.	PUC will continue participating and co-ordinating with the City.	Planning	Continue participating and co-ordinating with the City to reduce construction rework.
Goal 3 - Meet Service Requirements with Economic Efficiency							
Municipality meets service requirements	Facilities: Quality of water monitored at each treatment step or does the quality of water at outlet meet the regulatory limits defined in O. Reg. 169/03: ONTARIO DRINKING WATER QUALITY STANDARDS? Distribution: Quality of water monitored as specified in O. Reg. 170/03 for Large Municipal Residential System?	Y	Y	PUC monitors water quality as per the regulations and all permit requirements are met. Water quality monitoring is performed throughout the system. Sodium (Na) reported at Shannon and Lorna routinely exceeds aesthetic objectives. Manganese (Mn) also approaching aesthetic objectives. PUC has a program to manage lead services and have established a dead-end and corrosion program to reduce water quality issues.	PUC will continue with the programs to enhance water quality and reduce quality complaints.	Planning	Continue the established programs and monitor the water quality as per the regulations.
Service requirements are achieved with Economic Efficiency	Total Cost to Provide Water / Population Served	Y	Y	Currently, total cost to provide drinking water is approximately $234/person. Generally, PUC recovers 100% of the total costs.	PUC will continue its practices in providing quality water to customers at 100% cost recovery.	Planning	Continue the practices to provide quality water to customers at 100% cost recovery.
	Breakdown of O&M Cost / ML Treated (F) & / km Length (DS).	Y	Y	Total operation cost for linear assets is $4,700,711 Total operation cost for treatment facility assets is $3,886,696 Total length of watermains = 442 km O&M Cost / ML Treated (F) = $400 O&M Cost / km Length (DS) = $10,635	PUC will continue tracking and reporting this performance measure.	Planning O&M	It is recommended to continue tracking and measuring this performance measure and comparing it with some other cities/municipalities. It is recommended to breakdown the O&M cost into staff training, chemicals, energy, external contracted services, internal contracted services, equipment and materials, and wages.
	Cost of Water Quality Monitoring / Population Served.	Y	Y	This is currently not measured/tracked.	PUC aims at tracking this performance measure in the future.	Planning	It is recommended to track and measure this performance measure and compare it with some other cities/municipalities.
	Cost of Chemical per ML Treated.	Y	N	PUC reported a cost of chemical per ML treated to be $23.55. Other direct filtration systems reported chemical costs between $5 - $25.	PUC will continue tracking and reporting this performance measure.	O&M	It is recommended to continue tracking and measuring this performance measure and comparing it with some other cities/municipalities. It is recommended to track additional details such as chemical costs at each process.
	(O&M Cost + Capital Reinvestment Cost) / ML Treated.	Y	N	PUC reported O&M cost + capital reinvestment cost per ML treated at $1718.	PUC will continue tracking and reporting this performance measure	O&M	It is recommended to continue tracking and measuring this performance measure and comparing it with some other cities/municipalities.
	Cost of Main Breaks Repairs as % of Total O&M Cost.	N	Y	Approximately 12% of the O&M costs are used to repair main breaks.	PUC will utilize AECOM's prioritization framework to perform interventions. PUC allocates approximately 60% of the capital budget	O&M	It is recommended to utilize a risk-based approach to aid PUC in renewing the infrastructure and therefore, reduce the calculated percentage.

Sub-Goal	Performance Measure	Facilities	Linear Assets	Existing	Desired	Category	Recommendation
					to renew the distribution system. Such practices would reduce the calculated percentage.		
	Cost of Fire Hydrant O&M/# of Fire Hydrants.	N	Y	Currently, the average cost of maintaining and operating the fire hydrants is approximately $182 per hydrant.	PUC will continue to maintain fire hydrants to align with best practices.	O&M	Continue maintaining and inspecting fire hydrants.
	Is there co-ordination between PUC and the City for Capital municipal work (roads, water, sewers).	N	Y	PUC co-ordinates with the City in capital municipal work.	PUC will continue co-ordinating with the City for future capital municipal work.	Planning	Continue co-ordinating with the City to minimize construction rework.
Deliver Value to the Stakeholders	Volume of Non-Revenue Water in L/Connection/Day.	N	Y	Currently, PUC tracks the criterion. The estimated amount is 185.75 L/Connection/Day. However, it is not tracked based on real and apparent non-revenue water.	PUC will continue tracking and reporting this performance measure. The planned annual infrastructure renewals are expected to reduce this amount.	Planning	It is recommended to consider a smart monitoring system that would continuously detect and identify leaks in the water network. Such a system would aid in the decision-making process to conduct repairs; hence reduce water loss.
	Revenue Generated by Customer Billing / Cost of Treated Water.	Y	Y	PUC tracks this criterion. The current ratio is at 3.4. PUC experiences 100% cost recovery.	PUC will continue tracking this criterion.	Planning	Continue tracking this criterion.
Goal 4 -Protect the Environment							
Service requirements are moderated using conservation measures	% of Water Wasted During Treatment Process.	Y	N	PUC reported 3.6% of Water Wasted During Treatment Process.	PUC will continue tracking this criterion.	Planning	The % of Water Wasted During Treatment Process is similar to number reported by other similar municipalities Continue tracking this criterion.
	% of Backwash Waste Treated.	Y	N	PUC reported approximately 3.6% of water wasted during treatment processes. PUC also reported that backwash waste is typically not treated.	PUC to continue discharging backwash waste in sanitary sewer.	Planning	Continue tracking this criterion.
	Breakdown of GHG Emissions from Energy Consumed in the Operation of the Treatment Plant.	Y	N	PUC does not monitor or track GHG emissions from energy consumed in the operation of the treatment plant.	PUC to look into new reporting framework for GHG emissions.	Planning	It is recommended to track and measure this performance measure and compare it with some other cities/municipalities.
	Does the municipality have water conservation targets or GHG emission targets?	Y	N	PUC does not have conservation targets. Energy reduction is based on cost reduction. The 5-year efficiency plan for water is being updated and revised as required by Ministry. To reduce energy consumption, PUC has done some work like VFD conversions, control valves, building lighting upgrades etc. which are also included in the design criteria.	PUC to continue water conservation and GHG emission initiatives.	Planning	It is recommended to assign water conservation targets or GHG emission targets.
	Program in the community to promote the reduction of water use through education and the use of water efficient fixtures. *Or* Program in the community to convey how safe it is to drink tap water and more environmentally friendly compared bottled water.	Y	Y	There are no conservation programs currently in place, but by-laws are implemented for water use restriction when needed. PUC observed a decline in usage with pricing and installation of water-efficient fixtures. PUC is also developing a brochure to educate customers about water tap usage.	PUC will continue implementing some activities that would reduce water usage.	Planning	Maintain existing awareness programs that contributed in consumption reductions over the past years.
	Cost of Water Conservation Program/Population Served.	N	Y	Water conservation programs are not available.	PUC will continue implementing some activities that would reduce water usage.	Planning	It is recommended to establish conservation programs and increase community engagement to enhance awareness. It is recommended to track the costs of such programs.
	Average Residential Daily Consumption per Capita (L/Cap/D).	N	Y	Currently, PUC tracks this criterion but does not report it. The ratio is 200 L/Cap/D.	PUC will continue tracking this criterion.	Planning	Continue tracking this criterion and establish a conservation program that would decrease water usage per person.
	Peaking Factor (MDD/ADD).	N	Y	The factor is 1.5 as per the design criteria.	PUC believes that that the actual is within the design criteria.	O&M	It is recommended to measure the hourly consumption to better track this metric.
Leak Estimate in Water Systems	Infrastructure Leakage Index.	N	Y	Based on the information, the existing ratio is at 3.5.	PUC perform leak detection but not estimate on one third of the system annually.	O&M	It is recommended to consider real-time monitoring system and the existing 75-year renewal plan to reduce leaks and real losses
Goal 5 - Provide a Safe and Productive Workplace							

Sub-Goal	Performance Measure	Facilities	Linear Assets	Existing	Desired	Category	Recommendation
Safe Workplace	Are Health and Safety plans in place for SOPs?	Y	Y	PUC has H&S plans which are reviewed frequently. Each job function/role has defined training requirements based on a structured matrix.	PUC will continue its practice in maintaining a safe workplace.	Planning	Continue existing practices in H&S.
	Are regulatory requirements for O&M achieved (OSHA)?	Y	Y	PUC achieves regulatory requirements.	PUC will continue its practice in maintaining a safe workplace	Planning	Continue existing practices in H&S.
	Number of hours dedicated to safety training per year.	Y	Y	This criterion is only tracked for operators and some are tracked for corporate training.	PUC aims at enhancing its tracking system to include all personnel.	Planning	Track safety training hours for all employees at PUC.
Productive Workplace	Breakdown of Unavailable O&M Hours / Total Paid O&M Hours.	Y	Y	Currently, the estimated percentage is 22%. It is based on sick, vacation, training, meetings, etc.)	PUC aims at enhancing its tracking system for this criterion.	O&M	Track and record unavailable O&M hours to better estimate the ratio.
	# of O&M Accidents with Lost Time / 1,000 O&M Labour Hours.	Y	Y	Zero accidents with lost time. This is tracked for the operations team only.	PUC will continue tracking this criterion for the operations team.	O&M	Continue tracking this criterion but expand it to include other staff from different departments.
	Overtime hours paid as a result of emergency repairs.	Y	Y	It is estimated to be 3,000 hours and is used in labour budgeting.	PUC plans to track this criterion.	O&M	It is recommended to track this criterion based on actual overtime hours paid to better define future labour budgeting.
	Are activities defined and controlled using SOPs?	Y	Y	Not all tasks have SOPs. The work instructions are available, but resources are not defined.	PUC aims at developing defined and controlled work instructions within a year.	O&M	It is recommended to define instructions, resources and SOPs for all activities.
	Total Overtime Hours / Total Paid O&M Hours.	Y	Y	Currently, overtime hours are estimated at 9% of total paid O&M hours.	PUC will continue responding to emergencies and complete repairs to reduce failures impacts. PUC will continue tracking this criterion.	O&M	Continue tracking this criterion. Since overtime O&M hours are expected to be for reactive maintenance, it is recommended to utilize a condition assessment plan that would minimize future unexpected failures.
Goal 6 – Protect Public Health and Safety							
Water quality achieves regulatory requirements for public health and safety	# of Boil Water Advisory Days.	Y	N	PUC reported '0' boil advisory days.	Continue ensuring water quality achieves regulatory requirements for public health and safety.	Provisional Requirements and Best Practices	Continue existing practices.
	# of Total Coliform Occurrences in Treated Water.	Y	N	PUC reported 1 total coliform occurrence in 2019 and 3 in 2018.	Continue monitoring treatment system to identify source.	Provisional Requirements and Best Practices	Continue existing practices
	Average Value for Turbidity.	Y	N	Sault Ste. Marie maintained filter compliance each month above 95% - the required limit for dual media filtration to achieve necessary filtration credits for primary disinfection. One turbidity exceedance issue was reported in 2018.	Continue monitoring of turbidity and continue compliance with regulatory requirements.	Provisional Requirements and Best Practices	Continue monitoring treatment system and apply measures to limit and reduce coliform occurrences.
	Average Value for Treated Water Nitrates.	Y	N	An average value of 0.355 mg/L was reported which is well within the regulatory limits.	Continue existing practices.	Provisional Requirements and Best Practices	Continue existing practices.
	Cumulative Length Cleaned as % of System Length per Year.	N	Y	Currently, 33% of the system is annually cleaned using the unidirectional flushing methodology. There is no swabbing program in place.	PUC will continue cleaning the system to reduce water quality complains	O&M	It is recommended to increase the total length cleaned. It is also recommended to establish swabbing program as it is more effective than unidirectional flushing.
	Number of Water Quality Samplings (Distribution) exceeded Ontario Drinking Water Standard/Reg Requirements.	N	Y	The sodium test exceeded the limits in Shannon and Lorna Wells as per the Water Quality Report in 2018. Also, six lead samples exceeded the limits as per the same report.	PUC has established a lead service program to reduce the impacts of lead in the water system. PUC will collect samples and test the water quality as per the regulations.	O&M	Continue complying with Ontario Regulation 170/03 and in lead service program.
Goal 7 - Satisfied and Informed Customers							
Informed Customers	Are customer facing staff knowledgeable of the assets, common issues, and customer questions?	Y	Y	Customer facing staff are knowledgeable.	PUC will always ensure that customer facing staff are aware of the water system to answer questions.	Planning	Continue the existing methodology and practice.
	Does the municipality educate the public through outreach efforts?	Y	Y	Currently, there is no outreach program aimed at educating the public. The outreach programs are only related to significant operating/capital programs.	PUC will continue its existing practice and ensure that the public is informed about major operating and capital programs.	Planning	Increase water network knowledge of customers. Continue addressing customers' questions as they arise
	Does Council endorse the Levels of Service proposed for O. Reg 588/17 compliance?	Y	Y	The targets for customer complaints are governed by the Commission. Councillors participate in the Standard of Care training.	The Board will continue its practices to comply with O. Reg 588/17.	Planning and Provisional Requirements and Best Practices	Continue the existing practices to target performance measures.
	Is the public aware of the Level of Service it receives?	Y	Y	PUC prepares an annual report to inform the public about the levels of service they receive and organize educational tours.	PUC will continue their existing practice in informing the public about the levels of service.	Planning	Continue the existing methodology and practice.
Satisfied Customers	# of Water Quality Customer Complaints / 1,000 People Served.	Y	Y	PUC tracks and reports this criterion. However, they are not categorized. An internal system is used to code and track calls/complaints. The ratio is 1.36.	PUC will continue tracking and reporting this criterion. PUC has the lead service and dead-end program that is aimed to reduce water quality issues.	O&M	Continue the existing methodology and practice to reduce quality complaints. One of the options, along with systematic cleaning of mains, could be using non/semi structural lining in ferrous pipelines to reduce discoloration of water.

Sub-Goal	Performance Measure	Facilities	Linear Assets	Existing	Desired	Category	Recommendation
	# of Water Pressure Customer Complaints / 1,000 People Served.	N	Y	PUC does not track this criterion.	PUC aims at tracking this criterion in the future.	O&M	Track pressure complaints and ensure that the complaints are resolved. It is recommended to also follow-up with the customers.
	Target Response Times for Emergencies and Attainment.	Y	Y	PUC believes that the operations team report to the location in 30 minutes.	PUC will consider tracking this criterion	O&M	Track this criterion to measure the time required to repair emergencies.
	Target Response Times for Non-Emergencies and Attainment.	Y	Y	PUC does not track this criterion but responds to an emergency immediately.	PUC will consider tracking this criterion	O&M	Track this criterion to measure the time required to repair non-emergencies.

Appendix TM4

Appendix A

Definition of Performance Measures

Water Distribution							
Goal	KPI	Breakdown	Numerator	Numerator Definition	Denominator	Denominator Definition	Units
Have Satisfied and Informed Customers	Water Quality Customer Complaints	Other or unknown causes	(# of Water Quality Complaints due to Other or Unknown Causes) * 1000		Total Population served by Water Utility	Total population, excluding ICI equivalents and population equivalents for treated water supplied to neighbouring regions/municipalities, served by all water utility infrastructure (transmission/ distribution system and all treatment plants and wells). In most but not all cases, this figure will be the same as that entered under the Distribution-Description data tab (exceptions include cities that only benchmark a portion of their water distribution system or cities that manage more than one distribution or transmission system). Note that this number may well be different to the City's recorded population and, where possible, should estimate the typical number of residents receiving service.	# / 1,000 People Served
		Temperature	(# of Water Quality Complaints due to Temperature) * 1000		Total Population served by Water Utility	Total population, excluding ICI equivalents and population equivalents for treated water supplied to neighbouring regions/municipalities, served by all water utility infrastructure (transmission/ distribution system and all treatment plants and wells). In most but not all cases, this figure will be the same as that entered under the Distribution-Description data tab (exceptions include cities that only benchmark a portion of their water distribution system or cities that manage more than one distribution or transmission system). Note that this number may well be different to the City's recorded population and, where possible, should estimate the typical number of residents receiving service.	# / 1,000 People Served
		Colour	(# of Water Quality Complaints due to Colour) * 1000		Total Population served by Water Utility	Total population, excluding ICI equivalents and population equivalents for treated water supplied to neighbouring regions/municipalities, served by all water utility infrastructure (transmission/ distribution system and all treatment plants and wells). In most but not all cases, this figure will be the same as that entered under the Distribution-Description data tab (exceptions include cities that only benchmark a portion of their water distribution system or cities that manage more than one distribution or transmission system). Note that this number may well be different to the City's recorded population and, where possible, should estimate the typical number of residents receiving service.	# / 1,000 People Served

Water Distribution							
Goal	KPI	Breakdown	Numerator	Numerator Definition	Denominator	Denominator Definition	Units
		Taste and odour	(# of Water Quality Complaints due to Taste and Odour) * 1000		Total Population served by Water Utility	Total population, excluding ICI equivalents and population equivalents for treated w ater supplied to neighbouring regions/municipalities, served by all w ater utility infrastructure (transmission/ distribution system and all treatment plants and w ells). In most but not all cases, this figure w ill be the same as that entered under the Distribution-Description data tab (exceptions include cities that only benchmark a portion of their w ater distribution system or cities that manage more than one distribution or transmission system). Note that this number may w ell be different to the City's recorded population and, w here possible, should estimate the typical number of residents receiving service.	# / 1,000 People Served
	Water Pressure Complaints by Customers	Water Pressure Complaints	(# of Water Pressure Complaints) * 1000	# of customer complaints received at the customer service centre that w ere related to w ater pressure in the distribution system. Should be a sum of complaints regarding high and low w ater pressure. Note: A complaint w ill typically require follow -up action and should exclude general inquiries.	Total Population served by Water Utility	The population, excluding ICI equivalents and population equivalents for treated w ater supplied to neighbouring regions/municipalities, served by the distribution/transmission system. This includes the population of all w holesale and retail customers. Note that this number may w ell be different to the City's recorded population and, w here possible, should estimate the typical number of residents receiving service.	# / 1,000 People Served
	Percent Attainment of After Working Hours Emergency Target	% Attainment of After Working Hours Emergency Target	% Attainment of After Working Hours Emergency Target	When a site visit is made in response to a call that is received after w orking hours for an emergency, w hat is the target maximum amount of time betw een receiving the call and the O&M crew being on-site to undertake the preliminary assessment (not necessarily complete the full repair etc.)?	-	-	%
	Percent Attainment of During Working Hours Emergency Target	% Attainment of During Working Hours Emergency Target	% Attainment of During Working Hours Emergency Target	When a site visit is made in response to a call that is received during w orking hours for an emergency, w hat is the target maximum amount of time betw een receiving the call and the O&M crew being on-site to undertake the preliminary assessment (not necessarily complete the full repair etc.)?	-	-	%
		Regional Water Purchased	Total Regional Bulk Water Purchased Cost (distribution utilities only)	The total cost of w ater purchased from regional supplier(s). Applies only to distribution utilities.	Total Population served by Water Utility	The population, excluding ICI equivalents and population equivalents for treated w ater supplied to neighbouring regions/municipalities, served by the distribution/transmission system. This includes the population of all w holesale and retail customers. Note that this number may w ell be different to the City's recorded population and, w here possible, should estimate the typical number of residents receiving service.	$ / Population Served

Water Distribution								
Goal	**KPI**	**Breakdown**	**Numerator**	**Numerator Definition**	**Denominator**	**Denominator Definition**	**Units**
	Cost to Provide Water	Water Customer Billing	Cost of Water Customer Billing	The water utility cost to bill customers. That is the cost of producing bills and sending bills, but it also includes the cost of bill adjustments and re-bills and any extraordinary costs such as special needs and ad hoc requests. The cost to operate and maintain the billing system (operating system lease, back office) and collection agency costs must be included here as well. If there is shared customer billing, for example water and wastewater, then allocate the cost specifically for the water utility (if unknown then allocate by # of customers). This cost excludes the cost of metering O&M and meter reading.	Total Population served by Water Utility	The population, excluding ICI equivalents and population equivalents for treated water supplied to neighbouring regions/municipalities, served by the distribution/transmission system. This includes the population of all wholesale and retail customers. Note that this number may well be different to the City's recorded population and, where possible, should estimate the typical number of residents receiving service.	$ / Population Served
		Debt Servicing	Total Debt Servicing Cost	Cash paid on debt principal and interest.	Total Population served by Water Utility	The population, excluding ICI equivalents and population equivalents for treated water supplied to neighbouring regions/municipalities, served by the distribution/transmission system. This includes the population of all wholesale and retail customers. Note that this number may well be different to the City's recorded population and, where possible, should estimate the typical number of residents receiving service.	$ / Population Served
		Capital Cost	Total Capital Cost	A project which substantially maintains the life of the water system. This is intended to be a measure of reinvestment to maintain current facilities and excludes expansion of system to handle growth and upgrading to a higher level of service. Projects which serve one or more purpose (maintenance and expansion) should be prorated in order to also capture the capital applied for investment activities. Include both contracted capital work and internal costs associated with capital such as wages for capital engineering staff i.e. design, tendering, etc. Includes capital reinvestment (i.e. replacement and relining) costs for pipes (including valves, hydrants, reservoirs etc.), pump stations and meters.	Total Population served by Water Utility	The population, excluding ICI equivalents and population equivalents for treated water supplied to neighbouring regions/municipalities, served by the distribution/transmission system. This includes the population of all wholesale and retail customers. Note that this number may well be different to the City's recorded population and, where possible, should estimate the typical number of residents receiving service.	$ / Population Served
		Indirect Cost	Total Indirect Costs	The sum of all indirect costs for your utility including administrative overheads, property taxes (grains in lieu), dividends or return on capital and billing. Excludes conservation area charges.	Total Population served by Water Utility	The population, excluding ICI equivalents and population equivalents for treated water supplied to neighbouring regions/municipalities, served by the distribution/transmission system. This includes the population of all wholesale and retail customers. Note that this number may well be different to the City's recorded population and, where possible, should estimate the typical number of residents receiving service.	$ / Population Served

Water Distribution							
Goal	**KPI**	**Breakdown**	**Numerator**	**Numerator Definition**	**Denominator**	**Denominator Definition**	**Units**
		O&M Cost	Total O&M Cost for Water Distribution and Treatment	The sum of all annual operating costs (NOT INCLUDING indirect charge-backs) for water treatment and distribution/transmission systems. Include costs for all plants and systems in the water utility whether benchmarked individually or not. Includes all costs related to infrastructure that the utility owns and operates. Includes O&M revenues for treated water supplied to neighbouring regions/municipalities. Excludes indirect costs, capital costs and costs related to debt repayment, principal or interest. Excludes Regional bulk water purchases (considered separately).Includes conservation progam costs.	Total Population served by Water Utility	The population, excluding ICI equivalents and population equivalents for treated water supplied to neighbouring regions/municipalities, served by the distribution/transmission system. This includes the population of all wholesale and retail customers. Note that this number may well be different to the City's recorded population and, where possible, should estimate the typical number of residents receiving service.	$ / Population Served
	Indirect Costs	Administrative Overheads	Administrative Overheads	The total cost of all administrative overheads that the utility paid under the water utility's budget. Administrative overheads include Admin, Human Resources, Finance, Insurance, IT (including GIS and other information management systems except for Maintenance Management Systems as these are considered O&M) and any other similar costs that support the utility. Note that the cost of customer billing and the cost of conservation programs should not be included in this measure.	Total Population served by Water Utility	The population, excluding ICI equivalents and population equivalents for treated water supplied to neighbouring regions/municipalities, served by the distribution/transmission system. This includes the population of all wholesale and retail customers. Note that this number may well be different to the City's recorded population and, where possible, should estimate the typical number of residents receiving service.	$ / Population Served
		Dividends Paid to City	Dividends Paid To City	Total amount paid to the City (or the owner of the utility) as a dividend on the equity of the utility or as a regulated return on capital.	Total Population served by Water Utility	The population, excluding ICI equivalents and population equivalents for treated water supplied to neighbouring regions/municipalities, served by the distribution/transmission system. This includes the population of all wholesale and retail customers. Note that this number may well be different to the City's recorded population and, where possible, should estimate the typical number of residents receiving service.	$ / Population Served
		Conservation Area Charges	Conservation Area Charge (Ontario Only)	The total cost paid by the utility to the City to cover the cost of funding and operating the local Conservation Area. Include only the portion that is paid by the water utility. (Formal Conservation Areas only exist only in parts of Ontario.)	Total Population served by Water Utility	The population, excluding ICI equivalents and population equivalents for treated water supplied to neighbouring regions/municipalities, served by the distribution/transmission system. This includes the population of all wholesale and retail customers. Note that this number may well be different to the City's recorded population and, where possible, should estimate the typical number of residents receiving service.	$ / Population Served

Water Distribution							
Goal	**KPI**	**Breakdown**	**Numerator**	**Numerator Definition**	**Denominator**	**Denominator Definition**	**Units**
Meet Service Requirements with Economic Efficiency		Property Taxes	Property Taxes (or Grants-in-lieu)	Total cost of all property taxes or grant-in-lieu paid on land and buildings owned by the province or city that is used by the utility in the provision of providing utility services. For example, courthouses, provincial government office buildings, ambulance stations and warehouses would be included.	Total Population served by Water Utility	The population, excluding ICI equivalents and population equivalents for treated water supplied to neighbouring regions/municipalities, served by the distribution/transmission system. This includes the population of all wholesale and retail customers. Note that this number may well be different to the City's recorded population and, where possible, should estimate the typical number of residents receiving service.	$ / Population Served
		Energy	Total Energy Cost	Cost of all energy used in the operation and maintenance of the distribution/transmission/integrated system. Energy used at the works yard, offices or vehicle use should only be included under the pipes and total system O&M cost energy fields (not under pump stations). All energy purchase costs should include the direct cost of energy, its delivery, distribution, taxes, surcharges and similar costs.	1000 * (Total Length)	Total length of main in the distribution/transmission/integrated system (i.e. excluding length of service connections, hydrant leads and standpipe leads). For the distribution system length include all connecting pipes between pump stations, rechlorination facilities and storage facilities if these are located within the distribution system. Do not include service connections. For the transmission system length include all connecting pipes between pump stations, rechlorination facilities and storage facilities when located between the source and the treatment plant or between the treatment plant and the distribution system. This includes unassumed pipe that is operated and maintained by the municipality but is still under warranty.	('000 $) / km Length
		Internal Contracted Services	Total Contracted Services (Internal) Cost	Cost of work completed by an internal municipal department that relates to operations, maintenance or support and is charged back to the water utility as a contracted cost. Includes for example charge back for radio equipment and building services such as garbage collection and recycling. Excludes cost of wages for time worked on capital construction related projects (e.g. hydraulic modeling). Also excludes cost of wages for GIS staff as these are considered under indirect costs as they are IT related. For technical and engineering staff include only the cost of wages for time worked that is directly related to operations and maintenance (e.g. engineers undertaking supervision of pipe inspection work).	1000 * (Total Length)	Total length of main in the distribution/transmission/integrated system (i.e. excluding length of service connections, hydrant leads and standpipe leads). For the distribution system length include all connecting pipes between pump stations, rechlorination facilities and storage facilities if these are located within the distribution system. Do not include service connections. For the transmission system length include all connecting pipes between pump stations, rechlorination facilities and storage facilities when located between the source and the treatment plant or between the treatment plant and the distribution system. This includes unassumed pipe that is operated and maintained by the municipality but is still under warranty.	('000 $) / km Length

Water Distribution							
Goal	KPI	Breakdown	Numerator	Numerator Definition	Denominator	Denominator Definition	Units
		Wages	Total Wages	Cost of w ages for internal operations, maintenance and support staff. Includes regular salaries, overtime, holidays paid sick time, casual w ages, fringe benefits and meal allow ances. Also includes revenues/recoveries that balance w ork performed by w ater utility staff that is extraneous to the w ater utility (for example, w hen lab staff perform tests for other utilities). Excludes cost of w ages for time w orked on capital construction related projects (e.g. hydraulic modeling). Also excludes cost of w ages for GIS staff as these are considered under indirect costs as they are IT related. For technical and engineering staff include only the cost of w ages for time w orked that is directly related to operations and maintenance (e.g. engineers undertaking supervision of pipe inspection w ork).	1000 * (Total Length)	Total length of main in the distribution/transmission/integrated system (i.e. excluding length of service connections, hydrant leads and standpipe leads). For the distribution system length include all connecting pipes betw een pump stations, rechlorination facilities and storage facilities if these are located w ithin the distribution system. Do not include service connections. For the transmission system length include all connecting pipes betw een pump stations, rechlorination facilities and storage facilities w hen located betw een the source and the treatment plant or betw een the treatment plant and the distribution system. This includes unassumed pipe that is operated and maintained by the municipality but is still under w arranty.	('000 $) / km Length
	O&M Cost	Staff Training	Total Staff Training Cost	Includes association dues, membership fees, publications, conventions, training courses, conferences, travel associated w ith courses for operations, maintenance and support staff.	1000 * (Total Length)	Total length of main in the distribution/transmission/integrated system (i.e. excluding length of service connections, hydrant leads and standpipe leads). For the distribution system length include all connecting pipes betw een pump stations, rechlorination facilities and storage facilities if these are located w ithin the distribution system. Do not include service connections. For the transmission system length include all connecting pipes betw een pump stations, rechlorination facilities and storage facilities w hen located betw een the source and the treatment plant or betw een the treatment plant and the distribution system. This includes unassumed pipe that is operated and maintained by the municipality but is still under w arranty.	('000 $) / km Length

Water Distribution							
Goal	**KPI**	**Breakdown**	**Numerator**	**Numerator Definition**	**Denominator**	**Denominator Definition**	**Units**
		External Contracted Services	Total Contracted Services (External) Cost	Cost of work completed by an external contractor or business that relates to operations, maintenance or support and is charged to the water distribution system as a contracted cost. Includes for example advertising, building repairs, ground maintenance, hauling services, contracted janitorial services, consulting engineering fees related to non-capital work and fleet. Excludes external contracted costs for capital construction related work.	1000 * (Total Length)	Total length of main in the distribution/transmission/integrated system (i.e. excluding length of service connections, hydrant leads and standpipe leads). For the distribution system length include all connecting pipes between pump stations, rechlorination facilities and storage facilities if these are located within the distribution system. Do not include service connections. For the transmission system length include all connecting pipes between pump stations, rechlorination facilities and storage facilities when located between the source and the treatment plant or between the treatment plant and the distribution system. This includes unassumed pipe that is operated and maintained by the municipality but is still under warranty.	('000 $) / km Length
		Equipment and Materials	Total Equipment and Materials Cost	Cost of equipment and materials required for operations, maintenance or support activities and staff. Includes for example courier costs, postage, equipment rentals, repairs (parts), laundry, safety supplies, telephone, uniforms, vehicles, equipment,and vehicle and equipment insurance.	1000 * (Total Length)	Total length of main in the distribution/transmission/integrated system (i.e. excluding length of service connections, hydrant leads and standpipe leads). For the distribution system length include all connecting pipes between pump stations, rechlorination facilities and storage facilities if these are located within the distribution system. Do not include service connections. For the transmission system length include all connecting pipes between pump stations, rechlorination facilities and storage facilities when located between the source and the treatment plant or between the treatment plant and the distribution system. This includes unassumed pipe that is operated and maintained by the municipality but is still under warranty.	('000 $) / km Length

Water Distribution							
Goal	**KPI**	**Breakdown**	**Numerator**	**Numerator Definition**	**Denominator**	**Denominator Definition**	**Units**
		Other	Total Other Costs	Includes other O&M costs associated with the distribution system such as rent, permit fees, utility charges for water, garbage etc.	1000 * (Total Length)	Total length of main in the distribution/transmission/integrated system (i.e. excluding length of service connections, hydrant leads and standpipe leads). For the distribution system length include all connecting pipes between pump stations, rechlorination facilities and storage facilities if these are located within the distribution system. Do not include service connections. For the transmission system length include all connecting pipes between pump stations, rechlorination facilities and storage facilities when located between the source and the treatment plant or between the treatment plant and the distribution system. This includes unassumed pipe that is operated and maintained by the municipality but is still under warranty.	('000 $) / km Length
	Cost of Fire Hydrant O&M	Cost of Fire Hydrant O&M	Cost of Fire Hydrant O&M	Annual operations and maintenance costs allocated to fire hydrants (entire hydrant assemblies including hydrant valves). Includes the costs of regular inspections, testing and repairs.	# of Hydrants	Number of Hydrants (all types) in the distribution/transmission/integrated system that are operational.	$ / hydrant
	Cost of Main Break Repairs / Total O&M Cost	Cost of Main Break Repairs / Total O&M Cost	Cost of Main Break Repairs	Cost of main break repairs all inclusive of labour, equipment, overhead and contract costs. Restoration costs such as utility cuts, and paving are also to be included. See also “Unplanned Maintenance” & "# of main breaks".	Total Distribution System O&M Cost	Maintenance Costs (Pipes, PStn, & Metering)Sum of the actual O&M costs incurred in the operation of the distribution/transmission/integrated system (excludes capital costs, indirect costs, transfers to reserves and debt/interest charges). Total System O&M cost = Pipes O&M cost + Pump Station O&M cost + Metering O&M cost. Revenues are only included where they are recoveries for work done by Water Utility staff that is extraneous to the utility (for example, for lab tests for other utilities). Total O&M should exclude O&M revenues received for treated water supplied to neighbouring regions/municipalities.	%

Water Distribution							
Goal	KPI	Breakdown	Numerator	Numerator Definition	Denominator	Denominator Definition	Units
Protect Public Health and Safety	Cumulative Length Cleaned / System Length	Cumulative Length Cleaned / System Length	Cumulative Length of Main Cleaned	The total cumulative length of water mains cleaned using flushing, swabbing and/or pigging methods to remove biofilms, sediment, and corrosion by-products from water main interiors. This generally improves water quality and hydraulic capacity. Double count mains that are cleaned on two or more occasions. Excludes service connections and mains cleaned before cement lining, or flushing to increase demand/chlorine residual. Excludes lengths that are spot flushed for the purpose of retaining a chlorine residual.	Total Length	Total length of main in the distribution/transmission/integrated system (i.e. excluding length of service connections, hydrant leads and standpipe leads). For the distribution system length include all connecting pipes between pump stations, rechlorination facilities and storage facilities if these are located within the distribution system. Do not include service connections. For the transmission system length include all connecting pipes between pump stations, rechlorination facilities and storage facilities when located between the source and the treatment plant or between the treatment plant and the distribution system. This includes unassumed pipe that is operated and maintained by the municipality but is still under warranty.	%
Protect the Environment	Average Residential Daily Consumption	Average Residential Daily Consumption	Volume delivered to Residential Customers * 10^6	Annual volume of treated water delivered to residential customers residences (may have to be estimated if not all residential customers are metered). (Excludes treated water volumes exported to neighbouring municipalities.)	(Total Population served by Water Utility) * 365	The population, excluding ICI equivalents and population equivalents for treated water supplied to neighbouring regions/municipalities, served by the distribution/transmission system. This includes the population of all wholesale and retail customers. Note that this number may well be different to the City's recorded population and, where possible, should estimate the typical number of residents receiving service.	L / Cap / day
Provide a Safe and Productive Workplace	Total Overtime Hours / Total Paid O&M Hours	Total Overtime Hours / Total Paid O&M Hours	Total Overtime Hours	Total number of overtime hours recorded for all O&M staff; do not include overtime hours that are accrued from working a normal shift on a statutory holiday. Include overtime hours that are accrued to banked	Total Hours paid by Municipality	Include all other paid hours where O&M staff employees were unavailable for work (e.g. family issues, bereavements). Employees refers to the number of O&M	%
	Main Breaks	Main Breaks	(Total # of Main Breaks) * 100	# of occurrences of distribution or transmission main breaks (include all breaks whether in the pipe or joints), includes pinholes and major breaks. Please enter a value of "0" if there are no breaks for a specific material.	Total Length	Total length of main in the distribution/transmission/integrated system (i.e. excluding length of service connections, hydrant leads and standpipe leads). For the distribution system length include all connecting pipes between pump stations, rechlorination facilities and storage facilities if these are located within the distribution system. Do not include service connections. For the transmission system length include all connecting pipes between pump stations, rechlorination facilities and storage facilities when located between the source and the treatment plant or between the treatment plant and the distribution system. This includes unassumed pipe that is operated and maintained by the municipality but is still under warranty.	# / 100 km Length

Water Distribution							
Goal	**KPI**	**Breakdown**	**Numerator**	**Numerator Definition**	**Denominator**	**Denominator Definition**	**Units**
	Valves Cycled	Valves Cycled	# of Valves Cycled (Once)	# of mainline valves that w ere cycled or exercised as part of a documented valve maintenance/cycling program w here each valve is operated through a full cycle and returned to its normal position. Include every valve cycling occurrence. This metric measures the reach of the valve cycling program. Includes mainline valves in the distribution/integrated/transmission system. Pressure reducing valves, air relief valves and hydrant valves are not included.	# of Valves	Includes all mainline valves in the distribution/integrated/transmission system. Pressure reducing valves, air relief valves and hydrant valves are not included.	%
	Non-Revenue Water	Unbilled Authorized Consumption	(Unbilled Authorized Consumption) * 1000000	Unbilled authorized metered volume: Metered Consumption w hich is for any reason unbilled. This might for example include metered consumption of the utility itself or w ater provided to institutions free of charge. Unbilled authorized unmetered volume: Any kind of Authorized Consumption w hich is neither billed nor metered. This component typically includes items such as fire fighting, flushing of mains and sew ers, street cleaning, frost protection, etc. In a w ell run utility it is a small component w hich is very often substantially overestimated.	(Total # of Service Connections) * 365	# of residential service connections + # of ICI service connections. Service connections are the pipes that lead from the distribution w ater main to the customer's plumbing. Total # of service connections # of retail customers.	L / Cap / Day
		Apparent Losses	Apparent losses volume * 1000000	= unauthorized consumption + meter under-registration + data handling errors Includes all types of inaccuracies associated w ith customer metering as w ell as data handling errors (meter reading and billing), plus unauthorized consumption (theft or illegal use). NOTE: Over-registration of customer meters, leads to under-estimation of Real Losses. Under-registration of customer meters, leads to over-estimation of Real Losses.	(Total # of Service Connections) * 366	# of residential service connections + # of ICI service connections. Service connections are the pipes that lead from the distribution w ater main to the customer's plumbing. Total # of service connections # of retail customers.	L / Cap / Day

Water Distribution							
Goal	**KPI**	**Breakdown**	**Numerator**	**Numerator Definition**	**Denominator**	**Denominator Definition**	**Units**
Provide Reliable Service and Infrastructure		Real Losses	(Real losses volume) * 1000000	Physical water losses from the pressurized system and the utility's storage tanks, up to the point of customer consumption. In metered systems this is the customer meter, in unmetered situations this is the first point of consumption (stop tap/tap) within the property. The annual volume lost through all types of leaks, breaks and overflows depends on frequencies, flow rates, and average duration of individual leaks, breaks and overflows. May also be called leakage. It is calculated as the sum of the Total volume distributed from plants and the volume imported from neighbouring municipalities (D-Description) minus Billed authorized consumption, Bulk supply meter inaccuracies, unbilled authourized metered volume, unbilled authorized unmetered volume, and apparent losses.	(Total # of Service Connections) * 367	# of residential service connections + # of ICI service connections. Service connections are the pipes that lead from the distribution water main to the customer's plumbing. Total # of service connections # of retail customers.	L / Cap / Day
	Infrastructure Leakage Index	ILI	ILI	The ratio of the Current Annual Real Losses (Real Losses) to the Unavoidable Annual Real Losses (UARL). The ILI is a highly effective performance indicator for comparing the performance of utilities in operational management of real losses. UARL (litres/day)=(18.0Lm + 0.8Nc + 25.0Lp) xP where: Lm = length of mains (kilometres) Nc = number of service connections Lp = total length of private pipe (kilometres) = Nc x average distance of private pipe in m/1000 P = average operating pressure in metres of head	-	-	-
	Hydrants Inspected	Hydrants Inspected	# of Hydrant PM Inspections	Preventative work done in the winter to ensure operability. Winterization of hydrants may include pumping down hydrants, string tests, conditioning to prevent freezing and clearing. Snow removal alone should not be considered as a hydrant winterization. Do not double count Hydrant PM Inspections or Hydrant Teardowns.	# of Hydrants	Number of Hydrants (all types) in the distribution/transmission/integrated system that are operational.	%

Water Distribution							
Goal	KPI	Breakdown	Numerator	Numerator Definition	Denominator	Denominator Definition	Units
	Capital Reinvestment / Replacement Value	Capital Reinvestment / Replacement Value	Capital Reinvestment	A project w hich substantially maintains the life of the w ater system. This is intended to be a measure of reinvestment to maintain current facilities and excludes expansion of system to handle grow th and upgrading to a higher level of service. Projects w hich serve one or more purpose (maintenance and expansion) should be prorated in order to also capture the capital applied for investment activities. Include both contracted capital w ork and internal costs associated w ith capital such as w ages for capital engineering staff i.e. design, tendering, etc. Includes capital reinvestment (i.e. replacement and relining) costs for pipes (including valves, hydrants, reservoirs etc.), pump stations and meters.	Total Replacement Value	The approximate amount of money needed to replace all of the existing infrastructure pertaining to w ater transmission / distribution. The replacement value shall include all engineering costs, construction, supervision, taxes, etc. (excluding land purchasing).	%
	Main Length Replaced or Relined	Main Length Replaced	Length of Main Replaced	Total length of w ater mains that are replaced in a planned situation (non-emergency). See also "Planned Maintenance."	Total Length	Total length of main in the distribution/transmission/integrated system (i.e. excluding length of service connections, hydrant leads and standpipe leads). For the distribution system length include all connecting pipes betw een pump stations, rechlorination facilities and storage facilities if these are located w ithin the distribution system. Do not include service connections. For the transmission system length include all connecting pipes betw een pump stations, rechlorination facilities and storage facilities w hen located betw een the source and the treatment plant or betw een the treatment plant and the distribution system. This includes unassumed pipe that is operated and maintained by the municipality but is still under w arranty.	%
		Main Length Relined	Length of Main Relined	Total length of w ater mains that are relined including all cement lining of cast iron mains.	Total Length	Total length of main in the distribution/transmission/integrated system (i.e. excluding length of service connections, hydrant leads and standpipe leads). For the distribution system length include all connecting pipes betw een pump stations, rechlorination facilities and storage facilities if these are located w ithin the distribution system. Do not include service connections. For the transmission system length include all connecting pipes betw een pump stations, rechlorination facilities and storage facilities w hen located betw een the source and the treatment plant or betw een the treatment plant and the distribution system. This includes unassumed pipe that is operated and maintained by the municipality but is still under w arranty.	%

Water Facilities							
Goal	**KPI**	**Breakdown**	**Numerator**	**Numerator Definition**	**Denominator**	**Denominator Definition**	**Units**
Provide Reliable Service and Infrastructure	Capital Reinvestment / Replacement Value	Capital Reinvestment/ Replacement Value	Capital Reinvestment	A project w hich substantially maintains the life of the treatment system. This is intended to be a measure of reinvestment to maintain current facilities and excludes expansion of system to handle grow th and upgrading to a higher level of service. Projects w hich serve one or more purpose (maintenance and expansion) should be prorated in order to also capture the capital applied for investment activities. Include both contracted capital w ork and internal costs associated w ith capital such as w ages for capital engineering staff i.e. design, tendering, etc. Includes capital reinvestment (i.e. replacement) costs for utility systems components (for example: pipes (including valves, hydrants, reservoirs etc), pump stations and meters).	Total Replacement Value	The amount of money needed to replace all of the existing infrastructure pertaining to w ater treatment. The replacement value shall include all engineering costs, construction, supervision, taxes, etc (excluding land purchasing).	%
	Reactive Maintenance Hours / Total Maintenance Hours	Reactive Maintenance Hours / Total Maintenance Hours	Emergency (Unscheduled) Maintenance Hours	Emergency Maintenance Hours (Unscheduled): Emergency hours = # of hours spent by maintenance staff on emergency w ork (repairing equipment after it has broken dow n). Emergency w ork requires rapid response in order to protect life, property, or the environment. Emergency maintenance must be deployed as soon as possible and may require the use of overtime. Include both internal and external maintenance hours (e.g. some systems outsource all breakdow n w ork therefore they should estimate all maintenance hours, both internal and external). Use total hours and non-paid hours (in the case of overtime). Emergency maintenance hours completed by operations staff should also be included in this section. These hours should include the entire time spent completing w ork orders. Administration such as ordering parts, recording w ork order information and updating the maintenance management system should therefore be included as w ell. Urgent Maintenance Hours (Unscheduled): Urgent maintenance hours = # of hours spent by maintenance staff on maintenance w ork that causes you to interrupt your daily schedule but is not captured under emergency w ork (above). Urgent w ork may not result in loss of service as the system is protected by equipment redundancy, and maintenance is deployed at the earliest practical convenience. As a guide include w ork that w ould cause you to interrupt your daily maintenance plan. Include both internal and external maintenance hours (e.g. some systems outsource all breakdow n w ork therefore they should estimate all maintenance hours, both internal and external). Urgent maintenance hours completed by operations staff should also be included in this section. These hours should include the entire time spent completing w ork orders. Administration such as ordering parts, recording w ork order information and updating the maintenance management system should therefore be included as w ell.	Total Maintenance Hours	Sum of all maintenance hours below . = Emergency Maintenance + Urgent Maintenance + Corrective Maintenance + Preventative Maintenance + Inspections + Capital + Other hours.	%

Water Facilities							
Goal	KPI	Breakdown	Numerator	Numerator Definition	Denominator	Denominator Definition	Units
		Other	Other Costs	Includes other O&M costs associated with the water treatment plant such as rent, permit fees, utility charges for water etc.	Total Treated Water	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	$ / ML Treated
		Staff Training	Staff Training	Includes association dues, membership fees, publications, conventions, training courses, conferences, travel associated with courses for operations, maintenance and support staff.	Total Treated Water	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	$ / ML Treated
		Chemicals	Chemicals	All costs for chemicals consumed including the cost of delivery.	Total Treated Water	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	$ / ML Treated
		Energy	Energy	Cost of all energy used in the operation and maintenance of water treatment plant. Includes high lift pumps for treated water that are a part of the plant. Does NOT include the energy used at the works yard, offices or vehicle use. All energy purchase costs should include the direct cost of energy, its delivery, distribution, taxes, surcharges and similar costs.	Total Treated Water	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	$ / ML Treated
		External Contracted Services	Contracted Services (External)	Cost of work completed by an external contractor or business that relates to operations, maintenance or support and is charged to the water treatment plant as a contracted cost. Includes for example advertising, building repairs, ground maintenance, hauling services, contracted janitorial services, consulting engineering fees related to non-capital work and fleet. Excludes external contracted costs for capital construction related work.	Total Treated Water	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	$ / ML Treated

Water Facilities							
Goal	**KPI**	**Breakdown**	**Numerator**	**Numerator Definition**	**Denominator**	**Denominator Definition**	**Units**
	O&M Cost relative to Volume Treated	Internal Contracted Services	Contracted Services (Internal)	Cost of w ork completed by an internal municipal department that relates to operations, maintenance or support and is charged back to the w ater treatment plant as a contracted cost. Includes for example charge back for radio equipment and building services such as garbage collection and recycling. Excludes internal costs for capital construction related projects (e.g. hydraulic modeling). Also excludes internal costs for GIS staff as these are considered under indirect costs as they are IT related. For technical and engineering internal costs include only the costs that is directly related to operations and maintenance (e.g. for chemical engineers undertaking ongoing process optimization for the plant).	Total Treated Water	Annual volume of treated w ater delivered from the treatment plant to the transmission/distribution system. (Include treated w ater volume supplied to neighbouring regions/municipalities)	$ / ML Treated
		Equipment and Materials	Equipment and Materials	Cost of equipment and materials required for operations, maintenance or support activities and staff. Includes for example courier costs, postage, equipment rentals, repairs (parts), laundry, safety supplies, telephone, uniforms, vehicle and equipment insurance. Includes all cost incurred from vehicle use. Exclude cost of chemicals as these are tracked separately.	Total Treated Water	Annual volume of treated w ater delivered from the treatment plant to the transmission/distribution system. (Include treated w ater volume supplied to neighbouring regions/municipalities)	$ / ML Treated
		Wages	Wages	Cost of w ages for internal operations, maintenance and support staff. Includes regular salaries, overtime, holidays paid sick time, casual w ages, fringe benefits and meal allow ances. Also includes revenues/recoveries that balance w ork performed by w ater utility staff that is extraneous to the w ater utility (for example, w hen lab staff perform tests for other municipalities). Excludes internal costs for capital construction related projects (e.g. hydraulic modeling). Also excludes internal costs for GIS staff as these are considered under indirect costs as they are IT related. For technical and engineering internal costs include only the costs that is directly related to operations and maintenance (e.g. for chemical engineers undertaking ongoing process optimization for the plant).	Total Treated Water	Annual volume of treated w ater delivered from the treatment plant to the transmission/distribution system. (Include treated w ater volume supplied to neighbouring regions/municipalities)	$ / ML Treated

Water Facilities							
Goal	**KPI**	**Breakdown**	**Numerator**	**Numerator Definition**	**Denominator**	**Denominator Definition**	**Units**
Meet Service Requirements with Economic Efficiency		Taste and Odour	Annual Cost of Chemical used for Taste and Odour	-	Total Treated Water	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	$ / ML Treated
		Softening	Annual Cost of Chemical used for Softening	-	Total Treated Water	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	$ / ML Treated
		Sludge Conditioning	Annual Cost of Chemical used for Sludge Conditioning	-	Total Treated Water	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	$ / ML Treated
		Other	Annual Cost of Chemical used for Other	-	Total Treated Water	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	$ / ML Treated
		Pre-oxidation	Annual Cost of Chemical used for Pre-oxidation	-	Total Treated Water	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	$ / ML Treated
		Phosphorus Removal	Annual Cost of Chemical used for Phosphorus Removal	-	Total Treated Water	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	$ / ML Treated
		pH Control / Stabilisation	Annual Cost of Chemical used for pH Control / Stabilisation	-	Total Treated Water	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	$ / ML Treated

Water Facilities							
Goal	KPI	Breakdown	Numerator	Numerator Definition	Denominator	Denominator Definition	Units
	Chemical Cost	Ozone Generation	Annual Cost of Chemical used for Ozone Generation	-	Total Treated Water	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	$ / ML Treated
		Membrane Cleaning	Annual Cost of Chemical used for Membrane Cleaning	-	Total Treated Water	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	$ / ML Treated
		Iron Sequestering	Annual Cost of Chemical used for Iron Sequestering	-	Total Treated Water	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	$ / ML Treated
		Fluoridation	Annual Cost of Chemical used for Fluoridation	-	Total Treated Water	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	$ / ML Treated
		Flocculation	Annual Cost of Chemical used for Flocculation	-	Total Treated Water	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	$ / ML Treated
		Disinfection	Annual Cost of Chemical used for Disinfection	-	Total Treated Water	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	$ / ML Treated
		Dechlorination	Annual Cost of Chemical used for Dechlorination	-	Total Treated Water	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	$ / ML Treated

Water Facilities							
Goal	KPI	Breakdown	Numerator	Numerator Definition	Denominator	Denominator Definition	Units
		Corrosion Control	Annual Cost of Chemical used for Corrosion Control	-	Total Treated Water	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	$ / ML Treated
		Chlorination	Annual Cost of Chemical used for Chlorination	-	Total Treated Water	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	$ / ML Treated
		Coagulation	Annual Cost of Chemical used for Coagulation	-	Total Treated Water	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	$ / ML Treated
Protect the Environment	Water Wasted During Treatment Process	Water Wasted	Total Treated Water	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	Total Raw Water Abstracted	Annual volume of raw water delivered from the source to the treatment plant. (Include raw water abstracted required for supplying treated water volume to neighbouring regions/municipalities)	%
	GHG Emissions from Energy Consumed	Oil	(Oil Energy Consumed L) * 2703	Amount of oil consumed annually while operating and maintaining the plant.	(Total Treated Water) * 1000	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	kg CO2e / ML Treated
		Natural Gas	(Natural Gas Energy Consumed GJ) * 56000	Amount of natural gas in GJ consumed annually while operating and maintaining the plant. If data is provided in m³, then multiply by 0.0373 to convert to GJ.	(Total Treated Water) * 1000	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	kg CO2e / ML Treated
		Propane	(Propane Energy Consumed kg) * 1518 / 0.5812	Amount of propane consumed annually while operating and maintaining the plant.	(Total Treated Water) * 1000	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	kg CO2e / ML Treated

Water Facilities							
Goal	**KPI**	**Breakdown**	**Numerator**	**Numerator Definition**	**Denominator**	**Denominator Definition**	**Units**
		Diesel	(Diesel Energy Consumed L) * 2703	Amount of diesel consumed annually while operating and maintaining the plant.	(Total Treated Water) * 1000	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	kg CO2e / ML Treated
		Electricity	(Total Electricity Energy Consumed kWh) * (Electricity GHG Intensity)	Sum of the energy consumed in kWh in the operation and maintenance of the water treatment plant, and high lift pumps within the plant. Energy sources include electricity, natural gas, oil, propane and diesel and are converted to kWh using standard conversions.	(Total Treated Water) * 1000	Annual volume of treated water delivered from the treatment plant to the transmission/distribution system. (Include treated water volume supplied to neighbouring regions/municipalities)	kg CO2e / ML Treated
		Other	Total # of Other Unavailable Hours paid by Municipality	Include all other paid hours where O&M staff were unavailable for work (e.g. family issues, bereavements).	Total Hours paid by Municipality	Total number of standard paid hours recorded for all O&M staff excluding overtime hours. If total is unknown, it can be calculated by "# of actual O&M staff x average # of paid hours per O&M staff per year" where average # of paid hours per O&M staff per year is typically 2080 hours. Exclude hours for O&M staff that are on WCB, maternity leave or paternity leave for the full year. Exclude long term leave and union paid hours as these are not paid for by the municipality.	%
		Expended Banked Time	Total # of Hours expended from Banked Time	Total # of hours expended from banked time regardless of the year in which the banked hours were accrued.	Total Hours paid by Municipality	Total number of standard paid hours recorded for all O&M staff excluding overtime hours. If total is unknown, it can be calculated by "# of actual O&M staff x average # of paid hours per O&M staff per year" where average # of paid hours per O&M staff per year is typically 2080 hours. Exclude hours for O&M staff that are on WCB, maternity leave or paternity leave for the full year. Exclude long term leave and union paid hours as these are not paid for by the municipality.	%

Water Facilities							
Goal	**KPI**	**Breakdown**	**Numerator**	**Numerator Definition**	**Denominator**	**Denominator Definition**	**Units**
Provide a Safe and Productive Workplace	Unavailable O&M Hours / Total Paid O&M Hours	Long Term Leave	Total # of Long Term Leave Hours	The total number of long term leave hours for all O&M staff employees w hich is additional to sick days taken. Includes long term leave w hen staff are not replaced and hours paid by the Workplace Safety and Insurance Board or the Workers Compensation Board. If the employee w as on WCB for the full year, then their long term leave hours should not be included.	Total Hours paid by Municipality	Total number of standard paid hours recorded for all O&M staff excluding overtime hours. If total is unknow n, it can be calculated by "# of actual O&M staff x average # of paid hours per O&M staff per year" w here average # of paid hours per O&M staff per year is typically 2080 hours. Exclude hours for O&M staff that are on WCB, maternity leave or paternity leave for the full year. Exclude long term leave and union paid hours as these are not paid for by the municipality.	%
		Sick Time	Total # of Sick Hours taken	The total number of sick hours taken by O&M staff employees. Equals the number of average # of sick days taken per employee * # of employees * 8 hours per day.	Total Hours paid by Municipality	Total number of standard paid hours recorded for all O&M staff excluding overtime hours. If total is unknow n, it can be calculated by "# of actual O&M staff x average # of paid hours per O&M staff per year" w here average # of paid hours per O&M staff per year is typically 2080 hours. Exclude hours for O&M staff that are on WCB, maternity leave or paternity leave for the full year. Exclude long term leave and union paid hours as these are not paid for by the municipality.	%
		Union Paid Time	Total # of Union Paid Hours	Total # of union paid hours for actual employees. The total number of hours that plant staff employees w ere unavailable for w ork due to union duties (and their time w as paid for by the union) for example to attend union meetings.	Total Hours paid by Municipality	Total number of standard paid hours recorded for all O&M staff excluding overtime hours. If total is unknow n, it can be calculated by "# of actual O&M staff x average # of paid hours per O&M staff per year" w here average # of paid hours per O&M staff per year is typically 2080 hours. Exclude hours for O&M staff that are on WCB, maternity leave or paternity leave for the full year. Exclude long term leave and union paid hours as these are not paid for by the municipality.	%

Water Facilities							
Goal	**KPI**	**Breakdown**	**Numerator**	**Numerator Definition**	**Denominator**	**Denominator Definition**	**Units**
		Other Training	Total # of Other Training Hours	The total number of other training hours taken for all O&M staff employees that excludes safety training hours but includes conferences, seminars etc.	Total Hours paid by Municipality	Total number of standard paid hours recorded for all O&M staff excluding overtime hours. If total is unknown, it can be calculated by "# of actual O&M staff x average # of paid hours per O&M staff per year" where average # of paid hours per O&M staff per year is typically 2080 hours. Exclude hours for O&M staff that are on WCB, maternity leave or paternity leave for the full year. Exclude long term leave and union paid hours as these are not paid for by the municipality.	%
		Safety Training	Total # of Safety Training Hours	The total number of safety training hours taken for all O&M staff employees that includes confined space entry, safety meetings, hazardous chemical training, WHMIS etc.	Total Hours paid by Municipality	Total number of standard paid hours recorded for all O&M staff excluding overtime hours. If total is unknown, it can be calculated by "# of actual O&M staff x average # of paid hours per O&M staff per year" where average # of paid hours per O&M staff per year is typically 2080 hours. Exclude hours for O&M staff that are on WCB, maternity leave or paternity leave for the full year. Exclude long term leave and union paid hours as these are not paid for by the municipality.	%
		Vacation	Total # of Vacation Hours (include Stats)	The total number of vacation hours taken by O&M staff employees that includes annual leave, maternity or paternity leave, leave without pay and statutory holidays. If the employee was on maternity or paternity leave for the full year, then their hours should not be included.	Total Hours paid by Municipality	Total number of standard paid hours recorded for all O&M staff excluding overtime hours. If total is unknown, it can be calculated by "# of actual O&M staff x average # of paid hours per O&M staff per year" where average # of paid hours per O&M staff per year is typically 2080 hours. Exclude hours for O&M staff that are on WCB, maternity leave or paternity leave for the full year. Exclude long term leave and union paid hours as these are not paid for by the municipality.	%

Water Facilities							
Goal	KPI	Breakdown	Numerator	Numerator Definition	Denominator	Denominator Definition	Units
Protect Public Health and Safety	Average Annual Treated Water Turbidity	Treated Water Turbidity	Average Turbidity I Value or Average Turbidity II Value	Turbidity I: If the datasheets are being completed for a filtration plant (e.g. Direct filtration, membrane, or conventional filtration) then the values for the plant turbidity target, the average turbidity value and the number of days with an occurrence over the group target should be entered into this row of the datasheets (see definitions for these terms below). Turbidity II: If the datasheets are being completed for an unfiltered system (e.g. disinfection only, iron and manganese treatment or no treatment) then the values for the plant target, the average turbidity value and the number of days with an occurrence over the group target should be entered into this row of the datasheets (see definitions for these terms below).	-	-	NTU

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Appendix E

Facilities Assets Recommended Interventions

																								Adjusted for Risk and Condition			Original		
iItem ID	Asset Description	Level 1 – Functional Group	Level 2 – Facility Type / Location	Level 3 – Process Location	Level 4 – Asset Category	Level 5 (Asset Type)	Unique ID	Install Year	Refurbishment Year	Size / Capacity	Unit of Measure	Condition Score (1 to 5 Scale)	CoF Score (1 to 5 Scale)	ESL	Replacement Cost (2020)	Project Cost (includes Markup)	Action Required (Original)	Action Required (Adjusted)	Apparent Age	Risk Score (1 to 25 Scale)	# of years since Assessment	Age at Time of Assessment	Expected Condition at Time of Assessment	1st Repl. YR (Adj)	2nd Repl. YR (Adj)	3rd Repl. YR (Adj)	1st Repl. YR	2nd Repl. YR2	3rd Repl. YR3
1	Booster Pump#304	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Pump	Missing	1983	NA	5548	GPM	3	3	20	$ 75,000	$ 108,750	Assess	Assess	30	9	0	37	5	2020	2040	2060	2020	2040	2060
2	Motor Pump#304	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000065	1983	NA	400	HP	4	3	20	$ 35,000	$ 50,750	Assess	Assess	33	12	0	37	5	2020	2040	2060	2020	2040	2060
3	Motor Pump#303	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	Missing	1983	NA	400	HP	4	3	20	$ 35,000	$ 50,750	Assess	Assess	33	12	0	37	5	2020	2040	2060	2020	2040	2060
4	Booster Pump 303	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Pump	Missing	1983	NA	5548	GPM	3	3	20	$ 75,000	$ 108,750	Assess	Assess	30	9	0	37	5	2020	2040	2060	2020	2040	2060
5	Booster Pump 302	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Pump	Missing	1983	NA	2774	GPM	2	3	20	$ 60,000	$ 87,000	Assess	Assess	26	6	0	37	5	2020	2040	2060	2020	2040	2060
6	Booster Pump Motor 302	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000063	1983	NA	200	HP	4	3	20	$ 18,500	$ 26,825	Assess	Assess	33	12	0	37	5	2020	2040	2060	2020	2040	2060
7	Booster Pump 301	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Pump	Missing	1983	NA	2774	GPM	2	2	20	$ 60,000	$ 87,000	Replace on Failure	Replace on Failure	26	4	0	37	5	2020	2040	2060	2020	2040	2060
8	Booster Pump Motor 301	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000062	1983	NA	200	HP	4	2	20	$ 18,500	$ 26,825	Replace on Failure	Replace on Failure	33	8	0	37	5	2020	2040	2060	2020	2040	2060
9	Check Valve (BP 302) R.W. 8	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000080	1983	NA	16	in	3	3	35	$ 20,000	$ 29,000	Assess	No Action Required	30	9	0	37	5	2025	2060	2095	2020	2055	2090
10	Air relief valve (BP 302) RW 10	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000146	1983	NA	2	in	2	3	35	$ 1,000	$ 1,450	Assess	No Action Required	26	6	0	37	5	2029	2064	2099	2020	2055	2090
11	Check Valve (BP 301) R.W. 14	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000079	1983	NA	16	in	3	3	35	$ 20,000	$ 29,000	Assess	No Action Required	30	9	0	37	5	2025	2060	2095	2020	2055	2090
12	Air relief valve (BP301) RW 16	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000145	1983	NA	2	in	2	3	35	$ 1,000	$ 1,450	Assess	No Action Required	26	6	0	37	5	2029	2064	2099	2020	2055	2090
13	Butterfly Valve BV-5 901	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000067	1983	NA	18	in	2	3	35	$ 8,000	$ 11,600	Assess	No Action Required	26	6	0	37	5	2029	2064	2099	2020	2055	2090
14	Actuator Butterfly Valve RW 13	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Actuator	100000066	1983	NA			2	3	25	$ 6,000	$ 8,700	Assess	Assess	26	6	0	37	5	2020	2045	2070	2020	2045	2070
15	Butterfly Valve, Actuator BV-4 901 BP301	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Actuator	100000067	1983	NA	24	in	2	3	25	$ 6,000	$ 8,700	Assess	Assess	26	6	0	37	5	2020	2045	2070	2020	2045	2070
16	Butterfly Valve BV-4 902 BP302	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000073	1983	NA	24	in	3	3	35	$ 12,000	$ 17,400	Assess	No Action Required	30	9	0	37	5	2025	2060	2095	2020	2055	2090
17	Actuator Butterfly Valve RW 7	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Actuator	100000074	1983	NA			2	3	25	$ 6,000	$ 8,700	Assess	Assess	26	6	0	37	5	2020	2045	2070	2020	2045	2070
18	Butterfly Valve Motorized Manifold (BV3 RW1)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000148	1983	NA	30	in	2	3	35	$ 18,500	$ 26,825	Assess	No Action Required	26	6	0	37	5	2029	2064	2099	2020	2055	2090
19	Actuator Butterfly Valve RW 1 BV3	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Actuator	Missing	1983	NA	1700	RPM	2	3	25	$ 6,000	$ 8,700	Assess	Assess	26	6	0	37	5	2020	2045	2070	2020	2045	2070
20	Butterfly Valve BV2 RW12	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000139	1983	NA	30	in	2	4	35	$ 18,500	$ 26,825	Assess	No Action Required	26	8	0	37	5	2029	2064	2099	2020	2055	2090
21	Plug Valve BV9 SW1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000140	1983	NA	6	in	2	3	35	$ 1,200	$ 1,740	Assess	No Action Required	26	6	0	37	5	2029	2064	2099	2020	2055	2090
22	Plug Valve SW3 (BV 8)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000138	1983	NA	6	in	2	3	35	$ 1,200	$ 1,740	Assess	No Action Required	26	6	0	37	5	2029	2064	2099	2020	2055	2090
23	Air relief valve (cooling water line)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000151	1983	NA	1	in	2	1	35	$ 600	$ 870	Replace on Failure	No Action Required	26	2	0	37	5	2029	2064	2099	2020	2055	2090
24	Air Compressor 1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Compressor	Missing	1983	NA			2	3	20	$ 8,700	$ 12,615	Assess	Assess	26	6	0	37	5	2020	2040	2060	2020	2040	2060
25	Motor Air Compressor Fan 1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000121	1983	NA	5	HP	2	3	20	$ 2,000	$ 2,900	Assess	Assess	26	6	0	37	5	2020	2040	2060	2020	2040	2060
26	Compressor Tank 1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Pressure Vessel	100000119	1983	NA	30	Gallon	2	3	20	$ 800	$ 1,160	Assess	Assess	26	6	0	37	5	2020	2040	2060	2020	2040	2060
27	Compressor Disconnect 1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Disconnect	1000000117	1983	NA	20	HP	2	3	25	$ 1,000	$ 1,450	Assess	Assess	26	6	0	37	5	2020	2045	2070	2020	2045	2070
28	Compressor Tank 2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Pressure Vessel	100000118	1983	NA	30	Gallon	2	3	20	$ 800	$ 1,160	Assess	Assess	26	6	0	37	5	2020	2040	2060	2020	2040	2060
29	Motor Air Compressor Fan 2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000120	1983	NA	5	HP	2	3	20	$ 2,000	$ 2,900	Assess	Assess	26	6	0	37	5	2020	2040	2060	2020	2040	2060
30	Air Compressor 2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Compressor	Missing	1983	NA			2	3	20	$ 9,100	$ 13,195	Assess	Assess	26	6	0	37	5	2020	2040	2060	2020	2040	2060
31	Compressor Disconnect 2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Disconnect	100000116	1983	NA	20	HP	2	3	25	$ 1,000	$ 1,450	Assess	Assess	26	6	0	37	5	2020	2045	2070	2020	2045	2070
32	Screen 1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Screen	100000089	1983	NA			2	3	25	$ 154,000	$ 223,300	Assess	Assess	26	6	0	37	5	2020	2045	2070	2020	2045	2070
33	Gear box and motor Screen 1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000089	1983	NA			2	3	20	$ 2,000	$ 2,900	Assess	Assess	26	6	0	37	5	2020	2040	2060	2020	2040	2060
34	Bar screen 1 disconnect	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Disconnect	100000113	1983	NA	20	HP	2	3	25	$ 1,000	$ 1,450	Assess	Assess	26	6	0	37	5	2020	2045	2070	2020	2045	2070
35	Motorized Ball Valve, Screen 1 (Valve)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000142	1983	NA	2	in	3	3	35	$ 1,100	$ 1,595	Assess	No Action Required	30	9	0	37	5	2025	2060	2095	2020	2055	2090
36	Motorized Ball Valve, Screen 1 (Motor)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000142	1983	NA	2	in	3	3	20	$ 2,000	$ 2,900	Assess	Assess	30	9	0	37	5	2020	2040	2060	2020	2040	2060
37	Screen 2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Screen	100000090	1983	NA			2	3	25	$ 154,000	$ 223,300	Assess	Assess	26	6	0	37	5	2020	2045	2070	2020	2045	2070
38	Gear box and motor Screen 2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000090	1983	NA			2	3	20	$ 2,000	$ 2,900	Assess	Assess	26	6	0	37	5	2020	2040	2060	2020	2040	2060
39	Motorized Ball Valve, Screen 2 (Valve)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000143	2014	NA	2	in	2	3	35	$ 1,100	$ 1,595	No Action Required	No Action Required	9	6	0	6	1.685714286	2046	2081	2116	2049	2084	2119
40	Motorized Ball Valve, Screen 2 (Motor)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Motor	100000143	1983	NA	2	in	3	3	20	$ 2,000	$ 2,900	Assess	Assess	30	9	0	37	5	2020	2040	2060	2020	2040	2060
41	Barr screen 2 disconnect	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Disconnect	100000114	1983	NA	20	HP	2	3	25	$ 1,000	$ 1,450	Assess	Assess	26	6	0	37	5	2020	2045	2070	2020	2045	2070

Item ID	Asset Description	Level 1 – Functional Group	Level 2 – Facility Type / Location	Level 3 – Process Location	Level 4 – Asset Category	Level 5 (Asset Type)	Unique ID	Install Year	Refurbishment Year	Size / Capacity	Unit of Measure	Condition Score (1 to 5 Scale)	CoF Score (1 to 5 Scale)	ESL	Replacement Cost (2020)	Project Cost (includes Markup)	Action Required (Original)	Action Required (Adjusted)	Apparent Age	Risk Score (1 to 25 Scale)	# of years since Assessment	Age at Time of Assessment	Expected Condition at Time of Assessment	1st Repl. YR (Adj)	2nd Repl. YR (Adj)	3rd Repl. YR (Adj)	1st Repl. YR	2nd Repl. YR2	3rd Repl. YR3
42	Starter Pump 303 Raw Water	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Starter	100000099	2016	NA	420A		4	3	30	$ 16,000	$ 23,200	No Action Required	No Action Required	23	12	0	4	1.533333333	2027	2057	2087	2046	2076	2106
43	Starter Pump 304 Raw Water	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Starter	100000098	1983	NA	700A		4	3	30	$ 16,000	$ 23,200	Assess	Assess	33	12	0	37	5	2020	2050	2080	2020	2050	2080
44	Starter Pump 302 Raw Water	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Starter	100000097	1983	NA	700A		4	3	30	$ 16,000	$ 23,200	Assess	Assess	33	12	0	37	5	2020	2050	2080	2020	2050	2080
45	Starter Pump 301 Raw Water	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Starter	100000096	1983	NA	700A		4	3	30	$ 16,000	$ 23,200	Assess	Assess	33	12	0	37	5	2020	2050	2080	2020	2050	2080
46	Monorail disconnect	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Disconnect	100000102	1983	NA	20	HP	2	2	25	$ 1,000	$ 1,450	Replace on Failure	Replace on Failure	26	4	0	37	5	2020	2045	2070	2020	2045	2070
47	Check Valve (on p/p#304) R.W. #3	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000081	1983	NA	24	in	3	3	35	$ 26,000	$ 37,700	Assess	No Action Required	30	9	0	37	5	2025	2060	2095	2020	2055	2090
48	Check Valve (on p/p#303) R.W. #19	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000078	1983	NA	24	in	2	3	35	$ 26,000	$ 37,700	Assess	No Action Required	26	6	0	37	5	2029	2064	2099	2020	2055	2090
49	Valve Butterfly (Pump #4)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000076	1983	NA	24	in	2	3	35	$ 12,000	$ 17,400	Assess	No Action Required	26	6	0	37	5	2029	2064	2099	2020	2055	2090
50	Operator Butterfly Valve (RW#2) (Pump#4)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Actuator	100000075	1983	NA			2	3	25	$ 6,000	$ 8,700	Assess	Assess	26	6	0	37	5	2020	2045	2070	2020	2045	2070
51	Valve Butterfly BV 4-903 (Pump #3)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000070	1983	NA	24	in	2	3	35	$ 12,000	$ 17,400	Assess	No Action Required	26	6	0	37	5	2029	2064	2099	2020	2055	2090
52	Operator Butterfly Valve (RW#18) (Pump#4)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Actuator	100000069	1983	NA			2	3	25	$ 6,000	$ 8,700	Assess	Assess	26	6	0	37	5	2020	2045	2070	2020	2045	2070
53	Valve Butterfly (RW#24)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000141	1983	NA	16	in	2	5	35	$ 6,500	$ 9,425	Assess	No Action Required	26	10	0	37	5	2029	2064	2099	2020	2055	2090
54	Valve Butterfly (BV8) (RW#23)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000137	1983	NA	16	in	2	5	35	$ 6,500	$ 9,425	Assess	No Action Required	26	10	0	37	5	2029	2064	2099	2020	2055	2090
55	Surge Tank #1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Pressure Vessel	100000114	1983	NA			2	4	20	$ 241,200	$ 349,740	Assess	Assess	26	8	0	37	5	2020	2040	2060	2020	2040	2060
56	Surge Tank #2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Pressure Vessel	100000115	1983	NA			2	4	20	$ 241,200	$ 349,740	Assess	Assess	26	8	0	37	5	2020	2040	2060	2020	2040	2060
57	Air Valve Surge Tank #2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000160	1983	NA	1	in	2	4	35	$ 1,000	$ 1,450	Assess	No Action Required	26	8	0	37	5	2029	2064	2099	2020	2055	2090
58	Air Valve Surge Tank #2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000161	1983	NA	1	in	2	4	35	$ 1,000	$ 1,450	Assess	No Action Required	26	8	0	37	5	2029	2064	2099	2020	2055	2090
59	Control Panel Surge Tank #2	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Control Panel	100000133	1983	NA			2	4	25	$ 5,500	$ 7,975	Assess	Assess	26	8	0	37	5	2020	2045	2070	2020	2045	2070
60	Air Valve Surge Tank #1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000158	1983	NA	1	in	2	4	35	$ 1,000	$ 1,450	Assess	No Action Required	26	8	0	37	5	2029	2064	2099	2020	2055	2090
61	Air Valve Surge Tank #1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000159	1983	NA	1	in	2	4	35	$ 1,000	$ 1,450	Assess	No Action Required	26	8	0	37	5	2029	2064	2099	2020	2055	2090
62	Control Panel Surge Tank #1	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Electrical	Control Panel	100000132	1983	NA			2	4	25	$ 5,500	$ 7,975	Assess	Assess	26	8	0	37	5	2020	2045	2070	2020	2045	2070
63	Valve Limitorque (Main)	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000131	1983	NA	1200 x 1200	mm	2	3	35	$ 34,000	$ 49,300	Assess	No Action Required	26	6	0	37	5	2029	2064	2099	2020	2055	2090
64	Valve Limitorque	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000130	1983	NA	1200 x 1200	mm	2	3	35	$ 34,000	$ 49,300	Assess	No Action Required	26	6	0	37	5	2029	2064	2099	2020	2055	2090
65	Valve Limitorque	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000128	1983	NA	1200 x 1200	mm	2	3	35	$ 34,000	$ 49,300	Assess	No Action Required	26	6	0	37	5	2029	2064	2099	2020	2055	2090
66	Valve Torque	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000126	1983	NA	1200 x 1200	mm	2	3	35	$ 34,000	$ 49,300	Assess	No Action Required	26	6	0	37	5	2029	2064	2099	2020	2055	2090
67	Valve Torque	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000127	1983	NA	1200 x 1200	mm	2	3	35	$ 34,000	$ 49,300	Assess	No Action Required	26	6	0	37	5	2029	2064	2099	2020	2055	2090
68	Valve Torque	Surface Water Facilities	Gros Cap Raw Water Pumping Station	Pump Room	Process Mechanical	Valve	100000129	1983	NA	1200 x 1200	mm	2	3	35	$ 34,000	$ 49,300	Assess	No Action Required	26	6	0	37	5	2029	2064	2099	2020	2055	2090
69	Air Relief Low Lift 1	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000404	1986	NA	1	in	2	2	35	$ 600	$ 870	No Action Required	No Action Required	24	4	0	34	4.885714286	2031	2066	2101	2021	2056	2091
70	Air Relief Valve low lift 2	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000415	1986	NA	1	in	2	3	35	$ 600	$ 870	No Action Required	No Action Required	24	6	0	34	4.885714286	2031	2066	2101	2021	2056	2091
71	Air Relief Valve low lift 4	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000444	1986	NA	1	in	2	3	35	$ 600	$ 870	No Action Required	No Action Required	24	6	0	34	4.885714286	2031	2066	2101	2021	2056	2091
72	Air Relief Valve low lift 3	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000428	1986	NA	1	in	2	3	35	$ 600	$ 870	No Action Required	No Action Required	24	6	0	34	4.885714286	2031	2066	2101	2021	2056	2091
73	Low Lift Pump #1	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Pump	300000407	1986	NA	175	L/s	2	2	20	$ 25,000	$ 36,250	Replace on Failure	Replace on Failure	24	4	0	34	5	2020	2040	2060	2020	2040	2060
74	Low Lift Pump Motor #1	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Pump	300000401	1986	NA	30	HP	2	2	20	$ 3,500	$ 5,075	Replace on Failure	Replace on Failure	24	4	0	34	5	2020	2040	2060	2020	2040	2060
75	Low Lift Pump #2	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Pump	300000419	1986	NA	350	L/s	2	3	20	$ 35,000	$ 50,750	Assess	Assess	24	6	0	34	5	2020	2040	2060	2020	2040	2060
76	Low Lift Pump Motor #2	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Pump	300000418	1986	NA	60	HP	2	3	20	$ 5,500	$ 7,975	Assess	Assess	24	6	0	34	5	2020	2040	2060	2020	2040	2060
77	Low Lift Pump #3	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Pump	300000431	1986	NA	350	L/s	2	3	20	$ 35,000	$ 50,750	Assess	Assess	24	6	0	34	5	2020	2040	2060	2020	2040	2060
78	Low Lift Pump Motor #3	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Pump	300000430	1986	NA	60	HP	2	3	20	$ 5,500	$ 7,975	Assess	Assess	24	6	0	34	5	2020	2040	2060	2020	2040	2060
79	Low Lift Pump #4	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Pump	300000447	1986	NA	350	L/s	2	3	20	$ 35,000	$ 50,750	Assess	Assess	24	6	0	34	5	2020	2040	2060	2020	2040	2060
80	Low Lift Pump Motor #4	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Pump	300000446	1986	NA	60	HP	2	3	20	$ 5,500	$ 7,975	Assess	Assess	24	6	0	34	5	2020	2040	2060	2020	2040	2060
81	Mixer Inlet Blender #3	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Mixer	300000398	1986	NA			3	3	40	$ 35,600	$ 51,620	No Action Required	No Action Required	29	9	0	34	4.4	2031	2071	2111	2026	2066	2106
82	Mixer Inlet Blender Motor #3	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Motor	300000397	1986	NA	5	HP	2	3	20	$ 2,000	$ 2,900	Assess	Assess	24	6	0	34	5	2020	2040	2060	2020	2040	2060
83	Mixer Inlet Blender #4	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Mixer	300000439	1986	NA			3	3	40	$ 35,600	$ 51,620	No Action Required	No Action Required	29	9	0	34	4.4	2031	2071	2111	2026	2066	2106

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84	Mixer Inlet Blender Motor #4	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Motor	300000439	1986	NA	5	HP	2	3	20	$ 2,000	$ 2,900	Assess	Assess	24	6	0	34	5	2020	2040	2060	2020	2040	2060
85	Mixer Inlet Blender #1	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Mixer	300000424	1986	NA			3	2	40	$ 35,600	$ 51,620	No Action Required	No Action Required	29	6	0	34	4.4	2031	2071	2111	2026	2066	2106
86	Mixer Inlet Blender Motor #1	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Motor	300000423	1986	NA	5	HP	2	2	20	$ 2,000	$ 2,900	Replace on Failure	Replace on Failure	24	4	0	34	5	2020	2040	2060	2020	2040	2060
87	Mixer Inlet Blender Motor #2	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Motor	300000411	1986	NA	5	HP	2	3	20	$ 2,000	$ 2,900	Assess	Assess	24	6	0	34	5	2020	2040	2060	2020	2040	2060
88	Mixer Inlet Blender #2	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Mixer	300000412	1986	NA			2	3	40	$ 35,600	$ 51,620	No Action Required	No Action Required	26	6	0	34	4.4	2034	2074	2114	2026	2066	2106
89	Isolation Sluice Gate Valve S.G. 1	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	Missing	1986	NA	5	in	3	3	35	$ 25,200	$ 36,540	No Action Required	No Action Required	28	9	0	34	4.885714286	2027	2062	2097	2021	2056	2091
90	Valve gate east inlet surge relief	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000741	1986	NA	12	in	2	5	35	$ 4,000	$ 5,800	No Action Required	No Action Required	24	10	0	34	4.885714286	2031	2066	2101	2021	2056	2091
91	Valve gate east inlet surge relief	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000743	1986	NA	12	in	2	5	35	$ 4,000	$ 5,800	No Action Required	No Action Required	24	10	0	34	4.885714286	2031	2066	2101	2021	2056	2091
92	Valve gate west inlet surge relief	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000744	1986	NA	12	in	2	5	35	$ 4,000	$ 5,800	No Action Required	No Action Required	24	10	0	34	4.885714286	2031	2066	2101	2021	2056	2091
93	Valve gate west inlet surge relief	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000746	1986	NA	12	in	2	5	35	$ 4,000	$ 5,800	No Action Required	No Action Required	24	10	0	34	4.885714286	2031	2066	2101	2021	2056	2091
94	Valve, Inlet surge relief west	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000745	1986	NA	12	in	2	5	35	$ 4,000	$ 5,800	No Action Required	No Action Required	24	10	0	34	4.885714286	2031	2066	2101	2021	2056	2091
95	Valve Inlet surge relief east	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000742	1986	NA	12	in	2	5	35	$ 4,000	$ 5,800	No Action Required	No Action Required	24	10	0	34	4.885714286	2031	2066	2101	2021	2056	2091
96	Valve ball raw water isolating	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000748	1986	NA	24	in	2	5	35	$ 20,000	$ 29,000	No Action Required	No Action Required	24	10	0	34	4.885714286	2031	2066	2101	2021	2056	2091
97	Actuator for Valve ball raw water isolating	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Electrical	Actuator	300000748	1986	NA	24	in	2	5	25	$ 6,000	$ 8,700	Assess	No Action Required	24	10	0	34	5	2021	2046	2071	2020	2045	2070
98	Motor for Valve ball raw water isolating	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Electrical	Motor	300000748	1986	NA	75	HP	2	5	20	$ 11,000	$ 15,950	Assess	Assess	24	10	0	34	5	2020	2040	2060	2020	2040	2060
99	Actuator Low Lift #1 Isolating Valve	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Actuator	300000399	1986	NA		na	2	2	25	$ 6,000	$ 8,700	Replace on Failure	No Action Required	24	4	0	34	5	2021	2046	2071	2020	2045	2070
100	Actuator Low Lift #1 Gear Box	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Actuator	300000400	1986	NA	59.1	Ratio	2	2	25	$ 6,000	$ 8,700	Replace on Failure	No Action Required	24	4	0	34	5	2021	2046	2071	2020	2045	2070
101	Valve Low Lift #1 Isolating	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000402	1986	NA	18	in	2	2	35	$ 10,000	$ 14,500	No Action Required	No Action Required	24	4	0	34	4.885714286	2031	2066	2101	2021	2056	2091
102	Valve Low Lift #1 Check	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000406	1986	NA	10	in	2	2	35	$ 9,000	$ 13,050	No Action Required	No Action Required	24	4	0	34	4.885714286	2031	2066	2101	2021	2056	2091
103	Valve Low Lift #2 Check	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000413	1986	NA	14	in	2	3	35	$ 16,000	$ 23,200	No Action Required	No Action Required	24	6	0	34	4.885714286	2031	2066	2101	2021	2056	2091
104	Valve Low Lift #2 Isolating	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000408	1986	NA	18	in	2	3	35	$ 10,000	$ 14,500	No Action Required	No Action Required	24	6	0	34	4.885714286	2031	2066	2101	2021	2056	2091
105	Actuator Low Lift #2 Isolating Valve	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Actuator	300000408	1986	NA		na	2	3	25	$ 6,000	$ 8,700	Assess	No Action Required	24	6	0	34	5	2021	2046	2071	2020	2045	2070
106	Actuator Low Lift #2 Gear Box	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Actuator	300000410	1986	NA	59.1	Ratio	2	3	25	$ 6,000	$ 8,700	Assess	No Action Required	24	6	0	34	5	2021	2046	2071	2020	2045	2070
107	Valve Low Lift #3 Check	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000425	1986	NA	14	in	2	3	35	$ 16,000	$ 23,200	No Action Required	No Action Required	24	6	0	34	4.885714286	2031	2066	2101	2021	2056	2091
108	Valve Low Lift #3 Isolating	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000422	1986	NA	18	in	2	3	35	$ 10,000	$ 14,500	No Action Required	No Action Required	24	6	0	34	4.885714286	2031	2066	2101	2021	2056	2091
109	Actuator Low Lift #3 Gear Box	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Actuator	300000421	1986	NA	59.1	Ratio	2	3	25	$ 6,000	$ 8,700	Assess	No Action Required	24	6	0	34	5	2021	2046	2071	2020	2045	2070
110	Actuator Low Lift #3 Isolating Valve	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Actuator	300000420	1986	NA		na	2	3	25	$ 6,000	$ 8,700	Assess	No Action Required	24	6	0	34	5	2021	2046	2071	2020	2045	2070
111	Valve Low Lift #4 Check	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000441	1986	NA	14	in	2	3	35	$ 16,000	$ 23,200	No Action Required	No Action Required	24	6	0	34	4.885714286	2031	2066	2101	2021	2056	2091
112	Valve Low Lift #4 Isolating	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Mechanical	Valve	300000437	1986	NA	18	in	2	3	35	$ 10,000	$ 14,500	No Action Required	No Action Required	24	6	0	34	4.885714286	2031	2066	2101	2021	2056	2091
113	Actuator Low Lift #4 Isolating Valve	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Actuator	300000435	1986	NA		na	2	3	25	$ 6,000	$ 8,700	Assess	No Action Required	24	6	0	34	5	2021	2046	2071	2020	2045	2070
114	Actuator Low Lift #4 Gear Box	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Actuator	300000436	1986	NA	59.1	Ratio	2	3	25	$ 6,000	$ 8,700	Assess	No Action Required	24	6	0	34	5	2021	2046	2071	2020	2045	2070
115	Energy Recovery Turbines	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Motor	Missing	2010	NA			2	1	20	$ 11,000	$ 15,950	No Action Required	No Action Required	9	2	0	10	3	2031	2051	2071	2030	2050	2070
116	Valve Butterfly Energy Turbine Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000752	2010	NA	24	in	2	1	35	$ 12,000	$ 17,400	No Action Required	No Action Required	10	2	0	10	2.142857143	2045	2080	2115	2045	2080	2115
117	Valve Butterfly Energy Turbine Bypass	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000752	2010	NA	24	in	2	1	35	$ 12,000	$ 17,400	No Action Required	No Action Required	10	2	0	10	2.142857143	2045	2080	2115	2045	2080	2115
118	Valve Butterfly Energy Turbine Outlet	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000754	2010	NA	24	in	2	1	35	$ 12,000	$ 17,400	No Action Required	No Action Required	10	2	0	10	2.142857143	2045	2080	2115	2045	2080	2115
119	Valve Butterfly Raw Water Well 1 Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000755	1986	NA	30	in	2	3	35	$ 18,500	$ 26,825	No Action Required	No Action Required	24	6	0	34	4.885714286	2031	2066	2101	2021	2056	2091
120	Butterfly Valve Raw Well	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000751	1986	NA	24	in	2	3	35	$ 12,000	$ 17,400	No Action Required	No Action Required	24	6	0	34	4.885714286	2031	2066	2101	2021	2056	2091
121	Blender Motor #1 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	1986	NA	30	A	4	2	30	$ 10,000	$ 14,500	Replace on Failure	Replace on Failure	31	8	0	34	5	2020	2050	2080	2020	2050	2080
122	Blender Motor #2 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	1986	NA	30	A	4	3	30	$ 10,000	$ 14,500	Assess	Assess	31	12	0	34	5	2020	2050	2080	2020	2050	2080
123	Blender Motor #3 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	1986	NA	30	A	4	3	30	$ 10,000	$ 14,500	Assess	Assess	31	12	0	34	5	2020	2050	2080	2020	2050	2080
124	Blender Motor #4 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	1986	NA	30	A	4	3	30	$ 10,000	$ 14,500	Assess	Assess	31	12	0	34	5	2020	2050	2080	2020	2050	2080
125	Low lift Motor #1 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	1986	NA	60	A	4	2	30	$ 10,000	$ 14,500	Replace on Failure	Replace on Failure	31	8	0	34	5	2020	2050	2080	2020	2050	2080

Item ID	Asset Description	Level 1 – Functional Group	Level 2 – Facility Type / Location	Level 3 – Process Location	Level 4 – Asset Category	Level 5 (Asset Type)	Unique ID	Install Year	Refurbishment Year	Size / Capacity	Unit of Measure	Condition Score (1 to 5 Scale)	CoF Score (1 to 5 Scale)	ESL	Replacement Cost (2020)	Project Cost (includes Markup)	Action Required (Original)	Action Required (Adjusted)	Apparent Age	Risk Score (1 to 25 Scale)	# of years since Assessment	Age at Time of Assessment	Expected Condition at Time of Assessment	1st Repl. YR (Adj)	2nd Repl. YR (Adj)	3rd Repl. YR (Adj)	1st Repl. YR	2nd Repl. YR2	3rd Repl. YR3
126	Low lift Motor #2 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	1986	NA	100	A	4	3	30	$ 13,000	$ 18,850	Assess	Assess	31	12	0	34	5	2020	2050	2080	2020	2050	2080
127	Low lift Motor #3 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	1986	NA	100	A	4	3	30	$ 13,000	$ 18,850	Assess	Assess	31	12	0	34	5	2020	2050	2080	2020	2050	2080
128	Low lift Motor #4 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	1986	NA	100	A	4	3	30	$ 13,000	$ 18,850	Assess	Assess	31	12	0	34	5	2020	2050	2080	2020	2050	2080
129	ATS	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	MCC	Missing	2011	2018	225 A		4	5	30	$ 25,000	$ 36,250	No Action Required	Replace or Assess	23	20	0	2	1.266666667	2020	2050	2080	2048	2078	2108
130	Floc agitator #3 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	1986	NA	15	A	4	4	30	$ 10,000	$ 14,500	Assess	Replace or Assess	31	16	0	34	5	2020	2050	2080	2020	2050	2080
131	Floc agitator #4 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	1986	NA	15	A	4	4	30	$ 10,000	$ 14,500	Assess	Replace or Assess	31	16	0	34	5	2020	2050	2080	2020	2050	2080
132	Floc agitator #2 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	1986	NA	15	A	4	4	30	$ 10,000	$ 14,500	Assess	Replace or Assess	31	16	0	34	5	2020	2050	2080	2020	2050	2080
133	Floc agitator #1 starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	1986	NA	15	A	4	4	30	$ 10,000	$ 14,500	Assess	Replace or Assess	31	16	0	34	5	2020	2050	2080	2020	2050	2080
134	Low lift #2 capacitor bank	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	1986	NA	15	kVa	4	3	30	$ 10,000	$ 14,500	Assess	Assess	31	12	0	34	5	2020	2050	2080	2020	2050	2080
135	Inline Booster Pump Motor Starter	Surface Water Facilities	Surface Water Treatment Plant	Low Lift Pumping Station	Process Electrical	Starter	Missing	1986	NA	25	A	4	4	30	$ 10,000	$ 14,500	Assess	Replace or Assess	31	16	0	34	5	2020	2050	2080	2020	2050	2080
136	Floc agitator #1 disconnect	Surface Water Facilities	Surface Water Treatment Plant	locculation & Filter Chamber	Process Electrical	Disconnect	Missing	1986	NA	30	A	2	4	25	$ 1,000	$ 1,450	Assess	No Action Required	24	8	0	34	5	2021	2046	2071	2020	2045	2070
137	Floc agitator #2 disconnect	Surface Water Facilities	Surface Water Treatment Plant	locculation & Filter Chamber	Process Electrical	Disconnect	Missing	1986	NA	30	A	2	4	25	$ 1,000	$ 1,450	Assess	No Action Required	24	8	0	34	5	2021	2046	2071	2020	2045	2070
138	Floc agitator #3 disconnect	Surface Water Facilities	Surface Water Treatment Plant	locculation & Filter Chamber	Process Electrical	Disconnect	Missing	1986	NA	30	A	2	4	25	$ 1,000	$ 1,450	Assess	No Action Required	24	8	0	34	5	2021	2046	2071	2020	2045	2070
139	Floc agitator #4 disconnect	Surface Water Facilities	Surface Water Treatment Plant	locculation & Filter Chamber	Process Electrical	Disconnect	Missing	1986	NA	30	A	2	4	25	$ 1,000	$ 1,450	Assess	No Action Required	24	8	0	34	5	2021	2046	2071	2020	2045	2070
140	MCC E Feeder	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #1 (M)	Process Electrical	Feeder	Missing	1986	2011	250	A	4	5	30	$ 10,000	$ 14,500	No Action Required	Replace or Assess	23	20	0	9	2.2	2020	2050	2080	2041	2071	2101
141	High lift #3 starter	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #2 (M)	Process Electrical	Starter	Missing	1986	NA	540	A	4	3	30	$ 16,000	$ 23,200	Assess	Assess	31	12	0	34	5	2020	2050	2080	2020	2050	2080
142	Surface wash pump Motor #2 starter	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #1 (M)	Process Electrical	Starter	Missing	1986	NA	60	A	4	2	30	$ 10,000	$ 14,500	Replace on Failure	Replace on Failure	31	8	0	34	5	2020	2050	2080	2020	2050	2080
143	Surface wash pump Motor #1 starter	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #1 (M)	Process Electrical	Starter	Missing	1986	NA	60	A	4	2	30	$ 10,000	$ 14,500	Replace on Failure	Replace on Failure	31	8	0	34	5	2020	2050	2080	2020	2050	2080
144	Backwash pump Motor #1 starter	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #2 (M)	Process Electrical	Starter	Missing	1986	NA	200	A	4	4	30	$ 13,000	$ 18,850	Assess	Replace or Assess	31	16	0	34	5	2020	2050	2080	2020	2050	2080
145	Backwash pump Motor #2 starter	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #2 (M)	Process Electrical	Starter	Missing	1986	NA	200	A	4	4	30	$ 13,000	$ 18,850	Assess	Replace or Assess	31	16	0	34	5	2020	2050	2080	2020	2050	2080
146	Supernatant pump Motor #1 starter	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #2 (M)	Process Electrical	Starter	Missing	1986	NA	9	A	4	4	30	$ 5,000	$ 7,250	Assess	Replace or Assess	31	16	0	34	5	2020	2050	2080	2020	2050	2080
147	Sludge pump Motor #2 starter	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #2 (M)	Process Electrical	Starter	Missing	1986	NA	25	A	4	4	30	$ 10,000	$ 14,500	Assess	Replace or Assess	31	16	0	34	5	2020	2050	2080	2020	2050	2080
148	Soda Ash compressor breaker	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #2 (M)	Process Electrical	Breaker	Missing	2015	NA		A	4	3	20	$ 5,000	$ 7,250	No Action Required	No Action Required	15	12	0	5	2	2025	2045	2065	2035	2055	2075
149	Soda Ash makeup system breaker	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #2 (M)	Process Electrical	Breaker	Missing	2015	NA		A	4	3	20	$ 5,000	$ 7,250	No Action Required	No Action Required	15	12	0	5	2	2025	2045	2065	2035	2055	2075
150	Soda Ash hot water heater system breaker	Surface Water Facilities	Surface Water Treatment Plant	Motor Control Centre #2 (M)	Process Electrical	Breaker	Missing	2015	NA		A	4	3	20	$ 5,000	$ 7,250	No Action Required	No Action Required	15	12	0	5	2	2025	2045	2065	2035	2055	2075
151	Alum Pump No. 1	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Alun	Process Mechanical	Pump	300000812	2018	NA	42	L/s	2	3	20	$ 5,500	$ 7,975	No Action Required	No Action Required	5	6	0	2	1.4	2035	2055	2075	2038	2058	2078
152	Alum Pump No. 2	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Alun	Process Mechanical	Pump	300000813	2018	NA	42	L/s	2	3	20	$ 5,500	$ 7,975	No Action Required	No Action Required	5	6	0	2	1.4	2035	2055	2075	2038	2058	2078
153	Alum Pump No. 3	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Alun	Process Mechanical	Pump	300000814	2018	NA	42	L/s	2	3	20	$ 5,500	$ 7,975	No Action Required	No Action Required	5	6	0	2	1.4	2035	2055	2075	2038	2058	2078
154	Alum Tank No. 1	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Alun	Process Structural	Tanks / Basins	300000028	2018	NA	11000	L	2	4	60	$ 59,700	$ 86,565	No Action Required	No Action Required	15	8	0	2	1.133333333	2065	2125	2185	2078	2138	2198
155	Alum Tank No. 2	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Alun	Process Structural	Tanks / Basins	300000029	2018	NA	11000	L	2	4	60	$ 59,700	$ 86,565	No Action Required	No Action Required	15	8	0	2	1.133333333	2065	2125	2185	2078	2138	2198
156	Alum Day Tank	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Alun	Process Structural	Tanks / Basins	300000027	2018	NA	245	L	2	2	60	$ 1,000	$ 1,450	No Action Required	No Action Required	15	4	0	2	1.133333333	2065	2125	2185	2078	2138	2198
157	Chlorine Vacuum Regulator	Surface Water Facilities	Surface Water Treatment Plant	hemical Facilities (M) - Cl2 G	Process Mechanical	Regulator	300000791	2015	NA			1	5	20	$ 4,500	$ 6,525	No Action Required	No Action Required	5	5	0	5	2	2035	2055	2075	2035	2055	2075
158	Pre chlorine injector	Surface Water Facilities	Surface Water Treatment Plant	hemical Facilities (M) - Cl2 G	Process Mechanical	Injector	300000788	2016	NA			1	3	20	$ 3,000	$ 4,350	No Action Required	No Action Required	4	3	0	4	1.8	2036	2056	2076	2036	2056	2076
159	Standby chlorine injector	Surface Water Facilities	Surface Water Treatment Plant	hemical Facilities (M) - Cl2 G	Process Mechanical	Injector	300000789	2016	NA			1	4	20	$ 3,000	$ 4,350	No Action Required	No Action Required	4	4	0	4	1.8	2036	2056	2076	2036	2056	2076
160	Post chlorine injector	Surface Water Facilities	Surface Water Treatment Plant	hemical Facilities (M) - Cl2 G	Process Mechanical	Injector	300000790	2016	NA			1	4	20	$ 3,000	$ 4,350	No Action Required	No Action Required	4	4	0	4	1.8	2036	2056	2076	2036	2056	2076
161	Post chlorine injector solenoid	Surface Water Facilities	Surface Water Treatment Plant	hemical Facilities (M) - Cl2 G	Process Mechanical	Injector	300000787	2016	NA			1	4	20	$ 1,400	$ 2,030	No Action Required	No Action Required	4	4	0	4	1.8	2036	2056	2076	2036	2056	2076
162	Standby chlorine injector solenoid	Surface Water Facilities	Surface Water Treatment Plant	hemical Facilities (M) - Cl2 G	Process Mechanical	Injector	300000796	2016	NA			1	4	20	$ 1,400	$ 2,030	No Action Required	No Action Required	4	4	0	4	1.8	2036	2056	2076	2036	2056	2076
163	Pre chlorine injector solenoid	Surface Water Facilities	Surface Water Treatment Plant	hemical Facilities (M) - Cl2 G	Process Mechanical	Injector	300000795	2016	NA			1	3	20	$ 1,400	$ 2,030	No Action Required	No Action Required	4	3	0	4	1.8	2036	2056	2076	2036	2056	2076
164	Blended Phosphate Pump No. 1	Surface Water Facilities	Surface Water Treatment Plant	al Facilities (M) - Blended Ph	Process Mechanical	Pump	Missing	2015	NA	19.1	L/s	2	3	20	$ 7,500	$ 10,875	No Action Required	No Action Required	5	6	0	5	2	2035	2055	2075	2035	2055	2075
165	Blended Phosphate Pump No. 2	Surface Water Facilities	Surface Water Treatment Plant	al Facilities (M) - Blended Ph	Process Mechanical	Pump	Missing	2015	NA	19.1	L/s	2	3	20	$ 7,500	$ 10,875	No Action Required	No Action Required	5	6	0	5	2	2035	2055	2075	2035	2055	2075
166	Blended Phosphate Tank No. 1	Surface Water Facilities	Surface Water Treatment Plant	al Facilities (M) - Blended Ph	Process Structural	Tanks / Basins	Missing	2015	NA	600	L	2	3	60	$ 1,500	$ 2,175	No Action Required	No Action Required	15	6	0	5	1.333333333	2065	2125	2185	2075	2135	2195
167	Blended Phosphate Tank No. 2	Surface Water Facilities	Surface Water Treatment Plant	al Facilities (M) - Blended Ph	Process Structural	Tanks / Basins	Missing	2015	NA	600	L	2	3	60	$ 1,500	$ 2,175	No Action Required	No Action Required	15	6	0	5	1.333333333	2065	2125	2185	2075	2135	2195

Item ID	Asset Description	Level 1 – Functional Group	Level 2 – Facility Type / Location	Level 3 – Process Location	Level 4 – Asset Category	Level 5 (Asset Type)	Unique ID	Install Year	Refurbishment Year	Size / Capacity	Unit of Measure	Condition Score (1 to 5 Scale)	CoF Score (1 to 5 Scale)	ESL	Replacement Cost (2020)	Project Cost (includes Markup)	Action Required (Original)	Action Required (Adjusted)	Apparent Age	Risk Score (1 to 25 Scale)	# of years since Assessment	Age at Time of Assessment	Expected Condition at Time of Assessment	1st Repl. YR (Adj)	2nd Repl. YR (Adj)	3rd Repl. YR (Adj)	1st Repl. YR	2nd Repl. YR2	3rd Repl. YR3
168	Soda Ash Hopper	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Structural	Hopper	Missing	2015	NA			2	3	30	$ 65,000	$ 94,250	No Action Required	No Action Required	8	6	0	5	1.666666667	2042	2072	2102	2045	2075	2105
169	Soda Ash feeder	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	Missing	2015	NA			4	3	20	$ 2,000	$ 2,900	No Action Required	No Action Required	15	12	0	5	2	2025	2045	2065	2035	2055	2075
170	Soda Ash mixer	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	Missing	2015	NA			2	3	20	$ 2,000	$ 2,900	No Action Required	No Action Required	5	6	0	5	2	2035	2055	2075	2035	2055	2075
171	Soda Ash transfer pump motor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	Missing	2015	NA	1.4	A	2	3	20	$ 2,000	$ 2,900	No Action Required	No Action Required	5	6	0	5	2	2035	2055	2075	2035	2055	2075
172	Soda Ash Filter	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Filter	Missing	2015	NA			2	3	20	$ 2,500	$ 3,625	No Action Required	No Action Required	5	6	0	5	2	2035	2055	2075	2035	2055	2075
173	Soda Ash transfer pump	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	Missing	2015	NA	9	m^3/h	2	3	20	$ 7,100	$ 10,295	No Action Required	No Action Required	5	6	0	5	2	2035	2055	2075	2035	2055	2075
174	Soda Ash Solution Tank	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Structural	Chemical Tanks	Missing	2015	NA	1100	L	2	3	30	$ 2,000	$ 2,900	No Action Required	No Action Required	8	6	0	5	1.666666667	2042	2072	2102	2045	2075	2105
175	Soda Ash Tank Mixer	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	Missing	2015	NA			2	3	20	$ 2,000	$ 2,900	No Action Required	No Action Required	5	6	0	5	2	2035	2055	2075	2035	2055	2075
176	Soda Ash dosing pump no. 1	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	Missing	2015	NA			2	3	20	$ 21,300	$ 30,885	No Action Required	No Action Required	5	6	0	5	2	2035	2055	2075	2035	2055	2075
177	Soda Ash dosing pump no. 2	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	Missing	2015	NA			2	3	20	$ 21,300	$ 30,885	No Action Required	No Action Required	5	6	0	5	2	2035	2055	2075	2035	2055	2075
178	Soda Ash dosing pump no. 1 gearbox	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Gearbox	Missing	2015	NA			2	3	20	Cost Included in Pump	Cost Included in Pump	No Action Required	No Action Required	5	6	0	5	2	2035	2055	2075	2035	2055	2075
179	Soda Ash dosing pump no. 1 motor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	Missing	2015	NA	0.75	HP	2	3	20	$ 500	$ 725	No Action Required	No Action Required	5	6	0	5	2	2035	2055	2075	2035	2055	2075
180	Soda Ash dosing pump no. 2 gearbox	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Gearbox	Missing	2015	NA			2	3	20	Cost Included in Pump	Cost Included in Pump	No Action Required	No Action Required	5	6	0	5	2	2035	2055	2075	2035	2055	2075
181	Soda Ash dosing pump no. 2 motor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	Missing	2015	NA	0.75	HP	2	3	20	$ 500	$ 725	No Action Required	No Action Required	5	6	0	5	2	2035	2055	2075	2035	2055	2075
182	Soda Ash Compressor Tank	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Structural	Tanks / Basins	Missing	2015	NA	80	Gallon	1	3	60	$ 3,600	$ 5,220	No Action Required	No Action Required	5	3	0	5	1.333333333	2075	2135	2195	2075	2135	2195
183	Soda Ash Compressor Motor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	Missing	2015	NA	5	HP	1	3	20	$ 2,000	$ 2,900	No Action Required	No Action Required	5	3	0	5	2	2035	2055	2075	2035	2055	2075
184	Soda Ash Compressor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Compressor	Missing	2015	NA			1	3	20	$ 6,700	$ 9,715	No Action Required	No Action Required	5	3	0	5	2	2035	2055	2075	2035	2055	2075
185	UV System 3	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	UV Treatment	Missing	2017	NA	20		2	1	30	$ 6,900	$ 10,005	No Action Required	No Action Required	8	2	0	3	1.4	2042	2072	2102	2047	2077	2107
186	UV System 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	UV Treatment	Missing	2017	NA	20		2	1	30	$ 6,900	$ 10,005	No Action Required	No Action Required	8	2	0	3	1.4	2042	2072	2102	2047	2077	2107
187	UV System 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	UV Treatment	Missing	2017	NA	20		2	1	30	$ 6,900	$ 10,005	No Action Required	No Action Required	8	2	0	3	1.4	2042	2072	2102	2047	2077	2107
188	UV System 4	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	UV Treatment	Missing	2017	NA	20		2	1	30	$ 6,900	$ 10,005	No Action Required	No Action Required	8	2	0	3	1.4	2042	2072	2102	2047	2077	2107
189	UV System 1 Solenoid Valve	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Valve	Missing	2017	NA	20	in	2	1	35	$ 1,200	$ 1,740	No Action Required	No Action Required	9	2	0	3	1.342857143	2046	2081	2116	2052	2087	2122
190	UV System 2 Solenoid Valve	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Valve	Missing	2017	NA	20	in	2	1	35	$ 1,200	$ 1,740	No Action Required	No Action Required	9	2	0	3	1.342857143	2046	2081	2116	2052	2087	2122
191	UV System 3 Solenoid Valve	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Valve	Missing	2017	NA	20	in	2	1	35	$ 1,200	$ 1,740	No Action Required	No Action Required	9	2	0	3	1.342857143	2046	2081	2116	2052	2087	2122
192	UV System 4 Solenoid Valve	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Valve	Missing	2017	NA	20	in	2	1	35	$ 1,200	$ 1,740	No Action Required	No Action Required	9	2	0	3	1.342857143	2046	2081	2116	2052	2087	2122
193	Surface wash booster pump no. 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Pump	Missing	1986	NA	277	GPM	3	2	20	$ 10,600	$ 15,370	Replace on Failure	Replace on Failure	27	6	0	34	5	2020	2040	2060	2020	2040	2060
194	Surface wash booster pump no. 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Pump	Missing	1986	NA	277	GPM	3	2	20	$ 10,600	$ 15,370	Replace on Failure	Replace on Failure	27	6	0	34	5	2020	2040	2060	2020	2040	2060
195	Surface wash booster pump no. 1 motor	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Motor	Missing	1986	NA	2.5	HP	2	2	20	$ 1,000	$ 1,450	Replace on Failure	Replace on Failure	24	4	0	34	5	2020	2040	2060	2020	2040	2060
196	Surface wash booster pump no. 2 motor	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Motor	Missing	1986	NA	2.5	HP	2	2	20	$ 1,000	$ 1,450	Replace on Failure	Replace on Failure	24	4	0	34	5	2020	2040	2060	2020	2040	2060
197	Valve gate, surface wash line	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000695	1986	NA	4	in	3	2	35	$ 1,000	$ 1,450	No Action Required	No Action Required	28	6	0	34	4.885714286	2027	2062	2097	2021	2056	2091
198	valve BFP, scour system	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000378	1986	NA	4	in	3	2	35	$ 2,800	$ 4,060	No Action Required	No Action Required	28	6	0	34	4.885714286	2027	2062	2097	2021	2056	2091
199	Valve gate, surface wash line	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000694	1986	NA	4	in	3	2	35	$ 1,000	$ 1,450	No Action Required	No Action Required	28	6	0	34	4.885714286	2027	2062	2097	2021	2056	2091
200	Valve, gate W surface wash pump discharge	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000693	1986	NA	4	in	3	2	35	$ 1,000	$ 1,450	No Action Required	No Action Required	28	6	0	34	4.885714286	2027	2062	2097	2021	2056	2091
201	Valve, gate E surface wash pump discharge	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000690	1986	NA	4	in	3	2	35	$ 1,000	$ 1,450	No Action Required	No Action Required	28	6	0	34	4.885714286	2027	2062	2097	2021	2056	2091
202	Valve, gate E surface wash pump inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000688	1986	NA	6	in	3	2	35	$ 1,200	$ 1,740	No Action Required	No Action Required	28	6	0	34	4.885714286	2027	2062	2097	2021	2056	2091
203	Valve, gate W surface wash pump supply	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000691	1986	NA	6	in	3	2	35	$ 1,200	$ 1,740	No Action Required	No Action Required	28	6	0	34	4.885714286	2027	2062	2097	2021	2056	2091
204	Valve Check west surface wash pump	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000692	1986	NA	4	in	3	2	35	$ 3,500	$ 5,075	No Action Required	No Action Required	28	6	0	34	4.885714286	2027	2062	2097	2021	2056	2091
205	Valve gate, surface wash pump bypass	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000687	1986	NA	4	in	3	2	35	$ 1,000	$ 1,450	No Action Required	No Action Required	28	6	0	34	4.885714286	2027	2062	2097	2021	2056	2091
206	Valve gate, plant water supply	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000685	1986	NA	6	in	3	5	35	$ 1,200	$ 1,740	No Action Required	No Action Required	28	15	0	34	4.885714286	2027	2062	2097	2021	2056	2091
207	Valve gate, plant water supply pump bypass	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000686	1986	NA	6	in	3	5	35	$ 1,200	$ 1,740	No Action Required	No Action Required	28	15	0	34	4.885714286	2027	2062	2097	2021	2056	2091
208	Valve gate, plant water meter bypass	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000684	1986	NA	6	in	3	5	35	$ 1,200	$ 1,740	No Action Required	No Action Required	28	15	0	34	4.885714286	2027	2062	2097	2021	2056	2091
209	Valve gate, plant water supply	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000683	1986	NA	6	in	3	5	35	$ 1,200	$ 1,740	No Action Required	No Action Required	28	15	0	34	4.885714286	2027	2062	2097	2021	2056	2091

Item ID	Asset Description	Level 1 – Functional Group	Level 2 – Facility Type / Location	Level 3 – Process Location	Level 4 – Asset Category	Level 5 (Asset Type)	Unique ID	Install Year	Refurbishment Year	Size / Capacity	Unit of Measure	Condition Score (1 to 5 Scale)	CoF Score (1 to 5 Scale)	ESL	Replacement Cost (2020)	Project Cost (includes Markup)	Action Required (Original)	Action Required (Adjusted)	Apparent Age	Risk Score (1 to 25 Scale)	# of years since Assessment	Age at Time of Assessment	Expected Condition at Time of Assessment	1st Repl. YR (Adj)	2nd Repl. YR (Adj)	3rd Repl. YR (Adj)	1st Repl. YR	2nd Repl. YR2	3rd Repl. YR3
210	Strainer, plant water supply	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	Missing	1986	NA	4	in	3	5	35	$ 3,900	$ 5,655	No Action Required	No Action Required	28	15	0	34	4.885714286	2027	2062	2097	2021	2056	2091
211	Valve Check east surface wash pump	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000689	1986	NA	4	in	3	2	35	$ 3,500	$ 5,075	No Action Required	No Action Required	28	6	0	34	4.885714286	2027	2062	2097	2021	2056	2091
212	surface wash pump no. 1 disconnect	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Disconnect	Missing	1986	NA	60	A	2	2	25	$ 1,000	$ 1,450	Replace on Failure	No Action Required	24	4	0	34	5	2021	2046	2071	2020	2045	2070
213	surface wash pump no. 2 disconnect	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Disconnect	Missing	1986	NA	60	A	2	2	25	$ 1,000	$ 1,450	Replace on Failure	No Action Required	24	4	0	34	5	2021	2046	2071	2020	2045	2070
214	DP-ED step down transformer for panel	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Transformer	Missing	1986	NA	10	kV	2	5	25	$ 1,500	$ 2,175	Assess	No Action Required	24	10	0	34	5	2021	2046	2071	2020	2045	2070
215	DP-EB step down transformer for panel	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Transformer	Missing	1986	NA	25	kVa	2	5	25	$ 2,800	$ 4,060	Assess	No Action Required	24	10	0	34	5	2021	2046	2071	2020	2045	2070
216	Valve gate inline booster pump	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000699	1986	NA	4	in	3	4	35	$ 1,000	$ 1,450	No Action Required	No Action Required	28	12	0	34	4.885714286	2027	2062	2097	2021	2056	2091
217	Valve gate inline booster pump	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000698	1986	NA	4	in	3	4	35	$ 1,000	$ 1,450	No Action Required	No Action Required	28	12	0	34	4.885714286	2027	2062	2097	2021	2056	2091
218	Valve butterfly inline booster pump	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000700	1986	NA	4	in	3	4	35	$ 1,125	$ 1,631	No Action Required	No Action Required	28	12	0	34	4.885714286	2027	2062	2097	2021	2056	2091
219	Valve butterfly inline booster bypass	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000702	1986	NA	4	in	3	4	35	$ 1,125	$ 1,631	No Action Required	No Action Required	28	12	0	34	4.885714286	2027	2062	2097	2021	2056	2091
220	Valve check inline booster bypass	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000701	1986	NA	4	in	3	4	35	$ 3,500	$ 5,075	No Action Required	No Action Required	28	12	0	34	4.885714286	2027	2062	2097	2021	2056	2091
221	Valve gate inline booster pump	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Pump	300000593	2015	NA			2	4	20	$ 1,700	$ 2,465	No Action Required	No Action Required	5	8	0	5	2	2035	2055	2075	2035	2055	2075
222	Valve gate inline booster pump motor	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Motor	300000593	2015	NA	10	HP	2	4	20	$ 4,000	$ 5,800	No Action Required	No Action Required	5	8	0	5	2	2035	2055	2075	2035	2055	2075
223	Valve gate inline booster pump disconnect	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Disconnect	Missing	1986	NA	30	A	2	4	25	$ 1,000	$ 1,450	Assess	No Action Required	24	8	0	34	5	2021	2046	2071	2020	2045	2070
224	Valve pressure control inline booster pump	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000594	2018	NA			1	4	35	$ 675	$ 979	No Action Required	No Action Required	2	4	0	2	1.228571429	2053	2088	2123	2053	2088	2123
225	DP-EC step down transformer for panel	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Alum	Process Electrical	Transformer	Missing	1986	NA	25	kVa	2	5	25	$ 2,800	$ 4,060	Assess	No Action Required	24	10	0	34	5	2021	2046	2071	2020	2045	2070
226	Valve filter #1 filtrate	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000236	1986	NA	14	in	3	4	35	$ 3,000	$ 4,350	No Action Required	No Action Required	28	12	0	34	4.885714286	2027	2062	2097	2021	2056	2091
227	Valve actuator filter #1 filtrate	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Actuator	300000236	1986	NA	0.4	HP	3	4	25	$ 6,000	$ 8,700	Assess	Assess	27	12	0	34	5	2020	2045	2070	2020	2045	2070
228	Valve actuator filter #2 filtrate	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Actuator	300000237	1986	NA	0.4	HP	3	4	25	$ 6,000	$ 8,700	Assess	Assess	27	12	0	34	5	2020	2045	2070	2020	2045	2070
229	Valve filter #2 filtrate	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000237	1986	NA	14	in	3	4	35	$ 3,000	$ 4,350	No Action Required	No Action Required	28	12	0	34	4.885714286	2027	2062	2097	2021	2056	2091
230	Valve filter #3 filtrate	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000238	1986	NA	14	in	3	4	35	$ 3,000	$ 4,350	No Action Required	No Action Required	28	12	0	34	4.885714286	2027	2062	2097	2021	2056	2091
231	Valve actuator filter #3 filtrate	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Actuator	300000238	1986	NA	0.4	HP	3	4	25	$ 6,000	$ 8,700	Assess	Assess	27	12	0	34	5	2020	2045	2070	2020	2045	2070
232	Valve actuator filter #4 filtrate	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Actuator	300000239	1986	NA	0.4	HP	3	4	25	$ 6,000	$ 8,700	Assess	Assess	27	12	0	34	5	2020	2045	2070	2020	2045	2070
233	Valve filter #4 filtrate	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000239	1986	NA	14	in	3	4	35	$ 3,000	$ 4,350	No Action Required	No Action Required	28	12	0	34	4.885714286	2027	2062	2097	2021	2056	2091
234	Valve Butterfly BW waste header isolation	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000680	1986	NA	24	in	3	5	35	$ 12,000	$ 17,400	No Action Required	No Action Required	28	15	0	34	4.885714286	2027	2062	2097	2021	2056	2091
235	Valve Butterfly BW tank 1 inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000681	1986	NA	24	in	3	4	35	$ 12,000	$ 17,400	No Action Required	No Action Required	28	12	0	34	4.885714286	2027	2062	2097	2021	2056	2091
236	Valve Butterfly BW tank 2 inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000682	1986	NA	24	in	3	4	35	$ 12,000	$ 17,400	No Action Required	No Action Required	28	12	0	34	4.885714286	2027	2062	2097	2021	2056	2091
237	Valve plug, suction sludge pump BW Tank No. 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000188	1986	NA	4	in	4	3	35	$ 1,000	$ 1,450	No Action Required	No Action Required	31	12	0	34	4.885714286	2024	2059	2094	2021	2056	2091
238	Valve actuator plug, suction sludge pump, BW tank No. 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000188	1986	NA	1.1	A	2	3	35	$ 5,000	$ 7,250	No Action Required	No Action Required	24	6	0	34	4.885714286	2031	2066	2101	2021	2056	2091
239	Valve plug, suction sludge pump BW Tank No. 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	Missing	1986	NA	4	in	4	3	35	$ 1,000	$ 1,450	No Action Required	No Action Required	31	12	0	34	4.885714286	2024	2059	2094	2021	2056	2091
240	Valve actuator plug, suction sludge pump, BW tank No. 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	Missing	1986	NA	1.1	A	2	3	35	$ 5,000	$ 7,250	No Action Required	No Action Required	24	6	0	34	4.885714286	2031	2066	2101	2021	2056	2091
241	Valve plug, BW tank sludge pump 1 suction	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000671	1986	NA	4	in	2	3	35	$ 1,000	$ 1,450	No Action Required	No Action Required	24	6	0	34	4.885714286	2031	2066	2101	2021	2056	2091
242	Valve plug, BW tank sludge pump 2 suction	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000675	1986	NA	4	in	2	3	35	$ 1,000	$ 1,450	No Action Required	No Action Required	24	6	0	34	4.885714286	2031	2066	2101	2021	2056	2091
243	Valve plug, sludge pump 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000677	1986	NA	4	in	2	3	35	$ 1,000	$ 1,450	No Action Required	No Action Required	24	6	0	34	4.885714286	2031	2066	2101	2021	2056	2091
244	Valve plug, sludge pump 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000673	1986	NA	4	in	2	3	35	$ 1,000	$ 1,450	No Action Required	No Action Required	24	6	0	34	4.885714286	2031	2066	2101	2021	2056	2091
245	Valve plug, sludge pump 1 (to truck)	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000674	1986	NA	4	in	2	3	35	$ 1,000	$ 1,450	No Action Required	No Action Required	24	6	0	34	4.885714286	2031	2066	2101	2021	2056	2091
246	Valve plug, sludge pump 2 (to truck)	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000678	1986	NA	4	in	2	3	35	$ 1,000	$ 1,450	No Action Required	No Action Required	24	6	0	34	4.885714286	2031	2066	2101	2021	2056	2091
247	Valve Butterfly Raw Water Well 2 Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000756	1986	NA	30	in	2	3	35	$ 18,500	$ 26,825	No Action Required	No Action Required	24	6	0	34	4.885714286	2031	2066	2101	2021	2056	2091
248	Valve low lift Water Level Control	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000240	1986	NA	30	in	2	3	35	$ 10,000	$ 14,500	No Action Required	No Action Required	24	6	0	34	4.885714286	2031	2066	2101	2021	2056	2091
249	Valve Butterfly Filter 1 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000715	1986	NA	4	in	3	2	35	$ 1,125	$ 1,631	No Action Required	No Action Required	28	6	0	34	4.885714286	2027	2062	2097	2021	2056	2091
250	Valve Butterfly Filter 1 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000717	1986	NA	4	in	3	2	35	$ 1,125	$ 1,631	No Action Required	No Action Required	28	6	0	34	4.885714286	2027	2062	2097	2021	2056	2091
251	Valve Butterfly Filter 1 Backwash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000718	1986	NA	20	in	2	4	35	$ 10,000	$ 14,500	No Action Required	No Action Required	24	8	0	34	4.885714286	2031	2066	2101	2021	2056	2091

Item ID	Asset Description	Level 1 – Functional Group	Level 2 – Facility Type / Location	Level 3 – Process Location	Level 4 – Asset Category	Level 5 (Asset Type)	Unique ID	Install Year	Refurbishment Year	Size / Capacity	Unit of Measure	Condition Score (1 to 5 Scale)	CoF Score (1 to 5 Scale)	ESL	Replacement Cost (2020)	Project Cost (includes Markup)	Action Required (Original)	Action Required (Adjusted)	Apparent Age	Risk Score (1 to 25 Scale)	# of years since Assessment	Age at Time of Assessment	Expected Condition at Time of Assessment	1st Repl. YR (Adj)	2nd Repl. YR (Adj)	3rd Repl. YR (Adj)	1st Repl. YR	2nd Repl. YR2	3rd Repl. YR3
252	Actuator Valve Butterfly Filter 1 Backwash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000718	1986	NA	20	in	2	4	25	$ 6,000	$ 8,700	Assess	No Action Required	24	8	0	34	5	2021	2046	2071	2020	2045	2070
253	Actuator Valve Butterfly Filter 1 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000714	1986	NA	24	in	2	4	25	$ 6,000	$ 8,700	Assess	No Action Required	24	8	0	34	5	2021	2046	2071	2020	2045	2070
254	Valve Butterfly Filter 1 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000714	1986	NA	24	in	4	4	35	$ 12,000	$ 17,400	No Action Required	Replace or Assess	31	16	0	34	4.885714286	2020	2055	2090	2021	2056	2091
255	Valve Piston Filter 1 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000716	1986	NA	4	in	3	2	35	$ 4,700	$ 6,815	No Action Required	No Action Required	28	6	0	34	4.885714286	2027	2062	2097	2021	2056	2091
256	Valve Butterfly Filter 1 Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000713	1986	NA	24	in	2	4	35	$ 12,000	$ 17,400	No Action Required	No Action Required	24	8	0	34	4.885714286	2031	2066	2101	2021	2056	2091
257	Valve Plug Floc Tank 2 Drain Valve	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000739	1986	NA	6	in	2	4	35	$ 1,200	$ 1,740	No Action Required	No Action Required	24	8	0	34	4.885714286	2031	2066	2101	2021	2056	2091
258	Valve Plug Floc Tank 1 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000740	1986	NA	6	in	2	4	35	$ 1,200	$ 1,740	No Action Required	No Action Required	24	8	0	34	4.885714286	2031	2066	2101	2021	2056	2091
259	Valve Butterfly Filter 2 Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000719	1986	NA	24	in	3	4	35	$ 12,000	$ 17,400	No Action Required	No Action Required	28	12	0	34	4.885714286	2027	2062	2097	2021	2056	2091
260	Valve Butterfly Filter 2 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000720	1986	NA	24	in	4	4	35	$ 12,000	$ 17,400	No Action Required	Replace or Assess	31	16	0	34	4.885714286	2020	2055	2090	2021	2056	2091
261	Actuator Valve Butterfly Filter 2 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000720	1986	NA	24	in	2	4	25	$ 6,000	$ 8,700	Assess	No Action Required	24	8	0	34	5	2021	2046	2071	2020	2045	2070
262	Valve Butterfly Filter 2 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000721	1986	NA	4	in	3	2	35	$ 1,125	$ 1,631	No Action Required	No Action Required	28	6	0	34	4.885714286	2027	2062	2097	2021	2056	2091
263	Valve Piston Filter 2 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000722	1986	NA	4	in	2	2	35	$ 4,700	$ 6,815	No Action Required	No Action Required	24	4	0	34	4.885714286	2031	2066	2101	2021	2056	2091
264	Valve Butterfly Filter 2 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000723	1986	NA	4	in	2	2	35	$ 1,125	$ 1,631	No Action Required	No Action Required	24	4	0	34	4.885714286	2031	2066	2101	2021	2056	2091
265	Valve Butterfly Filter 2 Backwash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000724	1986	NA	20	in	2	4	35	$ 10,000	$ 14,500	No Action Required	No Action Required	24	8	0	34	4.885714286	2031	2066	2101	2021	2056	2091
266	Actuator Valve Butterfly Filter 2 Backwash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000724	1986	NA	20	in	2	4	25	$ 6,000	$ 8,700	Assess	No Action Required	24	8	0	34	5	2021	2046	2071	2020	2045	2070
267	Valve Butterfly Filter 3 Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000725	1986	NA	24	in	2	4	35	$ 12,000	$ 17,400	No Action Required	No Action Required	24	8	0	34	4.885714286	2031	2066	2101	2021	2056	2091
268	Actuator Valve Butterfly Filter 3 Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000725	1986	NA	24	in	2	4	25	$ 6,000	$ 8,700	Assess	No Action Required	24	8	0	34	5	2021	2046	2071	2020	2045	2070
269	Valve Butterfly Filter 3 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000726	1986	NA	24	in	2	4	35	$ 12,000	$ 17,400	No Action Required	No Action Required	24	8	0	34	4.885714286	2031	2066	2101	2021	2056	2091
270	Actuator Valve Butterfly Filter 3 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000726	1986	NA			2	4	35	$ 5,000	$ 7,250	No Action Required	No Action Required	24	8	0	34	4.885714286	2031	2066	2101	2021	2056	2091
271	Valve Butterfly Filter 3 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000727	2008	NA	4	in	3	2	35	$ 1,125	$ 1,631	No Action Required	No Action Required	18	6	0	12	2.371428571	2037	2072	2107	2043	2078	2113
272	Valve Butterfly Filter 3 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000729	1986	NA	4	in	3	2	35	$ 1,125	$ 1,631	No Action Required	No Action Required	28	6	0	34	4.885714286	2027	2062	2097	2021	2056	2091
273	Valve Piston Filter 3 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000728	1986	NA	4	in	2	2	35	$ 4,700	$ 6,815	No Action Required	No Action Required	24	4	0	34	4.885714286	2031	2066	2101	2021	2056	2091
274	Valve Butterfly Filter 3 Backwash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000730	1986	NA	20	in	2	4	35	$ 10,000	$ 14,500	No Action Required	No Action Required	24	8	0	34	4.885714286	2031	2066	2101	2021	2056	2091
275	Actuator Valve Butterfly Filter 3 Backwash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000730	1986	NA			2	4	25	$ 6,000	$ 8,700	Assess	No Action Required	24	8	0	34	5	2021	2046	2071	2020	2045	2070
276	Valve Butterfly Filter 4 Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000731	1986	NA	24	in	2	4	35	$ 12,000	$ 17,400	No Action Required	No Action Required	24	8	0	34	4.885714286	2031	2066	2101	2021	2056	2091
277	Actuator Valve Butterfly Filter 4 Inlet	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000731	1986	NA	24	in	2	4	25	$ 6,000	$ 8,700	Assess	No Action Required	24	8	0	34	5	2021	2046	2071	2020	2045	2070
278	Valve Butterfly Filter 4 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000732	1986	NA	24	in	2	4	35	$ 12,000	$ 17,400	No Action Required	No Action Required	24	8	0	34	4.885714286	2031	2066	2101	2021	2056	2091
279	Actuator Valve Butterfly Filter 4 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000732	1986	NA			2	4	25	$ 6,000	$ 8,700	Assess	No Action Required	24	8	0	34	5	2021	2046	2071	2020	2045	2070
280	Valve Butterfly Filter 4 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000733	1986	NA	4	in	2	2	35	$ 1,125	$ 1,631	No Action Required	No Action Required	24	4	0	34	4.885714286	2031	2066	2101	2021	2056	2091
281	Valve Butterfly Filter 4 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000735	1986	NA	4	in	4	2	35	$ 1,125	$ 1,631	No Action Required	No Action Required	31	8	0	34	4.885714286	2024	2059	2094	2021	2056	2091
282	Valve Piston Filter 4 Surface Wash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000734	1986	NA	4	in	2	2	35	$ 4,700	$ 6,815	No Action Required	No Action Required	24	4	0	34	4.885714286	2031	2066	2101	2021	2056	2091
283	Valve Butterfly Filter 4 Backwash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000736	1986	NA	20	in	2	4	35	$ 10,000	$ 14,500	No Action Required	No Action Required	24	8	0	34	4.885714286	2031	2066	2101	2021	2056	2091
284	Actuator Valve Butterfly Filter 4 Backwash	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Electrical	Actuator	300000736	1986	NA			2	4	25	$ 6,000	$ 8,700	Assess	No Action Required	24	8	0	34	5	2021	2046	2071	2020	2045	2070
285	Valve Plug Floc Tank 4 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000737	1986	NA	6	in	2	1	35	$ 1,200	$ 1,740	No Action Required	No Action Required	24	2	0	34	4.885714286	2031	2066	2101	2021	2056	2091
286	Valve Plug Floc Tank 3 Drain	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Main Floor)	Process Mechanical	Valve	300000738	1986	NA	6	in	2	1	35	$ 1,200	$ 1,740	No Action Required	No Action Required	24	2	0	34	4.885714286	2031	2066	2101	2021	2056	2091
287	Mixer #1 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chamber	Process Mechanical	Mixer	300000193	1986	NA			2	4	40	$ 36,300	$ 52,635	No Action Required	No Action Required	26	8	0	34	4.4	2034	2074	2114	2026	2066	2106
288	Motor #1 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chamber	Process Electrical	Motor	300000194	1986	NA			2	4	20	$ 800	$ 1,160	Assess	Assess	24	8	0	34	5	2020	2040	2060	2020	2040	2060
289	Sluice Gate # N-1 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chamber	Process Mechanical	Gate	Missing	1986	NA	24x24	in	2	4	20	$ 13,700	$ 19,865	Assess	Assess	24	8	0	34	5	2020	2040	2060	2020	2040	2060
290	Mixer #2 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chamber	Process Mechanical	Mixer	Missing	1986	NA			2	4	40	$ 36,300	$ 52,635	No Action Required	No Action Required	26	8	0	34	4.4	2034	2074	2114	2026	2066	2106
291	Motor #2 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chamber	Process Electrical	Motor	Missing	1986	NA			3	4	20	$ 800	$ 1,160	Assess	Assess	27	12	0	34	5	2020	2040	2060	2020	2040	2060
292	Sluice Gate # S-2 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chamber	Process Mechanical	Gate	Missing	1986	NA	24x24	in	2	4	20	$ 13,700	$ 19,865	Assess	Assess	24	8	0	34	5	2020	2040	2060	2020	2040	2060
293	Mixer #3 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chamber	Process Mechanical	Mixer	Missing	1986	NA			2	4	40	$ 36,300	$ 52,635	No Action Required	No Action Required	26	8	0	34	4.4	2034	2074	2114	2026	2066	2106

Item ID	Asset Description	Level 1 – Functional Group	Level 2 – Facility Type / Location	Level 3 – Process Location	Level 4 – Asset Category	Level 5 (Asset Type)	Unique ID	Install Year	Refurbishment Year	Size / Capacity	Unit of Measure	Condition Score (1 to 5 Scale)	CoF Score (1 to 5 Scale)	ESL	Replacement Cost (2020)	Project Cost (includes Markup)	Action Required (Original)	Action Required (Adjusted)	Apparent Age	Risk Score (1 to 25 Scale)	# of years since Assessment	Age at Time of Assessment	Expected Condition at Time of Assessment	1st Repl. YR (Adj)	2nd Repl. YR (Adj)	3rd Repl. YR (Adj)	1st Repl. YR	2nd Repl. YR2	3rd Repl. YR3
294	Motor #3 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chamber	Process Electrical	Motor	Missing	1986	NA			2	4	20	$ 800	$ 1,160	Assess	Assess	24	8	0	34	5	2020	2040	2060	2020	2040	2060
295	Sluice Gate # N-3 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chamber	Process Mechanical	Gate	Missing	1986	NA	24x24	in	2	4	20	$ 13,700	$ 19,865	Assess	Assess	24	8	0	34	5	2020	2040	2060	2020	2040	2060
296	Sluice Gate # N-4 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chamber	Process Mechanical	Gate	Missing	1986	NA	24x24	in	2	4	20	$ 13,700	$ 19,865	Assess	Assess	24	8	0	34	5	2020	2040	2060	2020	2040	2060
297	Mixer #4 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chamber	Process Mechanical	Mixer	Missing	1986	NA			2	4	40	$ 36,300	$ 52,635	No Action Required	No Action Required	26	8	0	34	4.4	2034	2074	2114	2026	2066	2106
298	Motor #4 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chamber	Process Electrical	Motor	Missing	1986	NA			2	4	20	$ 800	$ 1,160	Assess	Assess	24	8	0	34	5	2020	2040	2060	2020	2040	2060
299	Sluice Gate # S-1 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chamber	Process Mechanical	Gate	Missing	1986	NA	24x24	in	2	4	20	$ 13,700	$ 19,865	Assess	Assess	24	8	0	34	5	2020	2040	2060	2020	2040	2060
300	Sluice Gate # N-2 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chamber	Process Mechanical	Gate	Missing	1986	NA	24x24	in	2	4	20	$ 13,700	$ 19,865	Assess	Assess	24	8	0	34	5	2020	2040	2060	2020	2040	2060
301	Sluice Gate # S-3 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chamber	Process Mechanical	Gate	Missing	1986	NA	24x24	in	2	4	20	$ 13,700	$ 19,865	Assess	Assess	24	8	0	34	5	2020	2040	2060	2020	2040	2060
302	Sluice Gate # S-4 Floc	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chamber	Process Mechanical	Gate	Missing	1986	NA	24x24	in	2	4	20	$ 13,700	$ 19,865	Assess	Assess	24	8	0	34	5	2020	2040	2060	2020	2040	2060
303	Mixer Chamber #4	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chamber	Process Structural	Tanks / Basins	Missing	1986	NA			2	4	60	$ 53,920	$ 78,185	No Action Required	No Action Required	30	8	0	34	3.266666667	2050	2110	2170	2046	2106	2166
304	Mixer Chamber #3	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chamber	Process Structural	Tanks / Basins	Missing	1986	NA			2	4	60	$ 53,920	$ 78,185	No Action Required	No Action Required	30	8	0	34	3.266666667	2050	2110	2170	2046	2106	2166
305	Mixer Chamber #2	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chamber	Process Structural	Tanks / Basins	Missing	1986	NA			2	4	60	$ 53,920	$ 78,185	No Action Required	No Action Required	30	8	0	34	3.266666667	2050	2110	2170	2046	2106	2166
306	Mixer Chamber #1	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chamber	Process Structural	Tanks / Basins	Missing	1986	NA			2	4	60	$ 53,920	$ 78,185	No Action Required	No Action Required	30	8	0	34	3.266666667	2050	2110	2170	2046	2106	2166
307	Filter Chamber #1	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chamber	Process Structural	Tanks / Basins	Missing	1986	NA			2	4	60	$ 65,886	$ 95,534	No Action Required	No Action Required	30	8	0	34	3.266666667	2050	2110	2170	2046	2106	2166
308	Filter Chamber #2	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chamber	Process Structural	Tanks / Basins	Missing	1986	NA			2	4	60	$ 65,886	$ 95,534	No Action Required	No Action Required	30	8	0	34	3.266666667	2050	2110	2170	2046	2106	2166
309	Filter Chamber #3	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chamber	Process Structural	Tanks / Basins	Missing	1986	NA			2	4	60	$ 65,886	$ 95,534	No Action Required	No Action Required	30	8	0	34	3.266666667	2050	2110	2170	2046	2106	2166
310	Filter Chamber #4	Surface Water Facilities	Surface Water Treatment Plant	Flocculation & Filter Chamber	Process Structural	Tanks / Basins	Missing	1986	NA			2	4	60	$ 65,886	$ 95,534	No Action Required	No Action Required	30	8	0	34	3.266666667	2050	2110	2170	2046	2106	2166
311	Valve Backwash #2 Suction	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000180	1986	NA	24	in	2	5	35	$ 8,000	$ 11,600	No Action Required	No Action Required	24	10	0	34	4.885714286	2031	2066	2101	2021	2056	2091
312	Pump Backwash #2	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000179	1986	NA	16-DLB-20		2	5	20	$ 61,000	$ 88,450	Assess	Assess	24	10	0	34	5	2020	2040	2060	2020	2040	2060
313	Valve Backwash Pump #2 Check	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000177	1986	NA	16	in	2	5	35	$ 20,000	$ 29,000	No Action Required	No Action Required	24	10	0	34	4.885714286	2031	2066	2101	2021	2056	2091
314	Valve Backwash #2 Discharge	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000178	1986	NA	16	in	2	5	35	$ 4,000	$ 5,800	No Action Required	No Action Required	24	10	0	34	4.885714286	2031	2066	2101	2021	2056	2091
315	Motor Backwash Pump #2 Discharge Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000176	1986	NA			2	5	20	$ 11,000	$ 15,950	Assess	Assess	24	10	0	34	5	2020	2040	2060	2020	2040	2060
316	Motor Backwash Pump #2	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000174	1986	NA			4	5	20	$ 11,000	$ 15,950	Assess	Replace or Assess	31	20	0	34	5	2020	2040	2060	2020	2040	2060
317	Valve Backwash #1 Suction	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000181	1986	NA	24	in	2	5	35	$ 8,000	$ 11,600	No Action Required	No Action Required	24	10	0	34	4.885714286	2031	2066	2101	2021	2056	2091
318	Pump Backwash #1	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000173	1986	NA			2	5	20	$ 61,000	$ 88,450	Assess	Assess	24	10	0	34	5	2020	2040	2060	2020	2040	2060
319	Valve Check - Backwash Pump #2	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000171	1986	NA	16	in	2	5	35	$ 20,000	$ 29,000	No Action Required	No Action Required	24	10	0	34	4.885714286	2031	2066	2101	2021	2056	2091
320	Valve Backwash Pump #1 Discharge	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000170	1986	NA	16	in	2	5	35	$ 4,000	$ 5,800	No Action Required	No Action Required	24	10	0	34	4.885714286	2031	2066	2101	2021	2056	2091
321	Motor Backwash Pump #1 Discharge Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000169	1986	NA			2	5	20	$ 11,000	$ 15,950	Assess	Assess	24	10	0	34	5	2020	2040	2060	2020	2040	2060
322	Motor Backwash Pump #1	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000172	1986	NA			4	5	20	$ 15,000	$ 21,750	Assess	Replace or Assess	31	20	0	34	5	2020	2040	2060	2020	2040	2060
323	Surge Tank #2	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pressure Vessel	300000158	1986	NA			2	2	20	$ 55,000	$ 79,750	Replace on Failure	Replace on Failure	24	4	0	34	5	2020	2040	2060	2020	2040	2060
324	Surge Tank #1	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pressure Vessel	300000149	1986	NA			2	2	20	$ 55,000	$ 79,750	Replace on Failure	Replace on Failure	24	4	0	34	5	2020	2040	2060	2020	2040	2060
325	Valve Surge Tank #2 Isolation	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000157	1986	NA	16	in	2	2	35	$ 4,300	$ 6,235	No Action Required	No Action Required	24	4	0	34	4.885714286	2031	2066	2101	2021	2056	2091
326	Valve Surge Tank #1 Isolation	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000150	1986	NA	16	in	2	2	35	$ 4,300	$ 6,235	No Action Required	No Action Required	24	4	0	34	4.885714286	2031	2066	2101	2021	2056	2091
327	Motor Surge Tank #1 Compressor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000153	1986	NA			2	2	20	$ 3,500	$ 5,075	Replace on Failure	Replace on Failure	24	4	0	34	5	2020	2040	2060	2020	2040	2060
328	Motor Surge Tank #2 Compressor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000154	1986	NA			2	2	20	$ 3,500	$ 5,075	Replace on Failure	Replace on Failure	24	4	0	34	5	2020	2040	2060	2020	2040	2060
329	Disconnect Surge Tank #1 Compressor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Disconnect	300000151	1986	NA			2	2	25	$ 1,000	$ 1,450	Replace on Failure	No Action Required	24	4	0	34	5	2021	2046	2071	2020	2045	2070
330	Disconnect Surge Tank #2 Compressor	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Disconnect	300000152	1986	NA			2	2	25	$ 1,000	$ 1,450	Replace on Failure	No Action Required	24	4	0	34	5	2021	2046	2071	2020	2045	2070
331	Suction Header Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000524	1986	NA			3	1	20	$ 40,500	$ 58,725	Replace on Failure	Replace on Failure	27	3	0	34	5	2020	2040	2060	2020	2040	2060
332	Suction Header Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000522	1986	NA			3	3	20	$ 40,500	$ 58,725	Assess	Assess	27	9	0	34	5	2020	2040	2060	2020	2040	2060
333	Suction Header Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000523	1986	NA			3	3	20	$ 40,500	$ 58,725	Assess	Assess	27	9	0	34	5	2020	2040	2060	2020	2040	2060
334	Suction Header Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000525	1986	NA			3	3	20	$ 40,500	$ 58,725	Assess	Assess	27	9	0	34	5	2020	2040	2060	2020	2040	2060
335	Valve check, sludge pump 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000672	1986	NA	4	in	2	2	35	$ 3,500	$ 5,075	No Action Required	No Action Required	24	4	0	34	4.885714286	2031	2066	2101	2021	2056	2091

iItem ID	Asset Description	Level 1 – Functional Group	Level 2 – Facility Type / Location	Level 3 – Process Location	Level 4 – Asset Category	Level 5 (Asset Type)	Unique ID	Install Year	Refurbishment Year	Size / Capacity	Unit of Measure	Condition Score (1 to 5 Scale)	CoF Score (1 to 5 Scale)	ESL	Replacement Cost (2020)	Project Cost (includes Markup)	Action Required (Original)	Action Required (Adjusted)	Apparent Age	Risk Score (1 to 25 Scale)	# of years since Assessment	Age at Time of Assessment	Expected Condition at Time of Assessment	1st Repl. YR (Adj)	2nd Repl. YR (Adj)	3rd Repl. YR (Adj)	1st Repl. YR	2nd Repl. YR2	3rd Repl. YR3
336	Valve check, sludge pump 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000676	1986	NA	4	in	2	2	35	$ 3,500	$ 5,075	No Action Required	No Action Required	24	4	0	34	4.885714286	2031	2066	2101	2021	2056	2091
337	Pump, sludge pump 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Pump	Missing	1986	NA			3	2	20	$ 4,000	$ 5,800	Replace on Failure	Replace on Failure	27	6	0	34	5	2020	2040	2060	2020	2040	2060
338	Pump Motor, sludge pump 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Motor	Missing	1986	NA	10	HP	3	2	20	Cost Included in Pump	Cost Included in Pump	Replace on Failure	Replace on Failure	27	6	0	34	5	2020	2040	2060	2020	2040	2060
339	Pump, sludge pump 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Pump	Missing	1986	NA			5	2	20	$ 4,000	$ 5,800	Replace on Failure	Replace on Failure	34	10	0	34	5	2020	2040	2060	2020	2040	2060
340	Pump Motor, sludge pump 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Motor	Missing	1986	NA	10	HP	3	2	20	Cost Included in Pump	Cost Included in Pump	Replace on Failure	Replace on Failure	27	6	0	34	5	2020	2040	2060	2020	2040	2060
341	Valve plug, sludge to emergency tank truck	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000679	1986	NA	4	in	2	2	35	$ 1,000	$ 1,450	No Action Required	No Action Required	24	4	0	34	4.885714286	2031	2066	2101	2021	2056	2091
342	Valve plug, BW tank 2 bottom level	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000661	1986	NA	8	in	2	1	35	$ 1,500	$ 2,175	No Action Required	No Action Required	24	2	0	34	4.885714286	2031	2066	2101	2021	2056	2091
343	Valve plug, BW tank 2 middle level	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000660	1986	NA	8	in	2	1	35	$ 1,500	$ 2,175	No Action Required	No Action Required	24	2	0	34	4.885714286	2031	2066	2101	2021	2056	2091
344	Valve plug, BW tank 2 top level	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000661	1986	NA	8	in	2	1	35	$ 1,500	$ 2,175	No Action Required	No Action Required	24	2	0	34	4.885714286	2031	2066	2101	2021	2056	2091
345	Valve plug, BW tank 1 bottom level	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000658	1986	NA	8	in	2	1	35	$ 1,500	$ 2,175	No Action Required	No Action Required	24	2	0	34	4.885714286	2031	2066	2101	2021	2056	2091
346	Valve plug, BW tank 1 middle level	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000657	1986	NA	8	in	2	1	35	$ 1,500	$ 2,175	No Action Required	No Action Required	24	2	0	34	4.885714286	2031	2066	2101	2021	2056	2091
347	Valve plug, BW tank 1 top level discharge	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000656	1986	NA	8	in	2	1	35	$ 1,500	$ 2,175	No Action Required	No Action Required	24	2	0	34	4.885714286	2031	2066	2101	2021	2056	2091
348	Disconnect, sludge pump 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Disconnect	Missing	1986	NA	30	Amp	2	2	25	$ 1,000	$ 1,450	Replace on Failure	No Action Required	24	4	0	34	5	2021	2046	2071	2020	2045	2070
349	Disconnect, sludge pump 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Disconnect	Missing	1986	NA	30	Amp	2	2	25	$ 1,000	$ 1,450	Replace on Failure	No Action Required	24	4	0	34	5	2021	2046	2071	2020	2045	2070
350	Valve plug, supernatant pump 2 suction	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000665	1986	NA	8	in	2	2	35	$ 1,500	$ 2,175	No Action Required	No Action Required	24	4	0	34	4.885714286	2031	2066	2101	2021	2056	2091
351	Valve plug, supernatant pump 2 discharge	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000667	1986	NA	8	in	2	2	35	$ 1,500	$ 2,175	No Action Required	No Action Required	24	4	0	34	4.885714286	2031	2066	2101	2021	2056	2091
352	Valve check, supernatant pump 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000666	1986	NA	6	in	3	2	35	$ 6,500	$ 9,425	No Action Required	No Action Required	28	6	0	34	4.885714286	2027	2062	2097	2021	2056	2091
353	Pump, supernatant no. 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Pump	Missing	1986	2011			2	2	20	$ 16,400	$ 23,780	No Action Required	No Action Required	8	4	0	9	2.8	2032	2052	2072	2031	2051	2071
354	Pump Motor, supernatant no. 2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Motor	Missing	1986	2011	7.5	HP	2	2	20	$ 3,500	$ 5,075	No Action Required	No Action Required	8	4	0	9	2.8	2032	2052	2072	2031	2051	2071
355	Pump, supernatant no. 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Pump	Missing	1986	2011			2	2	20	$ 16,400	$ 23,780	No Action Required	No Action Required	8	4	0	9	2.8	2032	2052	2072	2031	2051	2071
356	Pump Motor, supernatant no. 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Motor	Missing	1986	2011	7.5	HP	2	2	20	$ 3,500	$ 5,075	No Action Required	No Action Required	8	4	0	9	2.8	2032	2052	2072	2031	2051	2071
357	Valve plug, supernatant pump 1 discharge	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000664	1986	NA	8	in	2	2	35	$ 1,500	$ 2,175	No Action Required	No Action Required	24	4	0	34	4.885714286	2031	2066	2101	2021	2056	2091
358	Valve plug, supernatant pump 1 suction	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000662	1986	NA	8	in	2	2	35	$ 1,500	$ 2,175	No Action Required	No Action Required	24	4	0	34	4.885714286	2031	2066	2101	2021	2056	2091
359	Valve check, supernatant pump 1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000663	1986	NA	6	in	3	2	35	$ 6,500	$ 9,425	No Action Required	No Action Required	28	6	0	34	4.885714286	2027	2062	2097	2021	2056	2091
360	Valve plug, BW tanks to supernatant line	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000668	1986	NA	8	in	2	2	35	$ 1,500	$ 2,175	No Action Required	No Action Required	24	4	0	34	4.885714286	2031	2066	2101	2021	2056	2091
361	Disconnect, supernatant pump #1	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Disconnect	Missing	1986	NA	30	HP	2	2	25	$ 1,000	$ 1,450	Replace on Failure	No Action Required	24	4	0	34	5	2021	2046	2071	2020	2045	2070
362	Disconnect, supernatant pump #2	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Electrical	Disconnect	Missing	1986	NA	30	HP	2	2	25	$ 1,000	$ 1,450	Replace on Failure	No Action Required	24	4	0	34	5	2021	2046	2071	2020	2045	2070
363	Valve plug, decant to pond valve	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000669	1986	NA	8	in	2	2	35	$ 1,500	$ 2,175	No Action Required	No Action Required	24	4	0	34	4.885714286	2031	2066	2101	2021	2056	2091
364	Valve plug, decant to overflow	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000670	1986	NA	8	in	2	2	35	$ 1,500	$ 2,175	No Action Required	No Action Required	24	4	0	34	4.885714286	2031	2066	2101	2021	2056	2091
365	Valve, BFP	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000810	2018	NA	2	in	1	4	35	$ 620	$ 899	No Action Required	No Action Required	2	4	0	2	1.228571429	2053	2088	2123	2053	2088	2123
366	Valve, BFP Alum	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000783	2018	NA	2	in	1	4	35	$ 620	$ 899	No Action Required	No Action Required	2	4	0	2	1.228571429	2053	2088	2123	2053	2088	2123
367	Valve, BFP Chlorine	Surface Water Facilities	Surface Water Treatment Plant	Chemical Facilities (M) - Cl2	Process Mechanical	Valve	300000784	2018	NA	2	in	1	4	35	$ 620	$ 899	No Action Required	No Action Required	2	4	0	2	1.228571429	2053	2088	2123	2053	2088	2123
368	Valve, butterfly backwash flow control	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000186	1986	NA	20	in	3	4	35	$ 10,000	$ 14,500	No Action Required	No Action Required	28	12	0	34	4.885714286	2027	2062	2097	2021	2056	2091
369	Valve Actuator Motor, butterfly backwash flow control	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000185	2011	NA	0.34	kW	2	4	35	$ 5,000	$ 7,250	No Action Required	No Action Required	9	8	0	9	2.028571429	2046	2081	2116	2046	2081	2116
370	Valve Actuator Gearbox, butterfly backwash flow control	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000185	2011	NA			2	4	35	$ 5,000	$ 7,250	No Action Required	No Action Required	9	8	0	9	2.028571429	2046	2081	2116	2046	2081	2116
371	Valve, butterfly backwash flow control, filter tank	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000747	1986	NA	24	in	3	4	35	$ 8,000	$ 11,600	No Action Required	No Action Required	28	12	0	34	4.885714286	2027	2062	2097	2021	2056	2091
372	Valve Actuator Motor, butterfly backwash flow control filter tanks	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000747	1986	NA	0.4	HP	3	4	35	$ 5,000	$ 7,250	No Action Required	No Action Required	28	12	0	34	4.885714286	2027	2062	2097	2021	2056	2091
373	Valve Actuator Gearbox, butterfly level control filter tanks	Surface Water Facilities	Surface Water Treatment Plant	Pipe Gallery (Basement)	Process Mechanical	Valve	300000747	1986	NA	250		3	4	35	$ 5,000	$ 7,250	No Action Required	No Action Required	28	12	0	34	4.885714286	2027	2062	2097	2021	2056	2091
374	Valve HL #3 Suction	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000129	1986	NA	20	in	2	3	35	$ 6,500	$ 9,425	No Action Required	No Action Required	24	6	0	34	4.885714286	2031	2066	2101	2021	2056	2091
375	Pump HL #3	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000128	1986	NA	4360	m3	2	3	20	$ 40,000	$ 58,000	Assess	Assess	24	6	0	34	5	2020	2040	2060	2020	2040	2060
376	Motor HL #3	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000127	1986	NA			4	3	20	$ 25,500	$ 36,975	Assess	Assess	31	12	0	34	5	2020	2040	2060	2020	2040	2060
377	Valve HL#3 Check	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000126	2013	NA	12	in	2	3	35	$ 12,500	$ 18,125	No Action Required	No Action Required	9	6	0	7	1.8	2046	2081	2116	2048	2083	2118

iItem ID	Asset Description	Level 1 – Functional Group	Level 2 – Facility Type / Location	Level 3 – Process Location	Level 4 – Asset Category	Level 5 (Asset Type)	Unique ID	Install Year	Refurbishment Year	Size / Capacity	Unit of Measure	Condition Score (1 to 5 Scale)	CoF Score (1 to 5 Scale)	ESL	Replacement Cost (2020)	Project Cost (includes Markup)	Action Required (Original)	Action Required (Adjusted)	Apparent Age	Risk Score (1 to 25 Scale)	# of years since Assessment	Age at Time of Assessment	Expected Condition at Time of Assessment	1st Repl. YR (Adj)	2nd Repl. YR (Adj)	3rd Repl. YR (Adj)	1st Repl. YR	2nd Repl. YR2	3rd Repl. YR3
378	Valve HL#3 Discharge	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000125	2013	NA	16	in	2	3	35	$ 4,000	$ 5,800	No Action Required	No Action Required	9	6	0	7	1.8	2046	2081	2116	2048	2083	2118
379	Motor HL#3 Discharge Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000124	2013	NA			2	3	20	$ 5,000	$ 7,250	No Action Required	No Action Required	7	6	0	7	2.4	2033	2053	2073	2033	2053	2073
380	Valve HL #2 Suction	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000123	1986	NA	20	in	2	3	35	$ 6,500	$ 9,425	No Action Required	No Action Required	24	6	0	34	4.885714286	2031	2066	2101	2021	2056	2091
381	Pump HL #2	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000122	1986	NA	4360	m3	2	3	20	$ 40,000	$ 58,000	Assess	Assess	24	6	0	34	5	2020	2040	2060	2020	2040	2060
382	Motor HL #2	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000121	1986	NA			4	3	20	$ 25,500	$ 36,975	Assess	Assess	31	12	0	34	5	2020	2040	2060	2020	2040	2060
383	Valve HL#2 Check	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000786	2012	NA	12	in	2	3	35	$ 12,500	$ 18,125	No Action Required	No Action Required	9	6	0	8	1.914285714	2046	2081	2116	2047	2082	2117
384	Valve HL#2 Discharge	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000785	2012	NA	16	in	2	3	35	$ 4,000	$ 5,800	No Action Required	No Action Required	9	6	0	8	1.914285714	2046	2081	2116	2047	2082	2117
385	Motor HL#2 Discharge Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000801	2012	NA			2	3	20	$ 5,000	$ 7,250	No Action Required	No Action Required	8	6	0	8	2.6	2032	2052	2072	2032	2052	2072
386	Motor Future High Lift Discharge Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000133	1986	NA			2	1	20	$ 5,000	$ 7,250	Replace on Failure	Replace on Failure	24	2	0	34	5	2020	2040	2060	2020	2040	2060
387	Valve Future High Lift Discharge	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000134	1986	NA	20	in	2	1	35	$ 6,500	$ 9,425	No Action Required	No Action Required	24	2	0	34	4.885714286	2031	2066	2101	2021	2056	2091
388	Valve Pipe Leading to Surface Wash Pumps	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000130	1986	NA	6	in	2	5	35	$ 1,200	$ 1,740	No Action Required	No Action Required	24	10	0	34	4.885714286	2031	2066	2101	2021	2056	2091
389	Valve HL #1 Suction	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000117	1986	NA	20	in	2	3	35	$ 6,500	$ 9,425	No Action Required	No Action Required	24	6	0	34	4.885714286	2031	2066	2101	2021	2056	2091
390	Pump HL #1	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000116	2011	NA	4360	m3	2	3	20	$ 40,000	$ 58,000	No Action Required	No Action Required	8	6	0	9	2.8	2032	2052	2072	2031	2051	2071
391	Motor HL #1	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000115	1986	NA			4	3	20	$ 25,500	$ 36,975	Assess	Assess	31	12	0	34	5	2020	2040	2060	2020	2040	2060
392	Valve HL#1 Check	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000114	2011	NA	12	in	2	3	35	$ 12,500	$ 18,125	No Action Required	No Action Required	9	6	0	9	2.028571429	2046	2081	2116	2046	2081	2116
393	Valve HL#1 Discharge	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000113	2011	NA	16	in	2	3	35	$ 4,000	$ 5,800	No Action Required	No Action Required	9	6	0	9	2.028571429	2046	2081	2116	2046	2081	2116
394	Motor HL#1 Discharge Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000112	2011	NA			2	3	20	$ 5,000	$ 7,250	No Action Required	No Action Required	8	6	0	9	2.8	2032	2052	2072	2031	2051	2071
395	Generator Backup Pump	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Pump	300000142	1986	NA			2	2	20	$ 120,000	$ 174,000	Replace on Failure	Replace on Failure	24	4	0	34	5	2020	2040	2060	2020	2040	2060
396	Pump Engine Diesel (WWT)	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Engine	300000140	1986	NA			4	2	20	$ 30,000	$ 43,500	Replace on Failure	Replace on Failure	31	8	0	34	5	2020	2040	2060	2020	2040	2060
397	Valve Backflow Preventor Chlorine	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000782	1986	NA	2	in	2	4	35	$ 1,600	$ 2,320	No Action Required	No Action Required	24	8	0	34	4.885714286	2031	2066	2101	2021	2056	2091
398	Valve Top Valve After Discharge Surge	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000108	1986	NA	12	in	2	5	35	$ 4,000	$ 5,800	No Action Required	No Action Required	24	10	0	34	4.885714286	2031	2066	2101	2021	2056	2091
399	Valve Lower Valve Before Discharge Surge	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000109	1986	NA	12	in	2	5	35	$ 4,000	$ 5,800	No Action Required	No Action Required	24	10	0	34	4.885714286	2031	2066	2101	2021	2056	2091
400	Motor Treated Water Isolating	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Motor	300000110	1986	NA			2	4	20	$ 5,000	$ 7,250	Assess	Assess	24	8	0	34	5	2020	2040	2060	2020	2040	2060
401	Valve Treated Water Isolating	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000111	1986	NA	24	in	2	4	35	$ 15,500	$ 22,475	No Action Required	No Action Required	24	8	0	34	4.885714286	2031	2066	2101	2021	2056	2091
402	Generator Backup Power	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Electrical	Generator	300000139	1986	NA			2	5	35	$ 120,000	$ 174,000	No Action Required	No Action Required	24	10	0	34	4.885714286	2031	2066	2101	2021	2056	2091
403	Backflow Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	300000809	1986	NA	1	in	2	5	35	$ 1,600	$ 2,320	No Action Required	No Action Required	24	10	0	34	4.885714286	2031	2066	2101	2021	2056	2091
404	Tank Emergency Power Fuel #1	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Structural	Tanks / Basins	300000164	1986	NA			2	5	60	$ 3,400	$ 4,930	No Action Required	No Action Required	30	10	0	34	3.266666667	2050	2110	2170	2046	2106	2166
405	Tank Emergency Power Fuel #2	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Structural	Tanks / Basins	300000165	1986	NA			2	5	60	$ 3,400	$ 4,930	No Action Required	No Action Required	30	10	0	34	3.266666667	2050	2110	2170	2046	2106	2166
406	Tank Emergency Power Fuel #3	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Structural	Tanks / Basins	300000166	1986	NA			2	5	60	$ 3,400	$ 4,930	No Action Required	No Action Required	30	10	0	34	3.266666667	2050	2110	2170	2046	2106	2166
407	Valve butterfly pressure reducing	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000749	1986	NA	24	in	2	2	35	$ 8,000	$ 11,600	No Action Required	No Action Required	24	4	0	34	4.885714286	2031	2066	2101	2021	2056	2091
408	Actuator Valve butterfly pressure reducing	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000749	1986	NA			2	2	35	$ 5,000	$ 7,250	No Action Required	No Action Required	24	4	0	34	4.885714286	2031	2066	2101	2021	2056	2091
409	Valve butterfly, level bypass	Surface Water Facilities	Surface Water Treatment Plant	Pressure Reducing Station	Process Mechanical	Valve	300000757	1986	NA	24	in	3	3	35	$ 8,000	$ 11,600	No Action Required	No Action Required	28	9	0	34	4.885714286	2027	2062	2097	2021	2056	2091
410	Treated Water Surge Relief Valve	Surface Water Facilities	Surface Water Treatment Plant	High Lift Pumping Station	Process Mechanical	Valve	Missing	1986	NA	12	in	2	4	35	$ 15,500	$ 22,475	No Action Required	No Action Required	24	8	0	34	4.885714286	2031	2066	2101	2021	2056	2091

Appendix F

Staged Condition Assessment Approach

1. Risk-based Inspection and Monitoring Strategies

Given the cost associated with many assessment techniques, it is important that the assessment of pressure pipe truly considers the combined risk of an asset, beginning with desktop assessment and progressing to more advanced methods of establishing condition where required. This progression should be driven by risk, material, observations, and suspected deterioration process. This is illustrated in **Figure 1**, demonstrating how the approach to condition assessment could scale with risk.

Evident from **Figure 1** is that only major risk assets may rationalize certain types of advanced condition assessment. The highest criticality assets must be managed proactively to avoid catastrophic failure. Doing so effectively requires an accurate understanding of the asset's deterioration mechanisms, which can only be achieved through a significant commitment of time and resources over its lifecycle.

Similarly, sustainable funding opportunities to restore the condition of water infrastructure through intervention actions are accomplished through the consideration of risk exposures. In some circumstances, however, interventions are performed on assets/cohorts with high vulnerabilities. These assets significantly contribute to breaks in the system and hence, decrease levels of service and disruptions (depending on the location).

Probability of Failure	**Very Poor**	Repair/Replace on Failure	Stage III Assessment	Stage IV Assessment
	Poor	Repair/Replace on Failure	Stage III Assessment	Stage IV Assessment
	Fair	Monitor	Stage II Assessment	Stage III Assessment
	Good	Monitor	Stage I Desktop Assessment	Stage I Desktop Assessment
	Very Good	Monitor	Stage I Desktop Assessment	Stage I Desktop Assessment
		Minor	**Moderate**	**Major**
		Consequence of Failure		

Figure 1: Risk Driven Staged Approach to Condition Assessment

2.1 Advanced Condition Assessment

Advanced condition assessment is ultimately required on moderate to major consequence watermains.

Inspection Approach – Large Diameter Mains

Because large diameter watermains are among those with the highest consequence of failure and smaller mains can be examined retroactively as well as with desktop assessment, the majority of planned, advanced assessments can be focused on watermains of 600 mm in diameter or larger that have a large potential to actively deteriorate in reaction with their environment. The result of this approach is that condition assessment technologies must be catered to the materials within this size cohort (notably pre-stressed concrete). Because there are high consequence mains with a number of active deterioration mechanisms (corrosion and wire breaks), the risk potential warrants a detailed inspection.

The overall initial risk screening for pipes 600 mm in diameter or greater highlights the need for considerable initial screening to better characterize material specifics and exposure conditions. This is in direct contrast to the smaller diameter ferrous watermains that have been explored and are well understood in their low consequence but an increasing rate of failure.

2.2 Inspection Approach – Medium and Small Diameter Mains

The inventory of watermains between 300 mm and 600 mm in diameter will be assessed by a balance of staged assessments and failure data assessment. Based on the prevalent material types, considerable information on condition can be inferred for the condition of all CI and DI through root cause failure assessments of smaller pipes and strategic use of opportunistic samplings. PVC and AC are a special case as current failure rates are very low when compared to ferrous pipelines (based on break records).

2.2.1 Retroactive Asset Failure Assessment and Root Cause Analysis

Given the rate at which failures are observed, there are ample opportunities to establish the root cause of failures at reduced cost for low consequence assets (which occupy more than half of all linear assets by length). For this reason, the majority of pressurized pipe screening can occur as retroactive responses, coupled with other preliminary condition assessment screening exercises to establish system vulnerabilities.

Maximizing information gained from failure will help PUC to understand performance of a particular cohort, local vulnerability, and the driver of a failure mode. By maximizing the information gained from failures, the need for condition assessment can be managed by extrapolating observations when logical to do so. This also provides the most cost-effective opportunity to validate the results of desktop assessment techniques. **Table 1** lists recommended attributes that should be collected in the event of a pipe failure.

Table 1: Recommended Data Collection during Pressurized Pipe Failure by Material Class

	Ferrous Metals	Thermoplastic	Concrete Pressure Pipe
Investigations	What are the characteristics of internal and external pipe corrosion? What soil units are present in the City and how do they contribute to external corrosion? What are other drivers of pipe failure (ex. live traffic loads or road salt application)? Do results reflect the Hazard Functions and Applied Loads Model?	Are there instances of poor extrusion quality? Can poor extrusion quality be tied to a manufacturer, era, geographic area of the City, or design standard? Do observed applied load conditions reflect the Model? Are operating pressures driving pipe failure? What PVC life funds are driving failures?	What types of defects drive failure (ex. wire breaks vs. joint failures)? What soil units are present in the corridor? What are the design standards of cement pressure pipe? Do designs match the resistivity requirements of the soil units?

Table 1: Recommended Data Collection during Pressurized Pipe Failure by Material Class

	Ferrous Metals	Thermoplastic	Concrete Pressure Pipe
Attributes to Collect	▪ Asset ID ▪ Date ▪ Age ▪ Material ▪ Diameter ▪ Pipe Class ▪ Road Class and AADT ▪ Design Standard ▪ Manufacturer ▪ Internal Lining (description) ▪ Internal Lining Thickness ▪ External Coating ▪ Internal Diameter (mm) ▪ Wall Thickness (mm) ▪ Joint Type ▪ Service Material ▪ External Maximum Pitting Depth ▪ External Average Pitting Depth ▪ External Pitting Surface Area ▪ External Pitting Material Loss ▪ External Pitting Rate ▪ External Maximum Wall Penetration ▪ Internal Maximum Pitting Depth ▪ Internal Average Pitting Depth ▪ Internal Pitting Surface Area ▪ Internal Pitting Material Loss ▪ Internal Pitting Rate ▪ Internal Maximum Wall Penetration ▪ Bed Class	▪ Asset ID ▪ Date ▪ Age ▪ Material ▪ Diameter ▪ Road Class and AADT ▪ Initial Wall Thickness ▪ Final Wall Thickness ▪ Operating Pressure ▪ Extrusion Quality (Laboratory analysis) ▪ Dimension Ratio ▪ Design Standard ▪ Manufacturer ▪ Bed Class	▪ Asset ID ▪ Date ▪ Age ▪ Material ▪ Diameter ▪ Road Class and AADT ▪ Wire Condition ▪ Joint Condition ▪ Design Standard ▪ Bed Class ▪ Manufacturer ▪ Soil Classification ▪ Soil Resistivity ▪ Soil Water Content ▪ Soil Resistivity Saturated ▪ Soil Redox Potential ▪ Soil Chlorides ▪ Soil Sulphides ▪ Soil pH ▪ Bed Class

Figure 2 presents a profile of the watermain breakages based on the PUC current GIS data. The breakage profile by material supports the observation and analysis produced during **TM #3A (Appendix A)**, which demonstrated that the overwhelming majority of pipe failures are attributed to small diameter cast iron watermains constructed between 1953 and 1975.

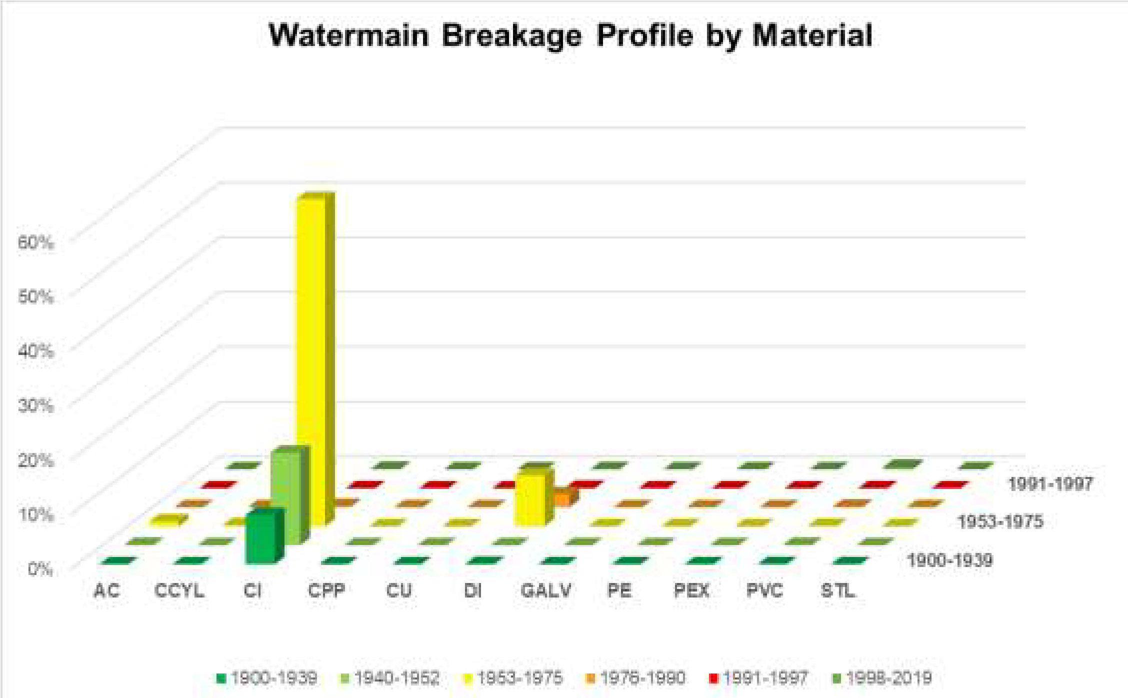


Figure 2: Watermain Breakage Profile by Material

2.2.2 Polyvinyl Chloride (PVC)

Almost all PVC pipelines were installed post 1975. This is significant as it suggests that most, if not all, of the installed PVC was manufactured to an AWWA Standard (C900) as opposed to being ASTM Series pipe. A 1994 AWWARF Study by Moser and Kellogg[1] found that ASTM Series pipe had twice the failure rate as pipe manufactured to the AWWA C900 Standard which was first released in 1975, largely attributed to an increased safety factor (i.e., 2.5 versus 2.0) and more robust quality assurance standards for production. Most PVC failures reported in the AWWARF study were driven by defects produced by installation and were not deterioration related. Moser[2] notes that PVC pipe in pressure service has three (3) independent life funds (**Table 2**). When the limits of either of these "funds" are exceeded, failure of the pipe is imminent.

Table 2: Life Funds of PVC Pipe

Life Fund #1: Sustained Pressure	Life Fund #2: Transient Pressure	Life Fund #3: Fatigue
Sustained pressure is seldom influenced by an external exposure environment, and generally relates to the original extrusion quality. Sustained pressure can be exacerbated by increased wall stress levels, and results in slow crack growth.	Transient pressure exploits the same aging vulnerability as sustained pressure (extrusion quality) but drives deterioration during brief instances of over pressure and under pressure, also known as water hammer. Over time, a pipe can become more vulnerable to short term over pressure due to deterioration driving by sustained pressure.	Fatigue drives PVC life funds when there is cyclic loadings.

Provided that extrusion quality of the material is not deficient, the wall stresses are low, and the pipe is not subjected to cyclic loading, thermoplastic pipes often exhibit very subtle to non-existent deterioration processes and may last for very long time periods. Therefore, the focus of PVC condition assessment could be extrusion quality sampling, coupled with continual

1. Moser and Kellogg, "AWWARF #90644 "Evaluation of Polyvinyl Chloride (PVC) Pipe Performance", AwwaRF - 1994
2. Moser and Folkman, "Buried Pipe Design, Third Edition", McGraw-Hill, 2008, ISBN: 9780071476898

monitoring of operating pressure. **Table 3** summarizes the staged approach, which should focus on investigating extrusion quality unless evidence demonstrates that joint assembly issues are present.

Table 3: Assessment Levels for Pressurized PVC Pipe

Assessment Observations	Assessment Technique	Assessment Stage
Condition is Unknown	Transient and Fatigue Analysis	Stage I
Slow Crack Growth Due to Applied Stress	Opportunistic or planned sampling and physical testing	Stage II
Slow Crack Growth Due to Poor Pipe Quality	Opportunistic or planned sampling and physical testing	Stage II
Poor joint assembly	Leakage Detection	Stage III

Although the break records are mainly observed in ferrous pipes, monitoring of extrusion quality will allow PUC to identify cohorts of pipes vulnerable to slow crack growth. A categorization of risk exposure by pipe age, diameter ratio, manufacturer, and wall stress would serve as the basis for a rehabilitation plan. Risk exposure can typically be managed through management of operating pressure in a manner that reflects the sensitivity of PVC pipes with varying design criteria and extrusion quality. This monitoring approach is summarized in **Table 4**.

Monitoring should begin by documenting the manufacturer and eras of construction of PUC's thermoplastic pressurized mains and map the areas of the City where these assets are situated. The asset level plan for thermoplastic opportunistic sampling should initiate the process of understanding the "life fund" vulnerabilities of each of these thermoplastic cohorts.

Table 4: Ramifications of Extrusion Quality and Applied Stress

Operating Pressure		Wall Stress			Vulnerability
psi	kPA	Dimension Ratio	Psi	MPa	
60	414	18	510	3.5	Rarely issues even with poor extrusion quality.
80	552	18	680	4.7	Very poor extrusion quality will drive active deterioration.
100	689	18	850	5.9	
180	1241	18	1530	10.5	
200	1379	18	1700	11.7	
220	1517	18	1870	12.9	Moderately poor extrusion quality will drive active deterioration
240	1655	18	2040	14.1	

While a low priority relative to cast and ductile iron failure management, it would be prudent to carry out some opportunistic sampling of PVC subjected to higher pressures, particularly in older vintages of PVC where extrusion quality is likely to be poorer.

Where opportunistic testing is carried out, the suite of tests listed in **Table 9** were developed by AECOM and PSI Test Labs (Denver, CO), to qualitatively assess the longevity of PVC in service. The suite of tests requires an approximate 600 mm sample section of pipe. Opportunistic sampling of PVC pipes can be carried out while completing capital improvement plans. These projects present ideal opportunities for PUC to undertake extrusion quality sampling for the lowest total cost, as expenses related to capital improvements (excavation, traffic control, dewatering, etc.) have already been incurred. PUC should review the opportunities for opportunistic sampling to determine whether such a sampling would be representative of all thermoplastic pipes by age, manufacturer, material, and applied wall stresses, or whether targeted measures in cohorts not captured within opportunistic sampling is required. Potential PVC pipes that could be a good candidate for opportunistic sampling, where operating pressures are anticipated to be greater than or equal to 80 psi.

Table 5: Suite of Tests to Assess PVC Degradation Risk – Opportunistic Sampling

PVC Longevity Assessment Tests
ASTM D1784 Cell Classification Testing
ASTM D256 IZOD Impact Test
ASTM D638 Tensile Properties (Tensile Strength at Yield) (Tensile Modulus)
ASTM D2122 Dimensions Determination
ASTM F1057 Heat Reversion
ASTM D2152 Acetone Immersion
ASTM D5630 Ashing or ASTM D2584 Loss on Ignition
ISO 18373-1 Differential Scanning Calorimetry (DSC) Method

2.2.3 Cast Iron (CI) and Ductile Iron (DI)

The monitoring strategy for ferrous metal pipes such as cast iron and ductile iron could predominantly focus on monitoring pipe corrosion. Because many of the vulnerable cohorts of ferrous metal mains identified in utility corridors for replacement, the focus of the asset-level condition assessment plan for ferrous metal mains can only focus on the Major Risk category. For pipes where advanced condition assessment to be used, **Table 6** provides the staged approach to condition assessment for both internal and external corrosion assessment.

Table 6: Assessment Levels for Ferrous Pipes

Assessment Observations	Assessment Stage	Assessment Technique	Approximate Cost
Internal Corrosion: Unlined Pipes	Stage I	Transient and Air Handling Assessment	$3,000 per pump station, or $6,500 per valve chamber, plus desktop analysis costs.
	Stage III	Hydraulic Flow Tests	$9,600 per pump station.
Internal Corrosion: Lining Failure	Stage I	CCTV	$10,000 per day, plus $17,000 per inspection.
External Corrosion	Stage II	Excavation and Non-destructive testing (random)	$24,000 per site
	Stage III	Excavation and Non-destructive testing (targeted)	$24,000 per site
	Stage III	Leak detection	$25/meter for <400 mm pipes $27,000 per survey plus $10 per meter plus $10/m for pipes >400 mm
	Stage III	Pure Pipe Diver Metallic Platform	$90,000 per inspection plus $55 per meter
	Stage IV	Continuous ultrasonic testing	$46,500 for 3 days, plus $15,000 per inspection.
	Stage IV	Electromagnetic Remote Eddy Field Current / MFL	$25,000/day, plus $46,000 per inspection

2.2.4 Concrete Cylinder Pipe

The failure of concrete pressure pipe is a function of PUC's potential risk exposure based on design standards of the day of construction. In the network, concrete pressure pipelines are made of SSP-381 (which is the early specification name for what is now AWWA C-303) and C-301. Although there is minimal research done comparing C-303 and C-301 concrete pressure failures, experience has revealed that the failure mechanism of C-303 is relatively similar to steel pipes and that some degradation warnings would precede any failures (assuming C-301 and C-303 are buried in the same environment). Vintages of

C-301 in 1964 to 1984 of CL-14 and CL-16 are relatively more vulnerable and therefore it would be recommended to prioritize assessing critical sections in C-301 over C-303.

The aging and deterioration of these wires will serve as the focus for condition assessment, as depicted in **Table 7**. Broken wire zones are typically localized, meaning that identification of a zone can allow for significant cost savings if a pipe failure is circumvented.

Table 7: Assessment Levels for Pre-Stressed Concrete Cylinder Pipe

Assessment Observations	Assessment Stage	Assessment Technique	Approximate Cost
External Corrosion and Wire Breaking	Stage II	Excavation and non-destructive testing (random)	$2,500 per pipe plus $13,000 per inspection
Internal/External	Stage III	Leak detection	$25/meter for <400 mm pipes $27,000 per survey plus $10 per meter plus $10/m for pipes >400 mm
	Stage IV	Electromagnetic Remote Eddy Field Current	$60/m plus $100,000 per inspection

High diameter concrete mains under pressure are among the highest consequence of failure assets due to their size and failure mode. Recommendations for the inspection of these assets are in line with the recommendations for the overall program – pressurized concrete mains will be among those with the highest priority for condition assessment screening due to (1) their high consequence of failure and (2) their unknown condition state.

Appendix G

Pipes with High Density of Lead/Galvanized Services

Lead/Galvanized

High Scores of Lead/Galvanized

Others

0 0.15 0.3 0.6 Kilometers

Drinking Water
Asset Management Plan

6/23/2021		Datum - UTM 1983 Z16 Source - GCS NA 1983
P#:	V#:	**Lead/ Galvanized**
AECOM		

Map location: C:\Users\khalid.kaddoura\Desktop\PUC\Lead-Galvanized Pipes.mxd
Date Saved: 6/23/2021 1:22:52 PM

Watermain ID	Material	Diameter (mm)	Length (mm)	Install Year	Total Cost
29	CI	150	108.2	1968	$173,165
554	CI	100	115.6	1910	$184,952
567	DI	150	54.7	1986	$87,528
575	CI	300	13.3	1910	$21,221
615	CI	100	81.5	1944	$130,348
723	CI	150	40.2	1906	$64,284
724	DI	200	34.3	1973	$54,858
737	CI	150	3.2	1906	$5,086
760	CI	400	59.0	1910	$94,368
789	CI	100	51.8	1906	$82,832
795	CI	150	21.3	1906	$34,137
872	CI	100	60.8	1910	$97,321
875	CI	250	98.5	1927	$266,015
886	CI	100	26.0	1906	$41,522
910	CI	150	52.0	1959	$83,241
958	CI	100	15.0	1931	$23,960
981	CI	150	78.0	1907	$124,847
1009	CI	150	95.1	1900	$152,218
1030	DI	150	29.1	1975	$46,629
1100	CI	150	78.8	1909	$126,154
1161	CI	100	92.6	1910	$148,103
1166	DI	150	33.9	1984	$54,201
1178	DI	200	59.3	1974	$94,927
1252	CI	150	68.5	1902	$109,643
1257	CI	150	23.3	1902	$37,228
1260	CI	150	84.2	1902	$134,721
1408	CI	100	81.2	1931	$129,842
1449	CI	150	27.0	1900	$43,275
1498	CI	100	133.0	1939	$212,834
1522	DI	150	144.1	1973	$230,504
1692	DI	300	7.9	1987	$21,247
1696	CI	300	33.6	1905	$90,796
1718	DI	200	126.7	1975	$342,039
1745	PVC	200	12.4	1998	$19,824
1824	DI	150	64.1	1970	$173,085
1878	CI	250	10.2	1927	$16,248
1965	CI	200	37.3	1927	$59,602
1969	CI	150	90.3	1900	$243,878
2011	CI	250	84.8	1927	$228,853
2037	CI	200	43.4	1927	$117,208
2040	CI	300	43.7	1967	$117,973
2047	CI	300	27.3	1967	$73,797
2048	CI	250	71.4	1927	$192,671
2073	CI	200	73.5	1923	$198,354
2108	CI	300	4.2	1967	$6,767
2123	CI	200	120.7	1969	$325,795
2167	CI	250	43.1	1927	$116,447
2212	CI	150	44.2	1900	$119,237
2239	CI	100	112.0	1930	$302,449
2283	DI	200	12.0	1975	$32,369
2353	CI	250	71.3	1927	$192,580
2356	PVC	150	5.0	1993	$13,513
2412	CI	250	65.9	1927	$178,002
2461	CI	300	79.6	1905	$127,311

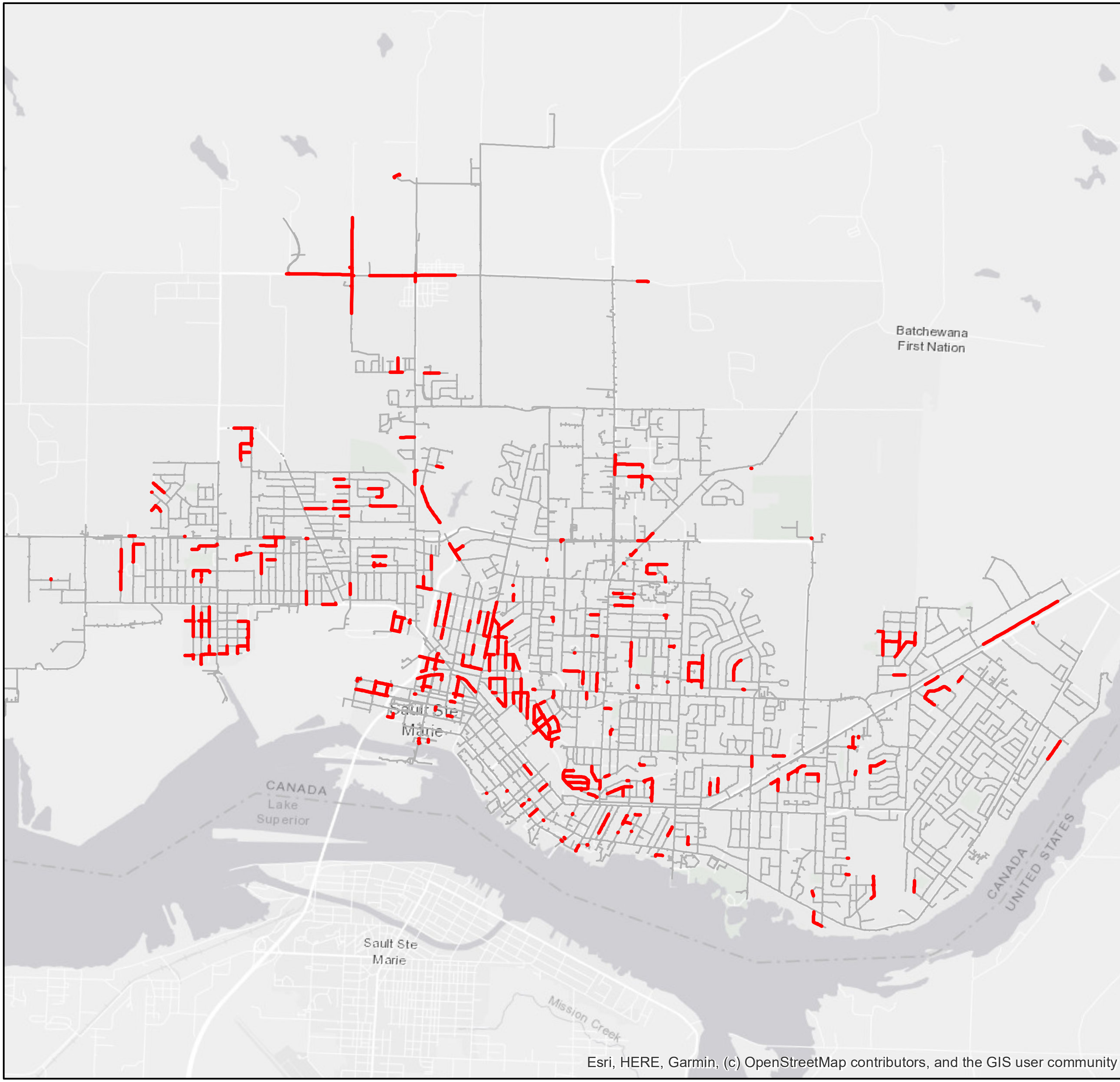
Watermain ID	Material	Diameter (mm)	Length (mm)	Install Year	Total Cost
2564	CI	200	26.6	1900	$71,852
2583	CI	200	33.8	1927	$91,223
2602	CI	300	53.1	1967	$143,497
2612	CI	250	26.0	1927	$70,128
2646	DI	200	9.1	1975	$14,627
2662	CI	200	22.4	1924	$60,427
2737	CI	200	71.2	1923	$192,207
2934	CI	150	59.8	1914	$95,684
3199	DI	150	30.8	1970	$49,247
3228	DI	150	14.3	1972	$22,917
3237	CI	200	26.3	1950	$42,128
3346	CI	150	14.7	1959	$23,455
3401	CI	150	57.3	1914	$91,711
4271	DI	200	25.1	1971	$40,175
4539	CI	200	57.1	1919	$91,420
5514	DI	200	11.0	1985	$17,590
5973	CI	300	34.2	1966	$54,748
6142	CI	150	25.6	1963	$40,984
6150	DI	300	19.1	1985	$30,519
7455	CI	200	33.2	1942	$53,085
8031	CI	100	16.5	1919	$26,392
8411	CI	150	12.0	1953	$19,180
8701	CI	100	16.2	1911	$25,905
8742	DI	200	14.0	1976	$22,401
9217	CI	150	28.8	1959	$46,119
9249	CI	300	94.8	1952	$151,669
9774	CI	150	11.0	1945	$17,616
9932	AC	150	4.1	1955	$6,628
10005	CI	200	59.6	1913	$95,352
10016	CI	150	3.9	1969	$6,281
10023	DI	200	5.8	1974	$9,202
10070	CI	150	66.9	1957	$107,009
10137	CI	100	5.3	1918	$8,441
10191	CI	150	42.6	1946	$68,203
10246	CI	150	70.0	1966	$111,978
10254	CI	150	3.4	1967	$5,376
10349	CI	150	59.3	1966	$94,882
10365	CI	150	18.3	1935	$29,260
10432	DI	150	60.0	1978	$96,055
10448	CI	200	13.7	1913	$21,872
10499	CI	300	70.7	1905	$113,185
10526	CI	150	90.8	1906	$145,349
10622	CI	200	118.4	1956	$189,480
10679	CI	150	3.7	1915	$5,877
10767	CI	150	73.9	1912	$118,195
10819	CI	150	28.0	1963	$44,817
10918	DI	150	23.2	1978	$37,200
11010	CI	150	65.5	1966	$104,856
11067	CI	150	9.9	1955	$15,769
11194	CI	150	82.4	1935	$131,886
11266	CI	100	12.3	1969	$19,644
11274	CI	150	68.5	1940	$109,588
11312	DI	150	61.9	1986	$98,993
11314	CI	150	98.5	1906	$157,550

Watermain ID	Material	Diameter (mm)	Length (mm)	Install Year	Total Cost
11403	DI	150	23.8	1978	$38,132
11428	DI	100	47.2	1981	$75,507
11485	DI	150	6.4	1978	$10,246
11609	CI	150	79.1	1922	$126,606
11632	DI	200	86.9	1985	$138,969
11684	CI	150	19.7	1906	$31,466
11699	CI	100	67.0	1920	$107,200
11738	CI	150	13.2	1955	$21,125
11904	CI	100	47.6	1940	$76,239
11953	CI	100	145.3	1955	$232,514
12087	CI	150	41.6	1946	$66,545
12280	CI	100	12.3	1906	$19,730
12356	CI	150	32.0	1969	$51,200
12467	CI	150	118.1	1953	$189,002
12488	CI	150	14.4	1968	$22,978
12531	CI	150	23.6	1962	$37,747
12533	CI	150	31.2	1965	$49,890
12611	CI	300	22.8	1966	$36,450
12629	DI	300	59.2	1976	$94,667
12808	CI	300	72.9	1967	$116,591
12991	DI	150	90.5	1971	$144,818
13130	CI	300	48.6	1942	$77,737
13167	CI	150	92.7	1969	$148,384
13207	CI	150	73.2	1967	$117,153
13342	CI	150	99.5	1949	$159,182
13431	CI	250	72.2	1941	$115,471
13453	CI	150	77.1	1966	$123,366
13454	CI	300	119.2	1958	$190,772
13506	DI	150	54.1	1974	$86,617
13545	CI	250	31.9	1950	$51,048
13769	CI	150	34.3	1949	$54,941
13947	CI	300	75.2	1944	$120,390
14014	CI	150	6.0	1954	$9,658
14024	CI	300	121.8	1958	$194,852
14165	CI	250	75.0	1950	$119,961
14321	PVC	150	66.8	1995	$106,954
14354	CI	150	70.8	1966	$113,318
14399	CI	150	57.6	1940	$92,168
14544	CI	300	82.3	1966	$131,673
14584	CI	150	13.0	1958	$20,808
14641	CI	300	38.3	1944	$61,221
14854	CI	300	91.4	1958	$146,239
14910	CI	150	93.0	1950	$148,821
15092	CI	150	80.8	1940	$129,320
15096	CI	150	94.2	1950	$150,784
15106	CI	200	94.5	1967	$151,127
15194	CI	150	74.4	1966	$119,094
15314	CI	300	159.1	1958	$254,492
15324	DI	150	106.2	1972	$169,993
15412	DI	150	85.1	1971	$136,157
15507	CI	150	75.6	1949	$120,967
15537	CI	150	32.0	1969	$51,184
15642	CI	250	79.0	1954	$126,321
15692	CI	300	152.7	1969	$244,360

Watermain ID	Material	Diameter (mm)	Length (mm)	Install Year	Total Cost
17000	DI	150	65.1	1974	$104,122
17001	CI	200	11.0	1947	$17,526
17282	CI	150	5.6	1966	$8,904
65351	CI	400	16.1	1920	$25,722
67902	CI	250	96.9	1910	$261,684
73038	CI	150	5.5	1969	$8,767
75216	CI	250	11.3	1927	$30,548
78377	PVC	250	15.7	2006	$25,144
78526	PVC	150	2.0	2006	$3,128
81858	CI	100	7.5	1915	$20,356
84412	CI	150	25.2	1955	$40,317
85549	CI	150	5.1	1954	$8,090
91040	CI	300	56.0	1905	$89,642
91700	CI	200	13.7	1967	$21,942
92042	PVC	300	11.3	2009	$30,540
92064	PVC	300	9.1	2009	$24,459
94500	CI	150	36.6	1920	$58,553
105985	PVC	200	7.3	2012	$11,614
108853	PVC	300	34.3	2012	$54,936
128583	PVC	300	4.8	2013	$7,679
132186	DI	200	5.4	1974	$8,643
137016	CI	200	11.7	1949	$18,695
155693	CI	400	17.5	1910	$27,964

Appendix H

Pipes with Higher % Difference of 20 or More than Minimum FF



FF Score

High FF Score

Others

0 0.4 0.8 1.6 Kilometers

Drinking Water
Asset Management Plan

6/23/2021		Datum - UTM 1983 Z16 Source - GCS NA 1983
P#:	V#:	**FF Criteria**

AECOM

Map location: C:\Users\khalid.kaddoura\Desktop\PUC\FF Pipes.mxd
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Watermain ID	Material	Diameter (mm)	Length (mm)	Install Year	Total Cost
13	CI	150	4.3	1968	$6,815
299	CI	150	6.0	1968	$9,606
554	CI	100	115.6	1910	$184,952
567	DI	150	54.7	1986	$87,528
574	CI	150	101.2	1902	$161,912
588	CI	150	9.3	1930	$14,916
590	DI	150	28.1	1983	$44,936
615	CI	100	81.5	1944	$130,348
657	CI	100	51.7	1939	$82,771
662	CI	100	16.6	1931	$26,567
688	CI	150	0.2	1902	$387
693	CI	100	91.0	1910	$145,576
694	CI	150	51.4	1900	$82,210
696	CI	100	13.2	1906	$21,123
703	CI	150	48.1	1906	$76,912
704	CI	150	1.2	1902	$1,997
705	CI	150	2.1	1902	$3,390
731	CI	150	11.3	1900	$18,059
737	CI	150	3.2	1906	$5,086
744	CI	100	85.0	1902	$135,978
747	CI	150	17.0	1930	$27,183
779	CI	100	2.7	1969	$4,289
780	CI	100	9.8	1919	$15,652
789	CI	100	51.8	1906	$82,832
829	CI	150	36.4	1900	$58,251
852	CI	100	75.5	1919	$120,798
862	DI	150	10.5	1973	$16,753
865	CI	150	17.8	1969	$28,516
872	CI	100	60.8	1910	$97,321
886	CI	100	26.0	1906	$41,522
887	DI	150	8.6	1973	$13,727
900	CI	150	5.5	1906	$8,726
932	DI	150	2.0	1973	$3,172
935	CI	150	53.3	1900	$85,349
941	CI	150	20.3	1930	$32,516
942	CI	100	36.4	1910	$58,185
944	CI	150	16.5	1930	$26,439
946	DI	200	3.6	1981	$5,712
957	CI	100	17.1	1931	$27,412
958	CI	100	15.0	1931	$23,960
963	CI	150	16.2	1905	$25,879
968	CI	150	13.0	1930	$20,866
1006	CI	100	14.9	1919	$23,819
1013	CI	150	7.8	1927	$12,529
1029	CI	150	6.7	1900	$10,735
1044	CI	100	5.6	1931	$8,962
1053	CI	100	7.8	1910	$12,545
1057	CI	100	4.2	1939	$6,678
1082	CI	150	1.2	1927	$1,919
1102	CI	100	61.8	1906	$98,905
1104	CI	100	60.9	1906	$97,491
1109	CI	100	12.3	1906	$19,691
1112	CI	100	1.4	1910	$2,292
1141	CI	100	23.1	1906	$36,920

Watermain ID	Material	Diameter (mm)	Length (mm)	Install Year	Total Cost
1143	DI	150	7.9	1973	$12,708
1159	DI	150	1.2	1973	$1,992
1166	DI	150	33.9	1984	$54,201
1194	CI	100	165.0	1906	$263,928
1201	DI	200	3.0	1981	$4,759
1228	CI	100	134.0	1931	$214,447
1229	CI	100	5.1	1930	$8,171
1255	CI	100	13.1	1906	$20,961
1259	DI	150	2.2	1986	$3,579
1275	DI	150	18.0	1984	$28,778
1287	CI	100	2.2	1944	$3,546
1291	DI	200	3.0	1981	$4,743
1304	CI	100	1.1	1906	$1,806
1311	CI	100	7.2	1910	$11,506
1319	CI	100	4.1	1906	$6,635
1321	DI	200	2.7	1981	$4,360
1325	DI	200	4.4	1981	$7,012
1341	CI	150	19.8	1930	$31,694
1345	DI	200	1.0	1981	$1,596
1349	CI	100	7.3	1910	$11,737
1363	CI	150	42.1	1905	$67,283
1366	CI	150	18.3	1902	$29,360
1371	CI	100	36.4	1906	$58,181
1395	CI	150	16.2	1930	$25,845
1404	CI	150	14.1	1930	$22,541
1408	CI	100	81.2	1931	$129,842
1418	CI	150	1.8	1930	$2,933
1439	CI	150	1.2	1969	$1,998
1449	CI	150	27.0	1900	$43,275
1457	CI	150	134.2	1905	$214,714
1461	CI	100	121.5	1931	$194,453
1469	CI	100	9.3	1939	$14,825
1509	CI	150	9.0	1969	$14,473
1512	CI	100	8.2	1906	$13,089
1519	CI	100	25.5	1910	$40,808
1531	CI	100	3.0	1910	$4,781
1535	DI	150	98.4	1973	$157,499
1545	CI	150	136.7	1927	$218,727
1548	CI	150	49.6	1919	$79,352
1549	CI	150	99.5	1900	$159,172
1584	CI	150	93.5	1902	$149,523
1673	CI	100	123.0	1927	$332,086
1691	CI	100	136.2	1919	$367,678
1908	CI	150	23.6	1910	$63,804
1947	CI	100	62.9	1927	$100,569
1950	CI	100	1.2	1919	$1,856
2091	CI	100	3.4	1900	$9,146
2196	CI	100	4.4	1900	$11,882
2239	CI	100	112.0	1930	$302,449
2399	CI	100	10.6	1927	$16,994
2603	CI	100	0.9	1927	$1,420
2672	DI	100	1.8	1973	$2,804
2775	DI	150	37.3	1977	$59,690
2779	CI	100	1.5	1900	$2,448

Watermain ID	Material	Diameter (mm)	Length (mm)	Install Year	Total Cost
2804	CI	150	9.2	1961	$14,666
2883	CI	150	1.6	1961	$2,489
2895	CI	150	11.2	1957	$17,964
2922	PVC	150	3.8	1999	$6,071
2942	CI	150	119.1	1956	$190,579
2977	CI	150	114.7	1964	$183,560
3060	DI	150	44.4	1987	$71,047
3117	CI	150	10.8	1957	$17,212
3185	CI	150	62.9	1949	$100,648
3220	CI	150	51.8	1957	$82,902
3251	CI	150	18.5	1921	$29,546
3257	CI	150	116.9	1945	$187,027
3276	CI	100	44.6	1956	$71,348
3280	CI	100	28.0	1939	$44,787
3283	CI	100	37.0	1939	$59,245
3315	CI	150	9.7	1949	$15,581
3322	CI	150	16.1	1959	$25,691
3376	CI	150	113.7	1914	$181,978
3401	CI	150	57.3	1914	$91,711
3464	CI	150	12.1	1956	$19,281
3466	CI	150	22.3	1959	$35,671
3468	CI	150	81.6	1959	$130,592
3478	CI	150	5.5	1959	$8,726
3543	CI	150	13.1	1957	$20,969
3552	CI	150	59.6	1959	$95,400
3580	CI	150	86.1	1946	$137,744
3629	CI	150	1.9	1964	$2,991
3659	CI	150	1.8	1959	$2,880
3710	CI	150	68.5	1957	$109,663
3759	CI	100	16.2	1956	$25,878
3773	CI	150	50.6	1957	$81,032
3797	CI	150	8.1	1959	$13,017
3838	CI	100	77.1	1921	$123,423
3945	CI	150	5.3	1956	$8,424
3950	CI	150	10.6	1959	$16,993
3956	CI	150	117.5	1957	$188,056
3995	CI	150	6.3	1946	$10,089
4067	PVC	200	1.3	2018	$2,093
4075	CI	150	113.1	1949	$180,911
4136	CI	150	3.6	1946	$5,767
4297	CI	150	77.5	1939	$123,936
4333	PVC	150	0.8	1999	$1,306
4418	PVC	200	1.0	2018	$1,656
4429	CI	150	8.4	1959	$13,472
4442	PVC	200	11.0	2018	$17,587
4459	CI	150	18.7	1914	$29,995
4463	CI	150	49.9	1949	$79,810
4544	CI	150	33.0	1959	$52,838
4561	CI	150	58.0	1959	$92,806
4563	CI	150	107.6	1959	$172,140
4584	CI	150	133.2	1959	$213,101
4589	CI	150	7.2	1964	$11,515
4698	PVC	150	90.6	1999	$144,975
4950	CI	150	31.5	1966	$50,327

Watermain ID	Material	Diameter (mm)	Length (mm)	Install Year	Total Cost
4952	CI	150	48.5	1968	$77,609
4992	DI	150	60.3	1976	$96,444
5015	DI	150	29.3	1976	$46,859
5109	CI	150	140.7	1955	$225,042
5123	CI	150	111.4	1962	$178,305
5160	DI	150	62.1	1976	$99,311
5190	DI	150	114.2	1976	$182,707
5193	DI	150	79.4	1976	$127,025
5199	DI	150	19.5	1976	$31,210
5258	CI	150	78.0	1966	$124,760
5290	CI	150	12.6	1966	$20,220
5295	CI	150	4.6	1969	$7,319
5296	CI	150	7.0	1966	$11,242
5324	CI	150	10.3	1966	$16,427
5360	DI	150	79.2	1975	$126,725
5364	CI	150	12.9	1966	$20,716
5375	DI	150	26.1	1976	$41,760
5386	CI	150	12.2	1966	$19,510
5396	DI	150	71.3	1970	$114,125
5400	CI	150	9.6	1966	$15,401
5413	CI	150	86.5	1966	$138,442
5432	CI	150	8.0	1966	$12,775
5441	CI	150	11.8	1962	$18,943
5468	CI	150	136.0	1969	$217,609
5471	CI	150	1.0	1966	$1,602
5595	CI	150	1.2	1962	$1,954
5612	CI	150	63.4	1962	$101,498
5620	CI	150	59.0	1965	$94,348
5688	CI	150	2.5	1962	$3,954
5695	CI	150	103.3	1962	$165,293
5719	CI	150	96.9	1968	$155,094
5722	DI	150	62.6	1976	$100,188
5742	DI	150	36.8	1976	$58,838
5745	DI	150	28.8	1976	$46,014
5748	CI	150	18.3	1966	$29,203
5767	DI	150	20.4	1976	$32,681
5821	CI	150	9.8	1962	$15,639
5900	CI	150	104.2	1966	$166,696
6018	CI	150	154.2	1966	$246,693
6060	CI	150	160.7	1962	$257,067
6067	CI	150	89.3	1966	$142,854
6259	DI	150	11.9	1976	$19,063
6279	DI	150	0.6	1976	$997
6794	DI	150	178.6	1973	$285,697
6927	CI	150	52.1	1969	$83,340
7175	DI	150	76.6	1976	$122,492
7250	CI	150	32.8	1969	$52,518
7307	CI	150	7.3	1961	$11,710
7325	CI	150	1.7	1960	$2,754
7399	CI	150	57.1	1919	$91,316
7400	CI	150	13.9	1960	$22,304
7441	CI	150	3.7	1961	$5,876
7459	CI	150	11.5	1960	$18,476
7498	DI	150	16.0	1972	$25,541

Watermain ID	Material	Diameter (mm)	Length (mm)	Install Year	Total Cost
7503	CI	150	100.0	1959	$159,998
7504	PVC	150	81.6	2012	$130,593
7507	CI	150	43.7	1963	$69,903
7517	CI	150	24.2	1941	$38,665
7531	CI	150	119.6	1960	$191,409
7532	CI	150	142.7	1959	$228,267
7567	CI	150	13.5	1960	$21,633
7593	CI	150	27.9	1959	$44,720
7594	CI	150	4.8	1961	$7,719
7598	CI	150	2.8	1960	$4,404
7610	CI	150	57.5	1963	$91,934
7614	CI	150	55.7	1963	$89,117
7617	CI	150	38.0	1959	$60,806
7657	CI	150	18.2	1960	$29,098
7664	CI	100	9.2	1963	$14,773
7678	CI	150	92.4	1961	$147,776
7743	CI	150	59.6	1963	$95,380
7757	DI	150	90.2	1974	$144,376
7764	CI	150	16.5	1960	$26,384
7862	CI	150	4.8	1959	$7,653
7883	CI	150	55.9	1959	$89,488
7985	CI	150	49.0	1956	$78,364
7988	CI	150	109.0	1959	$174,337
8030	CI	100	14.4	1919	$23,070
8039	CI	150	22.6	1959	$36,171
8053	CI	100	159.9	1919	$255,762
8054	CI	100	97.4	1919	$155,769
8056	CI	150	9.1	1963	$14,615
8085	CI	100	7.8	1919	$12,541
8180	CI	150	26.2	1960	$41,980
8208	CI	150	7.7	1960	$12,297
8218	CI	150	99.1	1960	$158,487
8234	PVC	100	69.4	2001	$110,997
8240	CI	100	7.7	1965	$12,254
8281	DI	150	11.3	1974	$18,042
8312	CI	150	11.7	1957	$18,760
8324	PVC	100	53.4	2001	$85,411
8328	DI	150	1.9	1974	$3,076
8348	DI	150	1.3	1974	$2,095
8369	CI	150	4.6	1963	$7,316
8408	CI	150	148.4	1960	$237,476
8418	CI	150	4.2	1960	$6,756
8424	CI	150	117.7	1957	$188,241
8447	CI	150	73.1	1960	$116,983
8503	CI	150	76.1	1956	$121,776
8516	CI	150	53.5	1960	$85,666
8579	CI	150	6.5	1957	$10,360
8583	CI	150	12.3	1957	$19,641
8615	CI	150	38.2	1957	$61,197
8616	CI	150	113.0	1960	$180,864
8618	CI	150	109.2	1960	$174,753
8670	CI	150	152.4	1961	$243,920
8724	CI	150	78.7	1956	$125,846
8784	CI	150	58.6	1961	$93,788

Watermain ID	Material	Diameter (mm)	Length (mm)	Install Year	Total Cost
8856	CI	150	205.3	1961	$328,541
8881	CI	150	83.7	1960	$133,998
8923	CI	150	85.8	1957	$137,270
9001	CI	150	8.7	1957	$13,897
9024	CI	150	33.5	1960	$53,598
9030	CI	150	24.2	1960	$38,740
9032	CI	150	5.5	1957	$8,790
9091	CI	150	25.8	1961	$41,299
9125	CI	100	52.9	1919	$84,661
9137	DI	150	22.9	1977	$36,677
9143	DI	150	19.1	1977	$30,572
9221	DI	150	20.0	1977	$31,955
9283	PVC	150	20.7	2012	$33,089
9319	CI	150	92.9	1960	$148,693
9366	CI	150	37.9	1960	$60,608
9420	DI	150	30.3	1972	$48,520
9460	CI	150	71.3	1961	$114,074
9481	PVC	200	2.7	1999	$4,355
9518	CI	150	11.7	1959	$18,708
9578	CI	150	15.0	1960	$23,949
9580	CI	150	14.2	1960	$22,762
9583	CI	150	1.4	1961	$2,275
9635	CI	100	12.7	1919	$20,353
9655	DI	150	2.1	1972	$3,428
9660	CI	150	8.0	1959	$12,798
9663	DI	150	6.5	1972	$10,376
9664	DI	100	4.8	1972	$7,738
9674	CI	150	82.1	1961	$131,342
9687	CI	150	1.4	1961	$2,258
9701	CI	150	35.8	1945	$57,355
9704	CI	150	45.2	1956	$72,323
9706	CI	150	2.5	1961	$3,987
9724	CI	100	35.4	1919	$56,682
9752	CI	150	5.9	1956	$9,485
9774	CI	150	11.0	1945	$17,616
9776	CI	100	1.2	1919	$1,906
9804	CI	150	4.7	1956	$7,513
9807	CI	150	15.3	1945	$24,516
9808	CI	150	86.7	1960	$138,753
9913	CI	150	15.8	1960	$25,323
10002	CI	150	94.1	1963	$150,570
10003	CI	100	56.2	1918	$89,871
10005	CI	200	59.6	1913	$95,352
10007	CI	100	69.0	1912	$110,355
10038	CI	100	13.3	1920	$21,251
10049	CI	150	13.4	1946	$21,452
10050	CI	150	15.6	1959	$25,035
10054	CI	150	8.4	1956	$13,391
10058	CI	100	5.8	1940	$9,223
10105	CI	150	114.7	1906	$183,564
10108	PVC	150	13.0	2012	$20,817
10109	CI	100	66.9	1936	$107,047
10112	CI	300	11.2	1905	$17,955
10126	CI	100	15.8	1940	$25,237

Watermain ID	Material	Diameter (mm)	Length (mm)	Install Year	Total Cost
10134	CI	100	39.1	1936	$62,612
10153	CI	100	14.5	1924	$23,273
10156	CI	100	8.5	1957	$13,584
10171	CI	150	39.2	1963	$62,685
10191	CI	150	42.6	1946	$68,203
10213	CI	150	119.9	1908	$191,775
10217	PVC	200	1.4	1996	$2,195
10223	CI	150	93.9	1920	$150,287
10224	CI	100	64.4	1915	$102,965
10231	CI	150	2.1	1915	$3,299
10239	CI	100	143.6	1935	$229,767
10241	CI	150	13.7	1951	$21,934
10255	CI	100	1.5	1924	$2,433
10288	CI	100	79.9	1914	$127,920
10312	CI	150	102.8	1946	$164,427
10330	CI	100	167.4	1914	$267,826
10331	CI	100	8.4	1935	$13,389
10375	CI	150	22.9	1908	$36,680
10387	CI	150	16.2	1963	$25,971
10394	CI	100	121.6	1910	$194,584
10400	CI	150	39.2	1915	$62,696
10401	CI	150	51.2	1915	$81,903
10417	CI	150	77.7	1956	$124,317
10425	CI	150	25.3	1912	$40,547
10434	CI	100	29.0	1921	$46,339
10436	PVC	150	5.3	2012	$8,524
10437	CI	100	43.6	1918	$69,827
10448	CI	200	13.7	1913	$21,872
10453	CI	100	71.2	1960	$113,963
10463	CI	100	77.9	1911	$124,615
10484	CI	100	6.2	1918	$9,926
10492	CI	100	1.4	1918	$2,277
10498	CI	300	73.6	1905	$117,729
10508	CI	100	2.8	1912	$4,480
10517	CI	150	12.7	1920	$20,264
10543	CI	150	36.5	1968	$58,350
10546	CI	100	160.5	1935	$256,723
10549	CI	150	31.7	1965	$50,735
10583	CI	150	5.2	1912	$8,343
10585	CI	150	5.6	1912	$8,913
10684	CI	150	121.0	1906	$193,614
10699	CI	100	11.9	1935	$18,978
10703	CI	300	91.4	1905	$146,293
10732	CI	100	73.6	1940	$117,703
10745	CI	150	67.1	1910	$107,406
10746	CI	100	118.2	1913	$189,081
10762	CI	100	131.9	1935	$211,110
10764	CI	150	102.0	1956	$163,149
10767	CI	150	73.9	1912	$118,195
10774	CI	100	51.8	1930	$82,880
10839	CI	100	114.4	1918	$182,970
10905	CI	100	44.1	1955	$70,494
10914	CI	150	115.5	1966	$184,853
11001	CI	150	12.0	1955	$19,220

Watermain ID	Material	Diameter (mm)	Length (mm)	Install Year	Total Cost
11019	DI	150	160.9	1990	$257,398
11030	CI	150	125.5	1910	$200,751
11053	CI	100	61.3	1940	$98,074
11059	CI	150	108.7	1969	$173,871
11063	CI	150	109.2	1948	$174,767
11067	CI	150	9.9	1955	$15,769
11095	CI	300	10.3	1905	$16,473
11096	CI	100	2.5	1955	$4,003
11100	CI	150	8.8	1955	$14,077
11117	CI	100	41.0	1966	$65,571
11133	PVC	100	59.1	1993	$94,489
11145	CI	150	75.3	1946	$120,553
11146	CI	100	149.1	1966	$238,608
11158	CI	100	13.6	1918	$21,747
11165	CI	150	10.9	1922	$17,504
11177	CI	150	13.1	1931	$20,933
11186	CI	150	6.7	1931	$10,667
11196	CI	100	76.0	1914	$121,598
11233	DI	150	7.7	1988	$12,359
11234	CI	150	63.7	1927	$101,896
11241	CI	150	0.5	1956	$792
11266	CI	100	12.3	1969	$19,644
11274	CI	150	68.5	1940	$109,588
11279	CI	150	79.4	1969	$127,060
11283	CI	100	55.2	1936	$88,394
11290	PVC	100	72.5	1999	$115,975
11291	CI	100	31.1	1912	$49,734
11299	CI	100	9.5	1906	$15,124
11306	CI	100	26.3	1920	$42,129
11360	CI	100	4.1	1949	$6,612
11404	CI	200	63.3	1913	$101,306
11419	CI	100	44.0	1912	$70,404
11426	CI	100	65.0	1912	$103,923
11437	CI	150	134.2	1935	$214,726
11449	CI	100	13.1	1913	$21,022
11451	CI	150	13.0	1935	$20,783
11454	CI	100	53.6	1910	$85,767
11477	CI	100	133.8	1969	$214,106
11487	CI	100	1.2	1920	$1,898
11489	CI	150	27.8	1963	$44,559
11498	CI	150	8.6	1912	$13,774
11503	CI	100	11.5	1912	$18,436
11552	CI	150	20.7	1906	$33,123
11565	CI	150	41.4	1948	$66,236
11574	CI	100	11.9	1920	$19,034
11579	CI	100	12.4	1913	$19,902
11582	CI	100	71.1	1930	$113,823
11595	CI	150	71.9	1963	$115,095
11599	CI	150	7.9	1940	$12,560
11602	CI	200	10.4	1969	$16,636
11603	CI	100	9.6	1920	$15,281
11606	CI	150	2.4	1963	$3,827
11614	CI	150	1.7	1906	$2,788
11621	CI	300	116.4	1905	$186,315

Watermain ID	Material	Diameter (mm)	Length (mm)	Install Year	Total Cost
11623	CI	100	1.8	1920	$2,884
11624	CI	200	3.1	1969	$4,890
11636	CI	150	66.9	1966	$107,005
11642	CI	100	19.5	1912	$31,255
11657	CI	100	24.3	1966	$38,837
11699	CI	100	67.0	1920	$107,200
11704	CI	150	15.6	1910	$25,013
11725	CI	150	78.3	1915	$125,360
11730	CI	150	144.4	1951	$231,045
11732	CI	150	125.1	1951	$200,240
11733	CI	150	101.9	1968	$163,009
11744	CI	150	125.2	1953	$200,268
11747	CI	150	80.0	1931	$128,002
11751	CI	300	7.0	1905	$11,145
11761	CI	150	26.0	1955	$41,622
11764	CI	150	5.4	1908	$8,704
11791	CI	150	47.9	1946	$76,600
11805	CI	150	13.4	1946	$21,491
11817	CI	150	121.9	1948	$195,069
11819	CI	150	182.4	1946	$291,790
11829	CI	150	33.1	1946	$52,932
11859	CI	100	5.8	1921	$9,226
11861	CI	150	81.8	1956	$130,946
11870	CI	200	32.8	1913	$52,454
11874	CI	100	140.5	1915	$224,761
11877	CI	150	130.1	1912	$208,120
11884	CI	150	120.0	1906	$192,014
11886	CI	150	91.7	1906	$146,676
11896	CI	100	38.6	1930	$61,748
11898	CI	150	2.6	1921	$4,105
11901	CI	100	12.3	1930	$19,658
11904	CI	100	47.6	1940	$76,239
11905	CI	150	49.0	1959	$78,429
11906	CI	100	4.1	1921	$6,526
11907	CI	150	4.6	1915	$7,400
11913	CI	100	93.5	1959	$149,529
11917	CI	150	3.1	1946	$5,037
11921	CI	150	7.4	1921	$11,878
11945	CI	200	22.4	1913	$35,778
11946	CI	200	11.3	1913	$18,049
11953	CI	100	145.3	1955	$232,514
11957	CI	200	17.7	1913	$28,318
11966	PVC	200	58.4	1996	$93,479
11975	CI	100	9.3	1912	$14,886
11978	CI	200	9.9	1913	$15,793
11991	CI	150	153.5	1921	$245,521
11993	CI	100	118.6	1949	$189,703
12015	CI	150	87.5	1949	$140,022
12020	CI	200	2.9	1913	$4,675
12029	CI	150	27.7	1908	$44,242
12033	CI	100	12.8	1940	$20,417
12034	CI	100	12.6	1931	$20,236
12059	CI	100	37.3	1963	$59,734
12060	CI	200	32.1	1913	$51,299

Watermain ID	Material	Diameter (mm)	Length (mm)	Install Year	Total Cost
12072	CI	100	3.4	1935	$5,381
12087	CI	150	41.6	1946	$66,545
12093	CI	100	5.5	1918	$8,792
12094	CI	100	3.7	1918	$5,926
12095	CI	100	3.6	1930	$5,820
12130	PVC	200	17.6	1996	$28,143
12137	PVC	200	0.2	1996	$352
12141	CI	100	153.1	1931	$244,928
12144	PVC	150	0.3	1996	$400
12146	CI	200	85.6	1913	$136,951
12148	CI	100	126.6	1912	$202,545
12151	CI	100	121.1	1912	$193,829
12152	CI	100	181.2	1912	$289,899
12153	DI	150	1.5	1990	$2,402
12154	DI	100	1.3	1990	$2,018
12165	CI	150	13.0	1956	$20,870
12168	CI	100	189.1	1921	$302,581
12188	CI	100	91.9	1906	$147,105
12191	DI	150	2.0	1990	$3,203
12192	CI	100	109.0	1906	$174,349
12195	CI	100	39.3	1915	$62,933
12197	CI	150	87.1	1956	$139,342
12202	CI	100	14.7	1914	$23,460
12203	DI	150	10.5	1990	$16,764
12212	CI	150	8.6	1946	$13,766
12218	CI	200	71.9	1913	$114,971
12223	CI	100	1.6	1914	$2,483
12225	DI	150	1.2	1990	$1,954
12227	DI	100	1.4	1990	$2,209
12233	DI	150	4.0	1990	$6,439
12235	CI	100	10.8	1930	$17,306
12263	CI	150	4.1	1956	$6,628
12275	CI	100	9.5	1906	$15,124
12280	CI	100	12.3	1906	$19,730
12285	CI	100	175.0	1918	$279,981
12287	CI	100	132.3	1906	$211,660
12299	CI	150	119.2	1959	$190,680
12309	CI	150	2.9	1940	$4,720
12310	CI	100	3.7	1908	$5,872
12323	CI	100	10.0	1908	$16,050
12352	DI	100	160.4	1983	$256,677
12374	CI	150	98.1	1954	$157,016
12412	CI	150	75.3	1959	$120,444
12421	CI	150	162.5	1962	$260,045
12458	CI	150	47.0	1953	$75,122
12535	DI	150	105.8	1974	$169,318
12536	CI	150	10.0	1959	$16,066
12570	CI	100	5.5	1954	$8,773
12581	CI	150	16.5	1956	$26,344
12596	CI	150	56.0	1968	$89,602
12600	CI	200	15.5	1968	$24,786
12651	PVC	200	27.5	1996	$43,964
12653	PVC	200	17.2	1996	$27,520
12670	CI	150	14.9	1945	$23,810

Watermain ID	Material	Diameter (mm)	Length (mm)	Install Year	Total Cost
12678	CI	150	13.3	1944	$21,355
12695	CI	150	2.5	1945	$4,008
12703	CI	100	59.5	1954	$95,263
12729	CI	150	4.1	1954	$6,499
12759	CI	150	2.6	1954	$4,171
12772	DI	150	123.5	1982	$197,648
12773	DI	150	98.2	1974	$157,113
12778	CI	150	5.5	1945	$8,727
12786	CI	100	8.0	1954	$12,732
12836	CI	150	6.5	1967	$10,396
12850	CI	100	2.0	1954	$3,197
12883	CI	150	8.6	1966	$13,763
12901	DI	150	33.7	1978	$53,989
12959	DI	150	73.0	1972	$116,742
12961	PVC	150	68.4	1995	$109,462
12964	DI	150	45.3	1972	$72,401
13000	CI	150	148.7	1969	$237,841
13094	CI	150	173.1	1954	$276,985
13097	CI	150	94.7	1969	$151,529
13106	DI	150	20.6	1972	$33,016
13155	DI	150	15.8	1978	$25,357
13169	CI	150	17.0	1969	$27,264
13218	DI	150	6.8	1974	$10,838
13221	DI	150	5.1	1971	$8,192
13248	CI	200	16.6	1968	$26,554
13254	CI	150	11.4	1949	$18,161
13269	CI	150	155.5	1959	$248,864
13341	CI	250	29.7	1964	$47,472
13354	CI	100	121.8	1906	$194,879
13373	DI	150	32.0	1974	$51,265
13389	CI	150	144.9	1965	$231,918
13392	CI	150	145.3	1965	$232,426
13403	CI	150	56.9	1966	$90,999
13404	CI	150	58.7	1968	$93,964
13413	CI	100	77.2	1906	$123,564
13432	CI	150	108.5	1951	$173,661
13436	CI	150	125.1	1919	$200,115
13437	DI	150	152.6	1972	$244,128
13449	CI	150	99.3	1966	$158,931
13458	DI	150	29.4	1972	$47,089
13506	DI	150	54.1	1974	$86,617
13530	CI	150	27.4	1969	$43,845
13531	CI	200	49.9	1968	$79,799
13532	CI	200	60.1	1968	$96,195
13536	CI	150	77.6	1949	$124,095
13590	CI	150	22.1	1962	$35,298
13604	CI	100	87.0	1954	$139,216
13613	CI	150	11.9	1922	$19,022
13627	CI	150	45.4	1951	$72,616
13636	CI	150	22.7	1922	$36,367
13672	CI	150	8.8	1922	$14,025
13729	CI	150	97.3	1949	$155,662
13744	PVC	150	21.0	1995	$33,591
13745	PVC	150	17.0	1995	$27,214

Watermain ID	Material	Diameter (mm)	Length (mm)	Install Year	Total Cost
13769	CI	150	34.3	1949	$54,941
13786	DI	150	67.6	1978	$108,115
13787	CI	150	165.3	1954	$264,427
13806	DI	200	38.1	1980	$60,961
13810	CI	150	5.5	1968	$8,822
13846	CI	150	8.6	1966	$13,746
13861	CI	150	8.6	1968	$13,811
13868	DI	150	12.3	1972	$19,728
13932	PVC	200	2.5	1995	$4,009
13940	DI	150	148.4	1979	$237,387
13950	DI	150	22.0	1978	$35,121
13956	DI	200	16.8	1980	$26,826
13977	CI	150	45.0	1954	$71,998
13980	CI	100	78.5	1954	$125,576
13988	PVC	200	2.2	1995	$3,591
14000	DI	150	34.0	1974	$54,406
14013	PVC	200	14.3	1995	$22,880
14030	DI	200	53.3	1980	$85,306
14046	DI	150	19.6	1988	$31,395
14071	CI	150	127.6	1962	$204,154
14087	CI	150	139.2	1945	$222,669
14102	CI	150	33.5	1962	$53,677
14104	CI	150	137.0	1956	$219,190
14111	DI	200	5.8	1980	$9,200
14130	PVC	200	2.8	1995	$4,537
14135	DI	200	48.8	1980	$78,025
14144	CI	200	5.7	1968	$9,156
14170	CI	150	5.8	1967	$9,226
14176	CI	150	31.9	1966	$51,108
14182	CI	150	65.5	1962	$104,797
14197	CI	150	37.2	1949	$59,544
14200	CI	150	27.3	1949	$43,601
14228	CI	150	9.5	1950	$15,247
14229	DI	150	10.0	1988	$15,990
14232	CI	150	6.1	1968	$9,750
14236	CI	100	10.4	1906	$16,680
14237	CI	100	8.5	1906	$13,617
14251	CI	150	1.5	1949	$2,444
14256	CI	150	1.8	1967	$2,919
14260	CI	150	10.8	1962	$17,328
14275	CI	150	12.6	1953	$20,095
14296	CI	150	8.2	1962	$13,188
14306	CI	150	3.1	1953	$5,019
14310	DI	150	6.5	1988	$10,386
14316	CI	150	17.6	1962	$28,090
14357	CI	150	29.4	1968	$47,020
14379	CI	150	30.9	1962	$49,377
14390	CI	150	37.5	1968	$59,993
14407	PVC	150	20.7	1995	$33,176
14425	PVC	150	6.0	1995	$9,610
14432	CI	150	55.4	1912	$88,670
14435	CI	150	20.3	1953	$32,412
14477	CI	150	5.5	1968	$8,764
14487	CI	200	5.8	1968	$9,270

Watermain ID	Material	Diameter (mm)	Length (mm)	Install Year	Total Cost
14499	CI	150	5.5	1968	$8,772
14518	CI	100	5.9	1906	$9,374
14526	CI	100	15.5	1958	$24,836
14534	CI	150	5.5	1968	$8,782
14567	DI	200	3.4	1980	$5,415
14593	CI	100	9.9	1906	$15,764
14625	DI	150	10.0	1988	$15,995
14631	CI	150	2.4	1968	$3,770
14664	DI	150	4.5	1984	$7,271
14668	CI	150	97.4	1964	$155,864
14698	DI	150	12.2	1978	$19,489
14700	DI	150	64.1	1982	$102,592
14742	DI	150	100.7	1974	$161,162
14744	DI	150	81.0	1984	$129,650
14749	PVC	200	65.7	1996	$105,150
14755	CI	150	105.2	1969	$168,323
14760	CI	150	179.5	1954	$287,129
14764	CI	150	82.1	1954	$131,414
14766	CI	150	87.4	1969	$139,906
14769	CI	100	16.9	1954	$26,997
14776	CI	150	49.1	1969	$78,532
14778	CI	150	76.6	1954	$122,639
14794	CI	100	8.0	1954	$12,868
14827	PVC	250	96.1	1995	$153,796
14834	CI	150	64.3	1953	$102,834
14853	CI	150	74.2	1966	$118,790
14912	DI	150	162.8	1971	$260,492
14920	CI	100	89.8	1906	$143,749
14959	PVC	200	12.9	1996	$20,718
14976	PVC	200	4.5	1996	$7,175
15010	CI	100	11.0	1906	$17,561
15032	CI	200	1.9	1962	$3,088
15058	CI	100	143.1	1906	$228,905
15068	CI	150	146.6	1969	$234,571
15075	DI	150	54.3	1980	$86,855
15099	DI	150	115.9	1972	$185,520
15128	CI	150	1.2	1969	$1,938
15137	CI	150	119.5	1963	$191,210
15141	DI	150	50.0	1974	$79,996
15153	CI	150	39.9	1969	$63,787
15156	CI	150	15.7	1954	$25,051
15174	DI	150	3.1	1980	$4,964
15177	DI	150	6.6	1980	$10,625
15187	DI	150	7.0	1980	$11,217
15196	CI	150	204.2	1964	$326,720
15207	CI	150	14.2	1954	$22,792
15251	PVC	250	13.1	1995	$20,895
15272	CI	150	140.9	1964	$225,423
15277	DI	150	3.1	1980	$4,944
15295	CI	150	5.2	1951	$8,352
15297	CI	150	5.4	1951	$8,583
15303	CI	150	7.9	1954	$12,583
15304	CI	150	8.6	1969	$13,817
15338	CI	150	10.3	1969	$16,427

Watermain ID	Material	Diameter (mm)	Length (mm)	Install Year	Total Cost
15372	CI	150	91.0	1967	$145,550
15379	DI	150	34.0	1974	$54,385
15404	CI	100	94.2	1954	$150,749
15412	DI	150	85.1	1971	$136,157
15422	PVC	250	18.0	1995	$28,758
15423	PVC	250	15.5	1995	$24,795
15428	DI	150	10.6	1971	$16,969
15431	DI	150	8.3	1974	$13,221
15435	CI	150	135.9	1944	$217,515
15444	CI	150	120.2	1964	$192,257
15447	CI	150	91.0	1964	$145,625
15472	DI	150	17.4	1974	$27,780
15507	CI	150	75.6	1949	$120,967
15511	CI	150	4.1	1956	$6,546
15519	DI	150	1.3	1971	$2,005
15525	DI	150	43.2	1971	$69,191
15546	CI	150	5.7	1965	$9,103
15553	CI	100	97.2	1954	$155,525
15569	DI	150	87.6	1974	$140,182
15595	PVC	200	80.4	1996	$128,618
15600	DI	150	4.0	1971	$6,448
15601	CI	150	4.4	1945	$7,059
15621	CI	200	54.4	1968	$86,986
15721	CI	150	16.5	1964	$26,417
15754	CI	150	13.3	1964	$21,221
15762	CI	150	7.2	1964	$11,579
15853	CI	150	2.8	1964	$4,468
15864	DI	150	1.7	1978	$2,707
15915	CI	100	10.8	1966	$17,321
15919	DI	150	1.7	1978	$2,790
15920	DI	150	1.7	1978	$2,760
15952	CI	150	148.6	1964	$237,821
15995	CI	100	15.9	1966	$25,492
16020	CI	150	88.7	1964	$141,978
16023	CI	150	118.5	1966	$189,545
16060	CI	150	4.9	1964	$7,829
16063	CI	150	7.2	1966	$11,443
16076	CI	100	15.7	1966	$25,091
16139	CI	100	17.5	1966	$28,064
16175	CI	100	24.4	1966	$39,014
16195	CI	100	11.6	1966	$18,528
16220	CI	100	147.2	1966	$235,469
16224	CI	100	131.7	1966	$210,740
16229	CI	150	92.5	1964	$148,020
16247	CI	150	1.4	1964	$2,308
16305	AC	150	95.7	1965	$153,049
16324	CI	150	108.2	1964	$173,191
16325	CI	150	3.7	1964	$5,930
16381	CI	200	68.7	1964	$109,969
16387	DI	100	174.2	1974	$278,733
16395	DI	150	22.4	1974	$35,869
16402	DI	150	87.8	1974	$140,430
16414	CI	200	192.9	1950	$308,693
16456	CI	200	7.4	1968	$11,796

Watermain ID	Material	Diameter (mm)	Length (mm)	Install Year	Total Cost
16457	DI	150	31.4	1974	$50,234
16498	CI	200	122.9	1950	$196,622
16531	CI	150	119.4	1940	$190,989
16548	CI	200	101.1	1968	$161,825
16555	CI	200	137.9	1950	$220,664
16610	CI	150	63.1	1964	$100,943
16613	CI	200	278.5	1950	$445,582
16672	CI	200	13.3	1950	$21,319
16673	CI	150	14.5	1964	$23,163
16676	CI	200	8.7	1964	$13,876
16682	CI	200	86.7	1968	$138,760
16686	CI	200	140.6	1968	$224,920
16694	CI	200	4.6	1950	$7,394
16709	DI	150	5.3	1974	$8,426
16762	DI	100	2.1	1974	$3,323
16784	CI	200	35.6	1968	$57,036
16883	CI	200	51.2	1968	$81,882
16895	CI	150	21.5	1964	$34,478
16916	CI	200	2.2	1968	$3,569
16926	CI	250	118.0	1964	$188,875
16938	CI	150	6.3	1940	$10,033
16987	CI	150	63.0	1968	$100,840
17001	CI	200	11.0	1947	$17,526
17005	CI	200	33.8	1968	$54,008
17031	CI	150	8.2	1968	$13,049
17035	CI	150	136.2	1964	$217,926
17046	CI	200	40.9	1968	$65,401
17152	CI	200	2.4	1968	$3,761
17154	CI	200	258.1	1950	$412,937
17173	CI	150	8.1	1964	$13,024
17212	CI	150	32.4	1964	$51,894
17301	CI	200	33.6	1950	$53,734
17340	CI	150	109.2	1964	$174,768
22461	PVC	300	3.9	2002	$6,300
22462	PVC	300	6.9	2002	$11,018
22463	PVC	300	93.3	2002	$149,247
22474	PVC	300	99.0	2002	$158,328
25982	PVC	100	99.5	2003	$159,261
25984	PVC	100	3.2	2003	$5,139
25985	PVC	150	5.9	2003	$9,376
26624	PVC	150	76.3	2003	$122,024
27271	PVC	150	142.9	2003	$228,628
27274	PVC	150	41.0	2003	$65,535
27275	PVC	150	107.1	2003	$171,348
27582	PVC	150	175.9	2003	$281,399
27585	PVC	150	138.6	2003	$221,780
27902	PVC	150	101.9	2003	$163,093
27903	PVC	150	31.6	2003	$50,521
27906	PVC	150	158.9	2003	$254,234
37821	PVC	200	3.1	1999	$5,016
37822	PVC	200	3.6	1999	$5,687
43581	PVC	150	7.7	2002	$12,309
43582	PVC	150	2.3	2002	$3,717
43583	PVC	150	9.3	2002	$14,935

Watermain ID	Material	Diameter (mm)	Length (mm)	Install Year	Total Cost
43584	PVC	150	80.8	2002	$129,277
43585	PVC	150	9.4	2002	$14,986
43586	PVC	150	19.4	2002	$31,041
43587	PVC	150	19.6	2002	$31,370
43588	PVC	150	8.6	2002	$13,719
43589	PVC	150	87.4	2002	$139,884
43590	PVC	150	9.0	2002	$14,376
43594	PVC	150	224.0	2002	$358,372
43901	PVC	150	3.1	2002	$4,952
43902	PVC	150	23.1	2002	$37,000
43909	PVC	150	414.0	2002	$662,401
50621	PVC	150	2.0	1999	$3,258
50622	PVC	150	12.1	1999	$19,370
51904	PVC	100	1.4	2004	$2,262
51905	PVC	100	1.3	2004	$2,069
51906	PVC	100	1.3	2004	$2,052
51908	PVC	100	6.5	2004	$10,438
53829	AC	150	87.8	1965	$140,511
53832	DI	150	15.5	2004	$24,849
57662	CI	150	94.6	1960	$151,299
57991	CI	150	112.1	1966	$179,321
60221	CI	200	5.7	1947	$9,148
60222	DI	150	0.7	2002	$1,172
62781	PVC	150	388.2	2002	$621,124
63101	PVC	150	316.5	2002	$506,469
69523	DI	150	1.8	1985	$2,826
69524	DI	100	1.9	1985	$3,071
71498	CI	100	8.3	1954	$13,270
72989	CI	100	2.4	1954	$3,910
72990	CI	100	1.8	1954	$2,926
73006	PVC	150	149.8	2003	$239,714
73069	CI	150	43.2	1964	$69,172
73156	PVC	200	116.6	2005	$186,545
73160	PVC	200	18.1	2005	$28,915
75293	CI	150	196.4	1940	$314,181
75294	CI	150	111.6	1940	$178,631
76395	PVC	250	0.8	2006	$1,215
76396	PVC	250	0.7	2006	$1,180
78059	PVC	150	21.4	2005	$34,314
78060	PVC	150	1.6	2005	$2,616
78493	PVC	150	49.0	2005	$78,422
78653	PVC	150	4.8	2007	$7,730
78654	CI	150	26.5	1940	$42,425
78669	PVC	150	2.3	2007	$3,737
78670	PVC	150	3.3	2007	$5,292
79041	CI	250	0.5	1956	$803
79043	CI	250	0.5	1956	$819
79044	CI	250	11.5	1956	$18,438
79047	CI	250	0.5	1956	$755
79048	CI	250	5.6	1964	$9,021
79051	CI	100	1.9	1906	$3,101
79056	CI	150	21.2	1957	$33,934
81858	CI	100	7.5	1915	$20,356
82189	CI	200	8.7	1913	$13,985

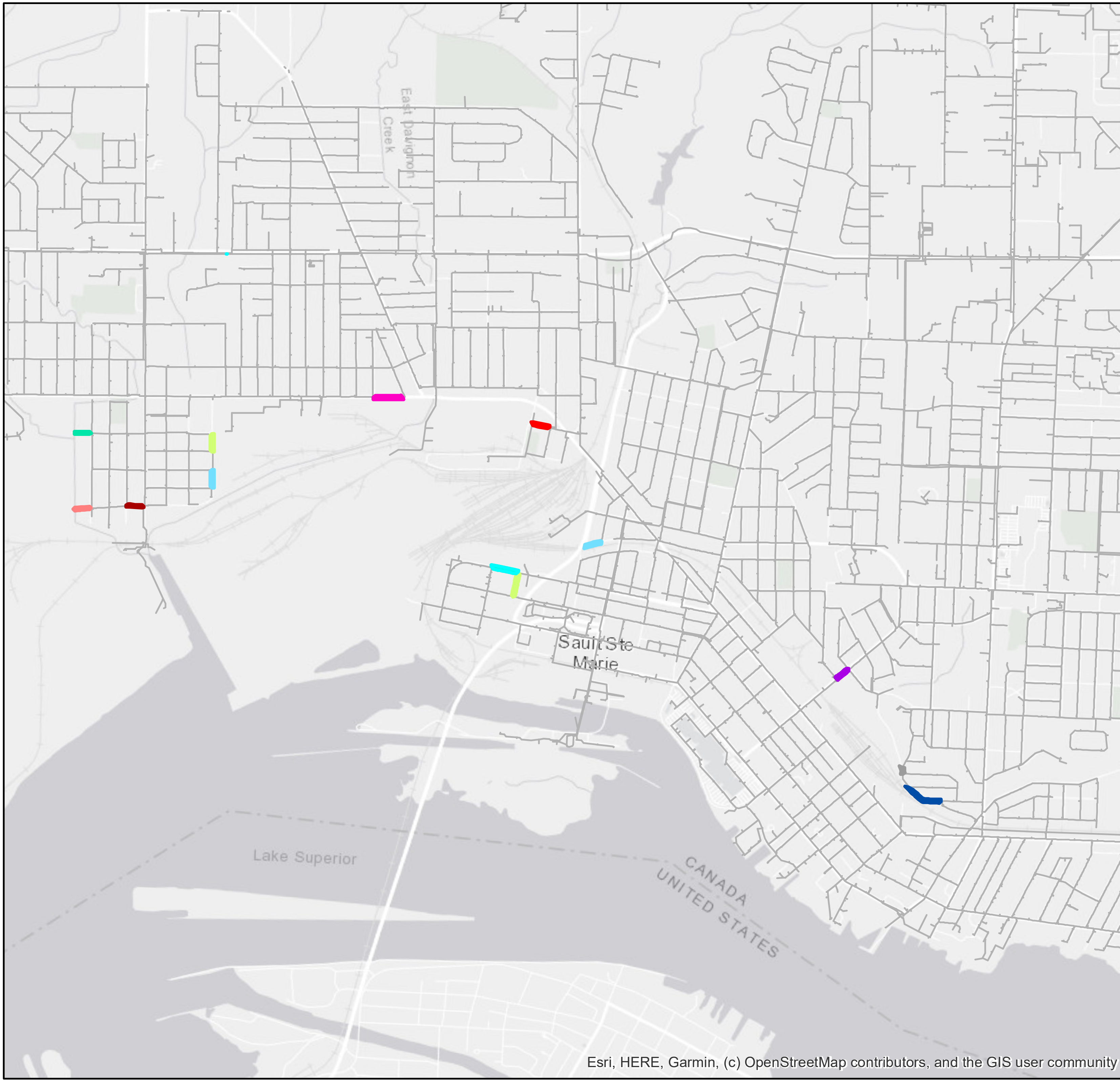
Watermain ID	Material	Diameter (mm)	Length (mm)	Install Year	Total Cost
82544	PVC	150	3.3	2009	$5,282
82545	PVC	150	0.9	2009	$1,409
82546	PVC	150	0.9	2009	$1,452
82558	PVC	150	2.0	2008	$3,200
82563	PVC	200	3.4	2008	$5,490
82564	PVC	100	1.8	2008	$2,845
82565	PVC	150	1.6	2008	$2,623
82945	CI	150	5.2	1908	$8,262
82946	CI	150	29.9	1908	$47,832
82948	CI	150	6.5	1908	$10,453
83006	CI	150	47.0	1966	$75,132
83021	CI	150	6.2	1963	$9,895
83025	CI	150	119.9	1964	$191,913
83373	CI	100	23.5	1963	$37,670
83742	CI	150	40.8	1964	$65,254
83785	PVC	100	3.3	2004	$5,359
83997	DI	100	0.7	2009	$1,757
84023	CI	150	19.9	1962	$31,812
84024	CI	150	2.5	1962	$3,980
84026	CI	150	25.3	1962	$40,546
84400	DI	150	1.9	1973	$3,013
84415	CI	150	3.0	1953	$4,836
84426	PVC	150	1.3	1995	$2,069
84430	CI	150	0.5	1963	$770
87299	CI	150	0.5	1964	$785
87343	CI	150	1.4	1902	$2,274
87816	DI	200	45.8	1990	$73,315
87818	DI	200	45.3	1990	$72,541
91070	DI	100	11.7	1981	$18,792
91072	CI	150	9.6	1957	$15,322
91074	CI	100	11.0	1968	$17,564
91697	CI	150	90.5	1969	$144,745
91853	PVC	150	6.6	2009	$10,562
91854	PVC	150	19.0	2009	$30,392
91858	PVC	150	1.0	2009	$1,596
91863	PVC	150	3.6	2009	$5,810
91864	PVC	150	1.2	2009	$1,899
91898	PVC	150	10.5	2010	$16,785
91917	DI	200	1.0	2010	$1,556
92109	DI	150	0.6	2010	$977
93150	DI	150	1.3	2010	$2,027
94499	CI	100	1.4	1948	$2,162
94502	CI	100	3.5	1912	$5,668
94688	CI	150	5.3	1945	$8,445
94689	CI	150	1.9	1945	$3,057
95492	CI	100	8.9	1901	$24,059
101116	DI	150	1.7	1972	$2,769
101523	PVC	150	1.6	2010	$2,594
101524	PVC	150	1.5	2010	$2,401
101525	PVC	150	1.1	2010	$1,756
101526	PVC	150	1.0	2010	$1,596
108071	CI	100	12.0	1927	$19,210
108948	PVC	150	12.5	2012	$19,980
108951	PVC	150	2.0	2012	$3,235

Watermain ID	Material	Diameter (mm)	Length (mm)	Install Year	Total Cost
108952	PVC	150	10.1	2012	$16,164
108953	PVC	150	23.4	2012	$37,369
108954	PVC	150	34.4	2012	$54,981
108955	PVC	150	10.6	2012	$17,020
108956	PVC	150	3.2	2012	$5,088
108965	PVC	200	2.0	2012	$3,267
108966	PVC	200	2.1	2012	$3,411
111000	PVC	100	4.9	2012	$7,899
111002	PVC	200	2.2	2012	$3,578
111800	PVC	200	5.5	2012	$8,853
111801	PVC	200	1.5	2012	$2,449
111802	PVC	200	1.0	2012	$1,607
111803	PVC	200	1.0	2012	$1,607
111804	CI	150	17.8	1963	$28,542
111807	PVC	200	92.6	2012	$148,128
112619	CI	150	10.8	1949	$17,342
120023	DI	100	0.5	2013	$801
120024	DI	100	1.0	2013	$1,668
120027	DI	100	1.3	2013	$2,006
120427	CI	150	35.9	1915	$57,424
122956	CI	150	20.6	1958	$32,888
124555	CI	100	39.0	1900	$105,242
126958	PVC	150	2.6	2012	$4,119
127359	PVC	150	1.9	2012	$2,979
127360	PVC	150	0.8	2012	$1,319
127361	PVC	150	0.7	2012	$1,103
127362	PVC	150	4.4	2012	$7,112
127363	PVC	150	2.4	2012	$3,841
129383	PVC	150	21.0	2013	$33,541
131784	CI	150	3.0	1964	$4,782
131785	CI	150	6.6	1964	$10,590
135396	CI	100	14.0	1910	$37,674
135400	CI	100	3.0	1910	$8,162
141438	PVC	150	44.6	2013	$71,365
142244	PVC	150	3.9	2014	$6,294
142246	PVC	150	2.6	2014	$4,117
142252	PVC	150	22.8	2002	$36,457
142253	PVC	150	10.2	2002	$16,344
143869	PVC	150	1.0	2014	$1,651
144673	CI	150	42.3	1966	$67,657
146277	CI	150	38.2	1914	$61,092
146278	PVC	150	3.1	2013	$5,038
146279	PVC	150	1.3	2012	$2,156
146280	PVC	150	3.1	2013	$4,916
146281	PVC	150	1.2	2013	$1,976
146282	PVC	150	3.0	2013	$4,788
146286	PVC	150	20.7	2013	$33,197
146287	PVC	150	3.1	2013	$4,931
146288	PVC	150	1.5	2013	$2,341
146290	PVC	150	4.9	2015	$7,872
146304	PVC	150	5.6	2014	$8,897
152798	CI	100	0.8	1910	$1,215
161310	CI	100	3.9	1927	$6,255
162943	CI	150	1.4	1964	$2,180

Watermain ID	Material	Diameter (mm)	Length (mm)	Install Year	Total Cost
162945	PVC	150	3.6	2012	$5,763
162947	PVC	150	1.6	2012	$2,496
162948	PVC	150	3.6	2012	$5,810
162949	PVC	150	1.0	2012	$1,552
171100	CI	150	2.4	1955	$3,915
2895	CI	150	11.2	1957	$17,964
171104	CI	100	12.5	1963	$19,975
171105	CI	150	33.8	1960	$54,088
173145	DI	100	2.0	2017	$3,134
180863	DI	150	1.3	1973	$2,134
182070	DI	150	12.8	1981	$20,469
182072	DI	150	11.2	1981	$17,883
182111	PVC	200	7.0	2018	$11,160
183360	PVC	200	1.5	2018	$2,342
183361	CI	250	1.5	1900	$2,376
183362	PVC	200	7.7	2018	$12,276
183364	PVC	150	3.2	2018	$5,140
183367	PVC	200	1.4	2018	$2,161
183370	PVC	200	11.6	2018	$18,520
183371	PVC	150	2.5	2018	$3,981
184561	PVC	100	1.0	2018	$1,661
184972	PVC	150	3.2	2018	$5,183
184973	PVC	150	1.3	2018	$2,057
184974	PVC	200	78.7	2018	$125,911
184978	PVC	200	8.0	2018	$12,877
184979	PVC	200	0.6	2018	$973
184980	PVC	200	3.6	2018	$5,809
184981	PVC	200	1.1	2018	$1,798
184982	PVC	200	1.4	2018	$2,166
184983	PVC	200	1.3	2018	$2,050
184984	PVC	200	18.1	2018	$29,022
184987	PVC	200	3.9	2018	$6,288
185361	PVC	200	5.4	2018	$8,605
185362	PVC	200	3.0	2018	$4,767
185763	PVC	100	0.5	1906	$774
185764	PVC	100	0.9	2018	$1,371
187369	PVC	150	1.0	2018	$1,596
187370	PVC	150	0.9	2018	$1,467
187371	PVC	200	2.0	2018	$3,191
187372	PVC	200	2.2	2018	$3,564
187373	PVC	200	0.8	2018	$1,222

Appendix I

Potential Interventions – Service Criteria Utility Corridors



PUC

Interventions - Utility Service Criteria

N

- 2020
- 2021
- 2022
- 2023
- 2024
- 2025
- 2026
- 2027
- 2028
- 2029
- Others

0 150 300 600 900
Meters

Drinking Water
Asset Management Plan

10/30/2020	1:28,521	Datum - UTM 1983 Z16 Source - GCS NA 1983
P#:	V#:	**Interventions**

AECOM

Map location: C:\PUC Calibration Session\PUC_CalibrationSession_2.mxd
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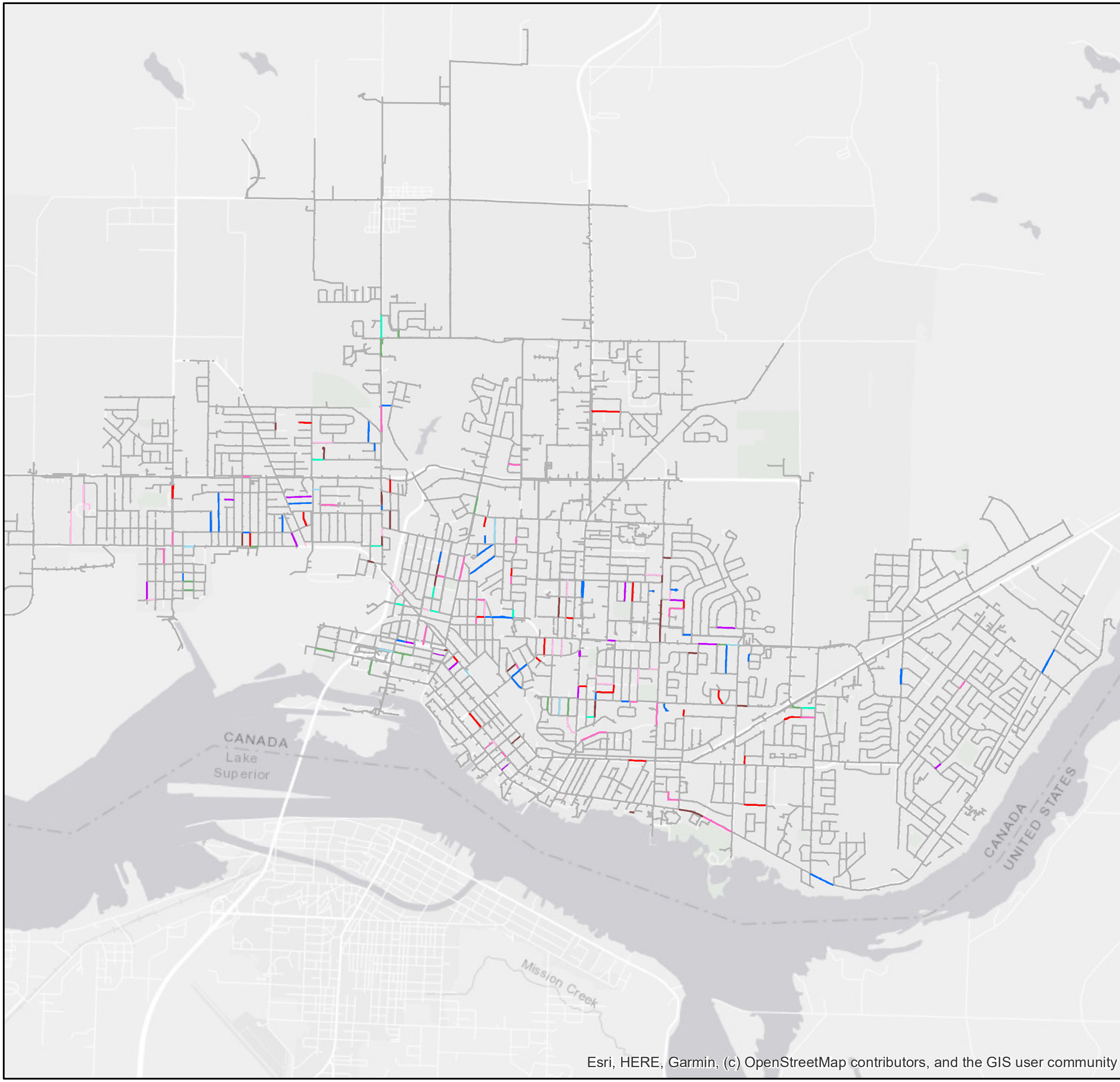
Corridor_ID	STREET_NAME	FROM_STREET	Street Length (m)	Total Cost	Year
6024	Goetz Street	Metzger Street	100.76	$155,187	2020
6959	St. Andrew's Terrace	Beverley Street	63.67	$91,107	2020
5739	Allen Street	Albert Street West	142.6	$240,268	2021
6026	Goetz Street	Dyment Street	101.36	$141,022	2021
5738	Cathcart Street	Allen Street	153.72	$265,570	2022
7468	Young Street	Glasgow Avenue	94.7	$131,414	2022
6397	Bruce Street	Wilson Street	89.29	$146,964	2023
6057	Bonney Street	Goulais Avenue	100.36	$148,277	2024
6045	Bonney Street	Glasgow Avenue	98.06	$132,411	2025
6558	Wallace Terrace	Sixth Avenue	167.06	$242,463	2026
5074	Wemyss Street	Hawthorne Avenue	209.37	$256,597	2027
6777	Bloor Street West	Adelaide Street	108.93	$332,798	2028
5068	Fauquier Avenue	Hamilton Avenue	39.28	$62,712	2029

Appendix J

Potential Interventions – Utility Risk Scores



PUC

Utility Risk Interventions

Light blue	2020
Green	2021
Aqua	2022
Purple	2023
Brown	2024
Light pink	2025
Pink	2026
Blue	2027
Red	2028
Grey	2029
Line	Others

0 475 950 1,900 Meters

Drinking Water
Asset Management Plan

6/23/2021

Datum - UTM 1983 Z16
Source - GCS NA 1983

P#:

V#:

AECOM

Interventions

Map location: C:\Users\khalid.kaddoura\Desktop\PUC\Risk Methodology Replacement.mxd
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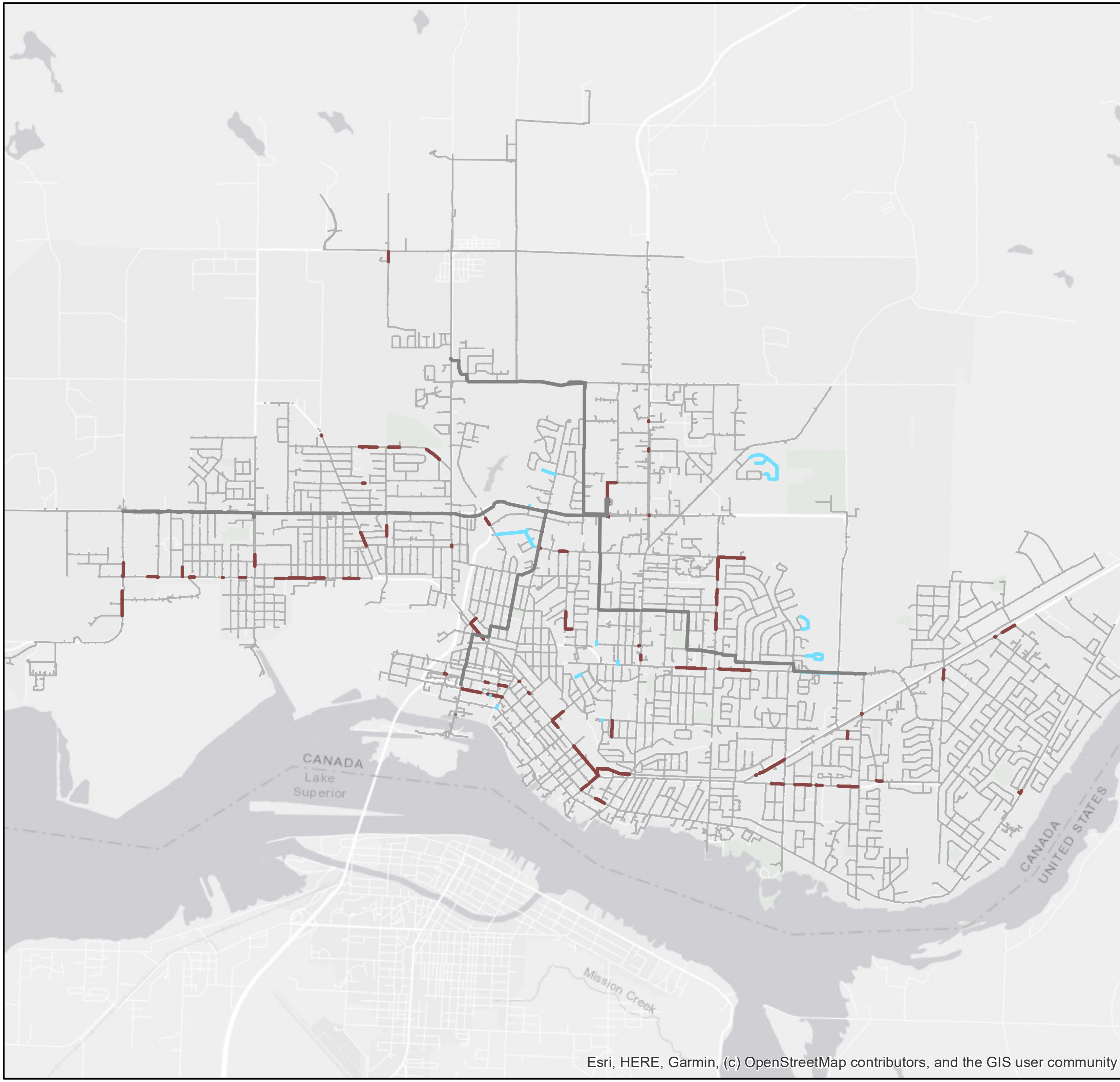
Corridor_ID	STREET_NAME	FROM_STREET	Street Length (m)	Total Cost	Year
5060	Laird Street	Borron Avenue	218.61	$362,337	2020
5694	Wellington Street East	Tancred Street	96.53	$363,655	2020
5748	Albert Street West	Huron Street	171.82	$219,286	2020
5960	McLean Court	Franklin Street / Laura Street	99.78	$290,672	2020
6540	Kitchener Road	Strand Avenue	302.71	$145,702	2020
6706	McNabb Street	Cartier Street	141.82	$2,586,772	2020
6568	Wallace Terrace	Central Street	123.63	$322,139	2020
5061	Summit Avenue	Borron Avenue	218.64	$624,757	2021
5063	Ferris Avenue	Borron Avenue	172.29	$431,668	2021
5314	Capp Avenue	Trunk Road	133.17	$143,268	2021
5379	McNabb Street	Windsor Street	111.41	$572,867	2021
6019	Metzger Street	Central Street	126.49	$198,510	2021
6020	McAllen Street	Central Street	126.59	$246,272	2021
6331	Beaumont Avenue	Third Line East	96.87	$562,625	2021
6561	Wallace Terrace	Second Avenue	93.23	$10,917	2021
6768	North Street	Northern Avenue East / Northern Avenue West	208.73	$213,947	2021
6910	Queen Street West	James Street	223.06	$364,722	2021
6330	Peoples Road	Sherbrook Drive	215.12	$371,601	2021
5759	Albert Street West	John Street	222.72	$290,231	2021
5723	Hudson Street	Private	175.89	$352,509	2021
4906	Capp Avenue	Clement Street	169.94	$261,772	2022
5088	Borron Avenue	Bellevue Avenue	101.66	$35,304	2022
5797	St. George's Avenue West	Huron Street	102.56	$168,682	2022
5812	St. George's Avenue West	Morin Street	100.91	$107,549	2022
5816	Bush Street	Cornwall Street	141.73	$162,230	2022
5899	Wallace Terrace	Wellington Street West	128.71	$16,680	2022
6281	Churchill Avenue	Dawson Avenue	139.97	$407,383	2022
6417	Grand Boulevard	St. George's Avenue East	99.39	$235,882	2022
6334	Peoples Road	Third Line East / Third Line West	270.25	$332,798	2022
4771	Birchwood Street	Denwood Drive	93.19	$91,579	2023
5287	Paladin Avenue	Paradise Avenue	215.29	$173,758	2023
5381	McNabb Street	Linstedt Street	217.53	$150,078	2023
5507	McNabb Street	Willow Avenue / YMCA Entrance	98.33	$471,273	2023
5540	Pim Street	MacDonald Avenue	146.26	$136,940	2023
5634	Bell Avenue	Bay Street	102.73	$342,773	2023
5706	Abbott Street	Albert Street East	141.73	$327,408	2023
5776	Cathcart Street	John Street	104.63	$164,416	2023
5926	Sixth Avenue	Wallace Terrace	177.49	$41,891	2023
5975	Raymond Street	Farwell Terrace	306.03	$59,009	2023
6058	Glasgow Avenue	Bonney Street	212.93	$183,156	2023
6209	Victor Emmanuel Avenue	Turner Avenue	106.37	$107,775	2023
6487	Passmore Road	Palace Drive	165.63	$131,836	2023
6882	Pim Street	Oxford Street	70.33	$6,161,269	2023
6880	Caledon Street	Marwayne Avenue	229.29	$342,259	2023
5768	Manilla Terrace	Gore Street	137	$246,283	2023
5096	Poplar Avenue	Borron Avenue	196.77	$305,625	2024
5120	Dufferin Street	Grosvenor Avenue	139.39	$145,605	2024
5209	Elmwood Avenue	Stevens Street	240.07	$176,099	2024
5273	Pleasant Drive	Panoramic Drive	97.77	$269,491	2024
5373	MacDonald Avenue	Lake Street	128.48	$320,120	2024
5387	Norden Crescent	Moluch Street	113.07	$540,961	2024
5416	Murton Avenue	Cheshire Road	89.23	$110,990	2024
5650	McDougald Street	Albert Street East	141.31	$383,679	2024
5824	Bush Street	York Street	130.95	$1,743,406	2024
5838	Bush Street	Bloor Street West	141.08	$150,742	2024
5893	Shafer Avenue	Conmee Avenue	223.47	$193,255	2024
5900	Wellington Street West	Wallace Terrace	117.79	$145,107	2024
5938	Wellington Street West	Estelle Street	162.95	$175,533	2024
5995	Prentice Avenue	Wallace Terrace	162.35	$164,882	2024

Corridor_ID	STREET_NAME	FROM_STREET	Street Length (m)	Total Cost	Year
6282	Dawson Avenue	Churchill Avenue	150.83	$171,520	2024
6386	Queen Street East	Elizabeth Street	290.34	$568,132	2024
6451	Pine Street	Willoughby Street	93.42	$26,541	2024
6453	Pine Street	McNabb Street	494.6	$162,289	2024
6760	Cathcart Street	Gore Street / Wellington Street East	46.75	$126,810	2024
6833	McPhail Avenue	End	49.78	$330,983	2024
5903	Bloor Street West	Lyons Avenue	86.46	$284,605	2024
5148	Maple Street	St. George's Avenue East	200.22	$350,660	2025
5062	Summit Avenue	Pim Street	246.03	$566,622	2025
5211	Cameron Avenue	Champlain Street	202.26	$385,459	2025
5246	Tilley Road	Dablon Street	198.68	$71,015	2025
5265	Plaintree Drive	Passmore Road	119.79	$326,991	2025
5520	Cunningham Road	Edmonds Avenue	111.4	$299,645	2025
5522	Weldon Avenue	Curran Drive	195.24	$333,709	2025
5533	Poplar Avenue	Bellevue Avenue	47.92	$25,598	2025
5534	Curran Drive	Poplar Avenue	201.92	$313,016	2025
5805	St. George's Avenue West	Bush Street	102.4	$482,897	2025
5896	Wellington Street West	Dundas Street	98.69	$340,714	2025
5922	Korah Road	Lyons Avenue / Wallace Terrace	59.57	$287,392	2025
6162	North Eden Street	Eden Square	237.24	$369,096	2025
6301	Johnson Avenue	Diane Street	241.94	$195,765	2025
6654	Woodward Avenue	Gordon Avenue	83.92	$215,738	2025
6783	Wellington Street West	Beverley Street / Boydell Place	180.08	$621,531	2025
6909	Queen Street East	March Street	98.15	$259,804	2025
6048	Bonney Street	Spadina Avenue	98.31	$750,196	2025
5118	Gladstone Avenue	Bruce Street	201.7	$146,305	2025
6529	Melrose Avenue	Bruce Street	201.68	$98,995	2025
6155	Eden Square	East Balfour Street	134.2	$337,710	2025
6161	Brookfield Avenue	Wallace Terrace	404.84	$508,102	2025
4908	Lewis Road	Clement Street	169.6	$294,769	2026
4985	McMeeken Street	Heavenor Street	235.51	$331,440	2026
5147	Spruce Street	Pardee Avenue	85.69	$131,886	2026
5051	Ontario Avenue	The Crescent	329.68	$493,819	2026
5119	Trelawne Avenue	Dufferin Street	51.74	$192,306	2026
5151	St. Mary's Avenue	Spruce Street	99.14	$709,955	2026
5174	Grand Boulevard	Grandmont Crescent	96.61	$21,599	2026
5187	Grand Boulevard	Strand Avenue	93.44	$139,348	2026
5260	Princess Crescent	Parasol Crescent	256.58	$1,290,606	2026
5489	Pine Street	Garrison Way	263.8	$92,939	2026
5586	Selkirk Road	Superior Drive	150.49	$376,321	2026
5639	Queen Street East	Bingham Street	78.79	$250,503	2026
5821	Bloor Street West	Morin Street	101.77	$228,213	2026
5956	Estelle Street	Moody Street	194.37	$287,281	2026
6003	Goulais Avenue	Wallace Terrace	163.58	$21,848	2026
6310	Peoples Road	Elliott Road	311.6	$405,162	2026
6385	Queen Street East	Churchill Boulevard / Rotary Parkway	381.41	$121,770	2026
6554	Second Line West	First Avenue	93.07	$287,295	2026
6597	Chambers Avenue	Celene Court	113.17	$766,186	2026
6714	MacDonald Avenue	Alworth Place / Campbell Avenue	93.05	$222,999	2026
6757	Brown Street	Cathcart Street	243.28	$4,287	2026
6908	March Street	Bay Street	122.89	$144,566	2026
6050	Pittsburgh Avenue	Young Street	182.08	$315,590	2026
6534	North Street	Birch Street / Bloor Street West	289.33	$331,540	2026
4698	Queen Street East	Dacey Road	306	$473,020	2027
4862	Queen Street East	Shannon Road	306.52	$487,813	2027
4878	Boundary Road	Broad Street	185.82	$270,359	2027
5104	Grosvenor Avenue	Bruce Street	180.17	$83,374	2027
5159	Anita Boulevard	Strand Avenue	87.72	$185,459	2027
5215	Great Northern Road	Champlain Street	203.86	$289,423	2027
5247	Blue Jay Court	Allard Street	62.06	$342,920	2027
5263	Peacock Crescent	Plaintree Drive	87.31	$484,035	2027
5372	Fields Square	Fields Square	99.44	$301,955	2027
5377	Cartier Street	Marconi Street	340.34	$181,996	2027
5395	Haviland Crescent	MacDonald Avenue	100.12	$112,135	2027
5778	Cathcart Street	St. James Street	105.13	$57,377	2027
5849	Bush Street	Kehoe Avenue	142.42	$202,464	2027
5939	Wellington Street West	Swartz Street	56.79	$291,794	2027
5973	Hocking Avenue	Korah Road	275.18	$258,935	2027
5986	Douglas Street	First Avenue	94.21	$111,802	2027
6006	Letcher Street	McAllen Street	100.96	$243,247	2027

Corridor_ID	STREET_NAME	FROM_STREET	Street Length (m)	Total Cost	Year
6215	Carufel Avenue	Douglas Street	463.84	$161,944	2027
6294	Lloyd Street	Lidstone Street	100.89	$127,983	2027
6300	Hill Street	Johnson Avenue	245.53	$295,146	2027
6311	Penno Road	Peoples Road	120.41	$512,561	2027
6396	Bruce Street	Grosvenor Avenue	235.37	$249,212	2027
6471	Poplar Avenue	MacDonald Avenue	98.19	$115,975	2027
6539	Knox Avenue	Walnut Street	366.43	$66,115	2027
6681	Placid Avenue	Palace Drive	96.02	$13,416	2027
6719	MacDonald Avenue	Crawford Avenue	93.66	$14,571	2027
6806	Wilding Avenue	Douglas Street	234.11	$402,519	2027
6416	St. George's Avenue East	Maple Street	328.77	$1,106,179	2027
5460	Fifth Avenue	Douglas Street	198	$241,125	2027
6940	Morrison Avenue	Hargreaves Avenue	242	$24,743	2027
4910	Lewis Road	Tuckett Street	205.7	$321,294	2028
4936	Angelina Avenue	Wellington Street East	106.04	$166,631	2028
4947	Mark Street	Retta Street	260.88	$235,545	2028
4996	Wellington Street East	Upton Road	211.75	$372,197	2028
5180	Grand Boulevard	Grandmont Crescent	92.85	$1,030,812	2028
5261	Palace Drive	Princess Crescent	95.86	$146,079	2028
5478	Elizabeth Street	Creery Avenue	62.46	$127,557	2028
5536	Oakwood Drive	Poplar Avenue	202.96	$310,710	2028
5537	Brien Avenue	Oakwood Drive	97.56	$97,749	2028
5550	Terrance Avenue	Great Northern Road	335.5	$977,882	2028
5678	Queen Street East	Bruce Street	220.71	$577,006	2028
5707	Wellington Street East	Blucher Street / Francis Street	87.57	$271,921	2028
5937	Shafer Avenue	Bainbridge Street	156.08	$31,391	2028
5967	Seventh Avenue	Douglas Street	177.64	$218,738	2028
6001	First Avenue	Wallace Terrace	164.91	$242,740	2028
6177	Goulais Avenue	Wright Street	160.11	$839,515	2028
6260	Sydenham Road	Farwell Terrace	180.2	$185,049	2028
6402	St. George's Avenue East	Spruce Street	96.51	$181,943	2028
6432	Stevens Street	Blake Avenue	87.78	$301,423	2028
6469	Oakwood Drive	Pim Street	100.52	$880,300	2028
6541	Anita Boulevard	End	116.9	$180,000	2028
6664	Salisbury Avenue	Bruce Street	83.81	$99,662	2028
6838	Sisson Street	MacDonald Avenue	193.95	$16,797	2028
5116	Algoma Avenue	Bruce Street	201.34	$411,458	2028
6875	Leslie Street	Marwayne Avenue	230.14	$160,163	2028
4694	Royal York Boulevard	River Road	402.36	$637,710	2029
5004	Victoria Avenue	Upton Road	158.44	$253,206	2029
5038	Simpson Street	Forest Avenue	124.24	$167,962	2029
5095	Pim Street	Borron Avenue	206.17	$138,635	2029
5121	Grosvenor Avenue	Trelawne Avenue	240.81	$146,137	2029
5208	Elmwood Avenue	Champlain Street	203.03	$53,062	2029
5223	Eagle Drive	Willow Avenue	202.52	$325,954	2029
5304	Adeline Avenue	Frontenac Street / McNabb Street	159	$128,768	2029
5317	MacDonald Avenue	Kingsmount Boulevard	686.72	$736,692	2029
5324	Ravina Street	Birchland Court	86.18	$211,814	2029
5376	Windsor Street	Marconi Street	340.64	$94,535	2029
5524	Campbell Avenue	Curran Drive	196.64	$589,021	2029
5529	Brien Avenue	Curran Drive	98.79	$590,241	2029
5668	Wellington Street East	Elgin Street	194.25	$387,675	2029
5686	Wellington Street East	Dennis Street	221.52	$106,553	2029
5705	Blucher Street	Albert Street East	141.09	$640,394	2029
6245	Korah Road	Cheshire Road	96.19	$409,815	2029
6288	Peoples Road	Second Line East / Second Line West	98.07	$219,213	2029
6290	Churchill Avenue	Peoples Road	81.57	$1,203,223	2029
6298	Peoples Road	Johnson Avenue	116.56	$352,137	2029
6490	Wawanosh Avenue	Blake Avenue	96.47	$132,412	2029
6677	Malabar Drive	Great Northern Road	309.25	$120,189	2029
6787	Douglas Street	Farwell Terrace	63.4	$63,662	2029
6525	McNabb Street	Great Northern Road / Pim Street	304.32	$163,923	2029
6730	Pilgrim Street	Herrick Street	187.8	$262,419	2029
5447	Grand Boulevard	Grandhaven Crescent	97	$107,312	2029

Appendix K

PVC Opportunistic Sampling Opportunities, Potential Ferrous Pipes for Condition Assessment, Potential CPP for Condition Assessment



Type

- CPP
- Ferrous Pipes
- Thermoplastic Opportunistic Sampling
- Others

0 500 1,000 2,000 Meters

Drinking Water
Asset Management Plan

6/24/2021		Datum - UTM 1983 Z16 Source - GCS NA 1983
P#:	V#:	CA
AECOM		

Map location: C:\Users\khalid.kaddoura\Desktop\PUC\Condition_Assessment.mxd
Date Saved: 6/24/2021 9:47:47 AM

Watermain ID	Type	Diameter (mm)	Length (mm)	Install Year	Total Cost
47	Ferrous Pipes	450	5.9	1968	$10,451
156	Ferrous Pipes	400	106.2	1985	$169,862
171	Ferrous Pipes	450	8.6	1968	$15,206
216	Ferrous Pipes	450	2.1	1968	$3,690
228	Ferrous Pipes	450	4.2	1968	$7,506
261	Ferrous Pipes	450	144.7	1968	$256,106
321	Ferrous Pipes	400	1.0	1985	$1,603
581	Ferrous Pipes	400	5.4	1923	$8,683
582	Ferrous Pipes	400	4.3	1923	$6,958
611	Ferrous Pipes	400	50.4	1923	$80,634
757	Ferrous Pipes	400	2.9	1923	$4,662
761	Ferrous Pipes	400	30.7	1923	$49,046
836	Ferrous Pipes	400	55.5	1923	$88,863
866	Ferrous Pipes	400	5.7	1900	$9,061
981	Ferrous Pipes	150	78.0	1907	$124,847
1026	Ferrous Pipes	400	5.5	1923	$8,812
1047	Ferrous Pipes	400	2.7	1910	$4,262
1097	Ferrous Pipes	400	0.6	1900	$953
1137	Ferrous Pipes	400	1.3	1900	$2,074
1147	Ferrous Pipes	400	91.2	1900	$145,953
1184	Ferrous Pipes	400	98.3	1920	$157,201
1196	Ferrous Pipes	250	119.1	1900	$190,592
1266	Ferrous Pipes	400	3.2	1924	$5,047
1372	Ferrous Pipes	250	10.7	1900	$17,130
1443	Ferrous Pipes	400	7.3	1920	$11,614
1479	Ferrous Pipes	400	15.0	1923	$24,053
1503	Ferrous Pipes	400	8.0	1923	$12,722
1540	Ferrous Pipes	250	37.1	1900	$59,435
1560	Ferrous Pipes	400	9.3	1923	$14,930
1604	Ferrous Pipes	400	108.2	1924	$173,168
1606	Ferrous Pipes	400	0.8	1924	$1,278
1612	Ferrous Pipes	400	5.3	1924	$8,475
1656	Ferrous Pipes	400	37.7	1924	$60,277
1671	Ferrous Pipes	400	46.7	1956	$74,667
1676	Ferrous Pipes	400	6.8	1924	$10,854
1693	Ferrous Pipes	400	6.6	1962	$10,544
1696	Ferrous Pipes	300	33.6	1905	$90,796
1700	Ferrous Pipes	400	105.3	1957	$168,549
1771	Ferrous Pipes	400	51.7	1956	$82,660
1810	Ferrous Pipes	400	18.1	1924	$29,020
1854	Ferrous Pipes	400	71.9	1957	$115,102
1912	Ferrous Pipes	400	15.4	1956	$24,639
1926	Ferrous Pipes	400	93.5	1924	$149,618
2000	Ferrous Pipes	400	58.3	1962	$93,301
2008	Ferrous Pipes	400	3.3	1962	$5,234
2040	Ferrous Pipes	300	43.7	1967	$117,973
2047	Ferrous Pipes	300	27.3	1967	$73,797
2074	Ferrous Pipes	300	74.4	1987	$200,944
2104	Ferrous Pipes	400	13.1	1956	$20,993
2108	Ferrous Pipes	300	4.2	1967	$6,767
2168	Ferrous Pipes	400	1.3	1962	$2,001
2309	Ferrous Pipes	400	66.6	1924	$106,579
2316	Ferrous Pipes	400	17.2	1957	$27,588
2339	Ferrous Pipes	400	6.9	1957	$10,976
2354	Ferrous Pipes	300	5.8	1987	$15,709
2390	Ferrous Pipes	400	5.3	1924	$8,509
2457	Ferrous Pipes	400	2.9	1957	$4,672
2461	Ferrous Pipes	300	79.6	1905	$127,311
2476	Ferrous Pipes	400	5.0	1924	$7,931
2544	Ferrous Pipes	400	1.5	1924	$2,410
2585	Ferrous Pipes	400	102.4	1924	$163,770
2589	Ferrous Pipes	400	84.0	1924	$134,347

Watermain ID	Type	Diameter (mm)	Length (mm)	Install Year	Total Cost
2592	Ferrous Pipes	300	61.4	1967	$165,911
2602	Ferrous Pipes	300	53.1	1967	$143,497
2620	Ferrous Pipes	400	19.7	1924	$31,556
2721	Ferrous Pipes	400	71.2	1956	$113,952
2724	Ferrous Pipes	400	45.2	1924	$72,354
2849	Ferrous Pipes	300	18.8	1956	$30,108
2864	Ferrous Pipes	400	3.2	1969	$5,095
3002	Ferrous Pipes	300	69.1	1959	$110,498
3059	Ferrous Pipes	400	2.1	1988	$3,322
3105	Ferrous Pipes	400	24.8	1969	$39,611
3111	Ferrous Pipes	400	10.3	1969	$16,483
3136	Ferrous Pipes	400	5.2	1969	$8,291
3174	Ferrous Pipes	300	97.7	1953	$156,289
3181	Ferrous Pipes	300	75.2	1956	$120,358
3202	Ferrous Pipes	400	80.3	1969	$128,477
3365	Ferrous Pipes	300	5.7	1956	$9,040
3408	Ferrous Pipes	150	88.0	1959	$140,809
3465	Ferrous Pipes	400	72.6	1969	$116,237
3475	Ferrous Pipes	400	13.5	1969	$21,621
3626	Ferrous Pipes	400	10.4	1969	$16,610
3760	Ferrous Pipes	300	24.8	1953	$39,609
3928	Ferrous Pipes	300	146.4	1956	$234,225
3969	Ferrous Pipes	400	1.3	1988	$2,076
3992	Ferrous Pipes	300	69.0	1956	$110,349
4072	Ferrous Pipes	400	2.9	1988	$4,605
4147	Ferrous Pipes	300	12.7	1956	$20,282
4417	Ferrous Pipes	300	12.5	1956	$19,993
4431	Ferrous Pipes	300	70.5	1956	$112,810
4513	Ferrous Pipes	300	108.6	1956	$173,715
4695	Ferrous Pipes	400	5.2	1969	$8,282
4709	Ferrous Pipes	400	1.1	1988	$1,739
5474	Ferrous Pipes	400	169.4	1973	$271,065
5974	Ferrous Pipes	400	35.0	1978	$55,923
5990	Ferrous Pipes	400	13.1	1978	$20,919
6044	Ferrous Pipes	400	3.1	1978	$4,888
6124	Ferrous Pipes	300	13.7	1966	$21,985
6193	Ferrous Pipes	400	1.0	1973	$1,562
6199	Ferrous Pipes	400	7.2	1973	$11,592
6713	Ferrous Pipes	300	104.5	1966	$167,195
6833	Ferrous Pipes	400	0.8	1973	$1,207
6841	Ferrous Pipes	400	5.8	1973	$9,272
6849	Ferrous Pipes	400	2.1	1973	$3,413
6910	Ferrous Pipes	400	1.2	1973	$1,953
6921	Ferrous Pipes	400	0.8	1973	$1,207
7369	Ferrous Pipes	300	112.5	1986	$179,940
7390	Ferrous Pipes	300	94.3	1986	$150,831
7421	Ferrous Pipes	300	90.6	1968	$144,976
7601	Ferrous Pipes	300	7.9	1961	$12,635
7613	Ferrous Pipes	300	104.4	1968	$167,106
7666	Ferrous Pipes	300	27.8	1968	$44,484
7902	Ferrous Pipes	300	35.8	1968	$57,286
8033	Ferrous Pipes	300	44.9	1952	$71,920
8061	Ferrous Pipes	300	12.4	1986	$19,824
8081	Ferrous Pipes	300	93.0	1968	$148,836
8413	Ferrous Pipes	300	33.9	1986	$54,262
8479	Ferrous Pipes	300	35.6	1952	$56,984
8497	Ferrous Pipes	300	63.1	1957	$101,010
8749	Ferrous Pipes	300	40.9	1957	$65,423
9027	Ferrous Pipes	300	60.8	1957	$97,278
9077	Ferrous Pipes	300	13.0	1957	$20,833
9568	Ferrous Pipes	300	99.2	1952	$158,734
9612	Ferrous Pipes	300	125.9	1954	$201,424

Watermain ID	Type	Diameter (mm)	Length (mm)	Install Year	Total Cost
9747	Ferrous Pipes	300	86.0	1968	$137,608
9837	Ferrous Pipes	300	13.9	1961	$22,260
9855	Ferrous Pipes	300	157.6	1954	$252,103
9861	Ferrous Pipes	300	25.2	1954	$40,275
9886	Ferrous Pipes	300	21.5	1954	$34,421
9897	Ferrous Pipes	300	174.1	1961	$278,556
10002	Ferrous Pipes	150	94.1	1963	$150,570
10086	Ferrous Pipes	400	4.9	1962	$7,838
10298	Ferrous Pipes	300	82.7	1955	$132,372
10395	Ferrous Pipes	300	94.2	1962	$150,791
10648	Ferrous Pipes	150	120.0	1987	$191,949
10898	Ferrous Pipes	400	2.3	1999	$3,640
11214	Ferrous Pipes	150	78.7	1987	$125,942
11305	Ferrous Pipes	300	11.3	1955	$18,094
11397	Ferrous Pipes	300	10.0	1956	$15,984
11714	Ferrous Pipes	300	74.4	1958	$119,013
12100	Ferrous Pipes	300	13.6	1956	$21,689
12361	Ferrous Pipes	150	65.5	1955	$104,747
12379	Ferrous Pipes	300	4.6	1967	$7,410
12395	Ferrous Pipes	300	31.9	1967	$50,967
12486	Ferrous Pipes	300	12.6	1967	$20,232
12487	Ferrous Pipes	300	12.2	1967	$19,509
12509	Ferrous Pipes	150	72.9	1945	$116,609
12519	Ferrous Pipes	300	4.1	1967	$6,591
12521	Ferrous Pipes	150	13.5	1945	$21,553
12525	Ferrous Pipes	200	81.9	1969	$131,093
12604	Ferrous Pipes	300	84.8	1967	$135,716
12611	Ferrous Pipes	300	22.8	1966	$36,450
12613	Ferrous Pipes	300	30.8	1966	$49,323
12780	Ferrous Pipes	150	10.8	1945	$17,311
12808	Ferrous Pipes	300	72.9	1967	$116,591
12985	Ferrous Pipes	300	5.0	1967	$7,999
13065	Ferrous Pipes	300	94.5	1968	$151,148
13081	Ferrous Pipes	300	11.1	1967	$17,808
13102	Ferrous Pipes	300	4.1	1967	$6,569
13376	Ferrous Pipes	300	69.0	1967	$110,346
13380	Ferrous Pipes	300	23.6	1968	$37,755
13385	Ferrous Pipes	300	7.3	1967	$11,645
13484	Ferrous Pipes	300	11.1	1980	$17,688
13634	Ferrous Pipes	300	76.3	1959	$122,053
13775	Ferrous Pipes	300	71.9	1966	$115,062
13790	Ferrous Pipes	200	13.9	1969	$22,231
13793	Ferrous Pipes	200	14.1	1969	$22,489
13827	Ferrous Pipes	200	5.5	1969	$8,769
13865	Ferrous Pipes	300	14.0	1966	$22,377
13918	Ferrous Pipes	150	59.9	1954	$95,771
14126	Ferrous Pipes	300	69.5	1959	$111,193
14289	Ferrous Pipes	300	18.6	1967	$29,749
14358	Ferrous Pipes	300	53.1	1967	$84,939
14462	Ferrous Pipes	300	3.3	1967	$5,341
14485	Ferrous Pipes	300	17.0	1967	$27,234
14545	Ferrous Pipes	300	9.0	1967	$14,448
14619	Ferrous Pipes	200	57.7	1959	$92,366
14621	Ferrous Pipes	200	76.2	1959	$121,969
14653	Ferrous Pipes	300	15.2	1967	$24,379
14840	Ferrous Pipes	200	11.7	1959	$18,672
14885	Ferrous Pipes	200	13.7	1959	$21,848
14900	Ferrous Pipes	200	70.5	1959	$112,818
14937	Ferrous Pipes	200	12.0	1959	$19,185
14998	Ferrous Pipes	150	71.3	1966	$114,148
15066	Ferrous Pipes	300	140.9	1967	$225,470
15104	Ferrous Pipes	150	117.6	1967	$188,084

Watermain ID	Type	Diameter (mm)	Length (mm)	Install Year	Total Cost
15263	Ferrous Pipes	150	7.3	1966	$11,604
15286	Ferrous Pipes	300	41.4	1967	$66,169
15466	Ferrous Pipes	300	33.9	1959	$54,250
15493	Ferrous Pipes	200	3.4	1950	$5,465
15498	Ferrous Pipes	200	37.2	1950	$59,531
15532	Ferrous Pipes	200	10.9	1959	$17,404
15537	Ferrous Pipes	150	32.0	1969	$51,184
15602	Ferrous Pipes	300	38.7	1967	$61,880
15643	Ferrous Pipes	200	109.8	1969	$175,601
15674	Ferrous Pipes	300	12.7	1965	$20,392
15680	Ferrous Pipes	400	58.1	1983	$92,970
15726	Ferrous Pipes	400	98.8	1983	$158,014
15773	Ferrous Pipes	400	5.5	1983	$8,866
15977	Ferrous Pipes	400	140.5	1983	$224,793
16153	Ferrous Pipes	300	25.7	1965	$41,130
16366	Ferrous Pipes	600	4.4	1965	$12,099
16531	Ferrous Pipes	150	119.4	1940	$190,989
21183	Ferrous Pipes	300	23.3	1951	$37,347
60229	Ferrous Pipes	400	62.9	1920	$100,574
60230	Ferrous Pipes	400	15.1	1920	$24,081
65351	Ferrous Pipes	400	16.1	1920	$25,722
72944	Ferrous Pipes	300	21.4	1967	$34,222
74136	Ferrous Pipes	300	127.3	1955	$203,633
77150	Ferrous Pipes	400	68.8	1969	$110,024
77151	Ferrous Pipes	400	62.4	1969	$99,888
79758	Ferrous Pipes	400	4.0	1999	$6,376
79759	Ferrous Pipes	400	4.9	1999	$7,767
82575	Ferrous Pipes	600	2.8	1965	$7,776
82580	Ferrous Pipes	400	2.5	1983	$4,057
82581	Ferrous Pipes	600	4.8	1965	$13,294
82582	Ferrous Pipes	600	2.7	1965	$7,447
82583	Ferrous Pipes	600	2.4	1965	$6,536
82584	Ferrous Pipes	600	2.4	1965	$6,564
82593	Ferrous Pipes	450	3.1	1965	$5,501
82596	Ferrous Pipes	450	3.0	1965	$5,290
82597	Ferrous Pipes	450	6.3	1965	$11,114
82600	Ferrous Pipes	450	6.0	1965	$10,665
87277	Ferrous Pipes	400	1.4	1913	$2,167
91040	Ferrous Pipes	300	56.0	1905	$89,642
91389	Ferrous Pipes	300	8.3	1967	$13,324
91438	Ferrous Pipes	300	9.4	1957	$15,058
94734	Ferrous Pipes	300	57.8	1986	$92,422
103547	Ferrous Pipes	400	2.7	1978	$4,245
103553	Ferrous Pipes	400	0.6	1978	$988
124557	Ferrous Pipes	400	27.3	1910	$43,651
124957	Ferrous Pipes	400	20.9	1923	$33,404
152362	Ferrous Pipes	400	145.8	1985	$233,303
161309	Ferrous Pipes	400	2.2	1924	$3,476
164121	Ferrous Pipes	300	42.5	1987	$114,732
164122	Ferrous Pipes	400	41.5	1900	$66,366
165342	Ferrous Pipes	300	55.4	1955	$88,614
170689	Ferrous Pipes	400	53.4	1985	$85,454
171098	Ferrous Pipes	400	35.9	1983	$57,503
183359	Ferrous Pipes	250	59.3	1900	$94,861
183361	Ferrous Pipes	250	1.5	1900	$2,376
7796	CPP	750	34.5	1964	$106,301
9119	CPP	750	112.6	1964	$346,764
11106	CPP	750	12.2	1964	$37,609
11109	CPP	750	9.1	1964	$28,114
10939	CPP	750	22.9	1964	$70,427
82525	CPP	600	275.9	1964	$758,764
16960	CPP	600	72.4	1965	$199,031

Watermain ID	Type	Diameter (mm)	Length (mm)	Install Year	Total Cost
16454	CPP	600	18.1	1965	$49,795
12887	CPP	600	137.1	1974	$377,152
158	CPP	900	15.0	1974	$65,265
188	CPP	900	6.0	1974	$26,071
596	CPP	750	16.8	1963	$51,644
876	CPP	600	7.7	1963	$21,083
943	CPP	750	73.0	1963	$224,829
1032	CPP	600	0.4	1900	$1,136
1035	CPP	750	48.8	1963	$150,376
1094	CPP	750	105.1	1963	$323,577
1127	CPP	750	63.5	1963	$195,544
1131	CPP	750	165.9	1963	$510,927
1264	CPP	750	13.4	1963	$41,300
1406	CPP	750	23.7	1963	$72,901
1436	CPP	750	3.7	1963	$11,266
1494	CPP	750	112.6	1963	$346,687
1558	CPP	750	163.3	1963	$502,850
7319	CPP	600	339.8	1964	$934,364
7387	CPP	600	206.5	1964	$567,903
7454	CPP	750	236.8	1964	$729,428
7580	CPP	600	6.5	1964	$17,786
7626	CPP	600	9.8	1964	$26,849
7724	CPP	750	110.2	1964	$339,307
7901	CPP	750	21.6	1964	$66,620
7942	CPP	600	158.3	1964	$435,214
8027	CPP	600	79.1	1964	$217,439
8083	CPP	600	495.1	1964	$1,361,547
8084	CPP	750	18.7	1964	$57,559
8137	CPP	750	94.5	1964	$291,077
8143	CPP	750	69.7	1964	$214,777
8279	CPP	750	37.5	1964	$115,454
8390	CPP	750	8.9	1964	$27,404
8391	CPP	750	267.0	1964	$822,494
8438	CPP	750	86.5	1964	$266,569
8604	CPP	750	84.6	1964	$260,557
8622	CPP	750	141.5	1964	$435,823
8626	CPP	750	83.6	1964	$257,530
8721	CPP	750	115.8	1964	$356,747
8793	CPP	600	44.5	1964	$122,483
8863	CPP	750	48.1	1964	$148,189
8937	CPP	750	22.5	1964	$69,230
9103	CPP	600	110.7	1964	$304,346
9338	CPP	600	16.0	1964	$43,981
9381	CPP	750	6.0	1964	$18,534
9391	CPP	750	8.0	1964	$24,666
9404	CPP	750	6.9	1964	$21,275
9408	CPP	750	1.6	1964	$4,994
9472	CPP	750	11.0	1964	$33,905
9491	CPP	750	5.1	1964	$15,691
9684	CPP	600	64.3	1964	$176,950
9888	CPP	600	203.3	1964	$558,943
9901	CPP	750	3.1	1964	$9,539
9902	CPP	750	7.8	1964	$24,166
9907	CPP	750	4.5	1964	$13,790
10004	CPP	600	150.2	1963	$413,095
10040	CPP	750	208.3	1964	$641,659
10053	CPP	750	54.3	1963	$167,337
10101	CPP	750	127.3	1964	$391,949
10327	CPP	750	262.2	1963	$807,721
10362	CPP	600	109.2	1965	$300,344
10364	CPP	900	129.8	1965	$564,599
10391	CPP	750	37.5	1963	$115,519

Watermain ID	Type	Diameter (mm)	Length (mm)	Install Year	Total Cost
10403	CPP	900	72.5	1963	$315,559
10431	CPP	600	142.5	1965	$391,767
10446	CPP	750	505.1	1964	$1,555,784
10477	CPP	900	5.7	1963	$24,639
10483	CPP	750	3.0	1963	$9,388
10486	CPP	600	254.1	1965	$698,694
10491	CPP	750	2.2	1963	$6,761
10500	CPP	750	160.4	1964	$494,119
10507	CPP	750	160.1	1963	$493,050
10512	CPP	750	25.4	1964	$78,322
10578	CPP	600	6.0	1965	$16,433
10608	CPP	900	5.2	1963	$22,514
10619	CPP	600	21.9	1963	$60,231
10621	CPP	600	25.9	1963	$71,241
10630	CPP	750	117.0	1964	$360,496
10646	CPP	600	16.4	1963	$45,188
10652	CPP	600	1.6	1965	$4,427
10785	CPP	750	126.6	1963	$389,826
10945	CPP	750	199.1	1963	$613,218
10949	CPP	600	9.0	1963	$24,627
11007	CPP	750	19.8	1964	$60,940
11062	CPP	750	152.8	1963	$470,604
11156	CPP	750	3.4	1963	$10,328
11258	CPP	750	24.7	1963	$76,147
11315	CPP	750	12.5	1963	$38,472
11499	CPP	750	81.6	1963	$251,324
11587	CPP	750	16.8	1963	$51,605
11596	CPP	750	32.0	1963	$98,682
11597	CPP	750	33.5	1963	$103,325
11625	CPP	750	438.4	1963	$1,350,415
11677	CPP	750	6.1	1963	$18,800
11691	CPP	750	391.1	1963	$1,204,689
11693	CPP	750	452.7	1964	$1,394,250
11701	CPP	750	0.6	1963	$1,767
11705	CPP	600	462.3	1963	$1,271,353
11739	CPP	600	35.0	1963	$96,272
11821	CPP	750	505.2	1963	$1,556,056
11876	CPP	750	27.6	1964	$84,960
11899	CPP	600	26.0	1963	$71,511
12018	CPP	600	4.2	1963	$11,529
12044	CPP	750	39.6	1963	$122,041
12046	CPP	750	13.3	1963	$41,071
12081	CPP	600	5.5	1965	$15,098
12086	CPP	600	7.1	1963	$19,487
12201	CPP	600	34.0	1963	$93,484
12207	CPP	600	24.4	1965	$67,196
12213	CPP	600	35.0	1963	$96,251
12222	CPP	750	4.3	1963	$13,133
12232	CPP	600	34.0	1963	$93,613
12261	CPP	600	35.0	1963	$96,225
12278	CPP	750	17.4	1963	$53,502
12282	CPP	750	11.6	1963	$35,665
12839	CPP	600	82.5	1974	$226,766
12916	CPP	600	83.2	1967	$228,781
12946	CPP	600	67.8	1974	$186,387
13026	CPP	600	141.3	1974	$388,530
13133	CPP	600	163.0	1964	$448,122
13177	CPP	600	95.0	1964	$261,186
13179	CPP	600	27.7	1963	$76,208
13239	CPP	600	24.6	1964	$67,532
13247	CPP	600	13.0	1964	$35,691
13253	CPP	600	65.1	1967	$178,934

Watermain ID	Type	Diameter (mm)	Length (mm)	Install Year	Total Cost
13261	CPP	600	9.2	1967	$25,299
13316	CPP	600	12.0	1967	$32,891
13338	CPP	600	2.8	1967	$7,759
13371	CPP	600	77.0	1963	$211,848
13393	CPP	600	5.2	1967	$14,248
13401	CPP	600	11.2	1967	$30,756
13441	CPP	600	88.0	1974	$242,022
13462	CPP	600	61.0	1967	$167,629
13563	CPP	600	4.0	1967	$10,917
13588	CPP	600	41.3	1967	$113,480
13650	CPP	600	4.5	1967	$12,457
13652	CPP	600	7.0	1967	$19,254
13656	CPP	600	1.3	1967	$3,445
13658	CPP	600	0.8	1967	$2,067
13667	CPP	600	8.2	1967	$22,626
13704	CPP	600	58.2	1964	$159,986
13706	CPP	600	12.1	1967	$33,139
13738	CPP	600	64.7	1967	$177,939
13771	CPP	600	53.3	1967	$146,677
13839	CPP	600	50.3	1974	$138,282
13842	CPP	600	6.6	1967	$18,031
13847	CPP	600	5.5	1967	$15,192
13880	CPP	600	7.6	1967	$20,957
13886	CPP	600	41.2	1974	$113,327
13892	CPP	600	4.8	1967	$13,208
13894	CPP	600	18.3	1974	$50,316
13895	CPP	600	3.9	1974	$10,632
13900	CPP	600	12.2	1967	$33,525
13902	CPP	600	4.0	1967	$10,917
13905	CPP	600	6.0	1967	$16,376
13907	CPP	600	7.5	1967	$20,594
13955	CPP	600	76.5	1967	$210,494
13957	CPP	600	13.6	1964	$37,491
13996	CPP	600	43.2	1967	$118,680
14011	CPP	600	15.0	1964	$41,377
14054	CPP	900	29.1	1966	$126,620
14059	CPP	600	3.3	1964	$8,949
14061	CPP	600	18.7	1974	$51,558
14106	CPP	600	9.6	1974	$26,371
14120	CPP	600	7.0	1967	$19,134
14134	CPP	600	8.7	1974	$23,923
14139	CPP	600	2.7	1967	$7,445
14142	CPP	600	14.3	1974	$39,453
14149	CPP	600	4.1	1974	$11,354
14152	CPP	600	2.9	1974	$7,905
14156	CPP	600	4.3	1964	$11,862
14190	CPP	600	18.8	1974	$51,624
14198	CPP	600	48.3	1967	$132,699
14241	CPP	600	8.4	1974	$23,148
14259	CPP	600	4.2	1974	$11,545
14274	CPP	600	3.7	1974	$10,232
14293	CPP	600	2.4	1974	$6,628
14300	CPP	600	4.7	1974	$13,009
14335	CPP	600	9.9	1964	$27,099
14339	CPP	600	52.1	1963	$143,395
14348	CPP	600	58.0	1967	$159,635
14362	CPP	600	4.6	1967	$12,573
14393	CPP	600	51.1	1974	$140,643
14410	CPP	600	39.1	1967	$107,652
14427	CPP	600	13.3	1964	$36,470
14470	CPP	600	33.4	1974	$91,898
14503	CPP	600	5.1	1974	$13,970

Watermain ID	Type	Diameter (mm)	Length (mm)	Install Year	Total Cost
14541	CPP	600	14.0	1974	$38,468
14555	CPP	600	47.6	1967	$130,959
14559	CPP	600	5.2	1974	$14,219
14576	CPP	600	6.2	1974	$17,179
14599	CPP	600	48.8	1967	$134,106
14601	CPP	600	45.7	1967	$125,710
14614	CPP	600	4.4	1974	$12,042
14617	CPP	600	10.8	1967	$29,750
14643	CPP	600	21.3	1967	$58,693
14656	CPP	600	15.8	1974	$43,584
14657	CPP	600	1.2	1967	$3,168
14678	CPP	600	18.2	1963	$49,932
14694	CPP	600	67.6	1967	$185,847
14704	CPP	600	5.0	1963	$13,754
14730	CPP	600	14.4	1967	$39,729
14740	CPP	600	4.1	1967	$11,358
14768	CPP	600	4.3	1974	$11,905
14785	CPP	600	16.0	1967	$43,945
14797	CPP	600	23.9	1967	$65,617
14805	CPP	600	5.1	1967	$13,923
14811	CPP	900	12.2	1966	$53,037
14821	CPP	600	7.9	1967	$21,817
14906	CPP	600	3.4	1967	$9,264
14918	CPP	600	7.0	1967	$19,215
14926	CPP	600	13.0	1974	$35,652
14942	CPP	900	3.1	1966	$13,386
15005	CPP	600	4.5	1974	$12,379
15020	CPP	600	6.1	1974	$16,764
15044	CPP	600	5.8	1974	$15,935
15054	CPP	600	107.1	1974	$294,566
15060	CPP	600	4.3	1966	$11,770
15076	CPP	600	46.8	1963	$128,780
15077	CPP	600	3.4	1974	$9,291
15086	CPP	600	63.3	1963	$174,144
15124	CPP	600	1.5	1967	$4,024
15134	CPP	600	4.3	1967	$11,883
15143	CPP	600	5.6	1967	$15,302
15266	CPP	600	206.0	1974	$566,569
15268	CPP	600	19.3	1967	$53,177
15290	CPP	600	120.8	1974	$332,094
15291	CPP	600	23.5	1967	$64,537
15339	CPP	600	5.8	1967	$15,908
15353	CPP	600	3.6	1974	$9,840
15403	CPP	600	148.9	1974	$409,573
15504	CPP	600	49.4	1967	$135,865
15660	CPP	600	40.0	1963	$109,913
15997	CPP	600	18.8	1965	$51,791
16186	CPP	600	19.1	1965	$52,536
16209	CPP	900	67.1	1965	$291,701
16223	CPP	900	0.8	1965	$3,273
16351	CPP	600	7.5	1965	$20,740
16399	CPP	600	1.5	1965	$4,081
16401	CPP	600	3.0	1965	$8,386
16435	CPP	600	57.6	1965	$158,423
16437	CPP	600	21.1	1965	$58,137
16483	CPP	600	210.9	1965	$579,973
16492	CPP	600	38.3	1965	$105,409
16504	CPP	600	147.8	1965	$406,522
16516	CPP	600	72.9	1965	$200,340
16538	CPP	600	5.7	1965	$15,699
16542	CPP	600	4.7	1965	$12,908
16547	CPP	600	5.1	1965	$13,956

Watermain ID	Type	Diameter (mm)	Length (mm)	Install Year	Total Cost
16550	CPP	600	6.7	1965	$18,449
16553	CPP	600	13.6	1965	$37,474
16569	CPP	600	153.3	1965	$421,582
16570	CPP	600	286.2	1965	$786,994
16582	CPP	600	7.0	1965	$19,124
16593	CPP	600	44.4	1965	$122,012
16598	CPP	600	104.1	1965	$286,175
16620	CPP	600	29.0	1965	$79,781
16623	CPP	600	19.6	1965	$53,855
16654	CPP	600	34.9	1965	$95,920
16662	CPP	600	20.0	1965	$55,070
16670	CPP	600	6.8	1965	$18,820
16679	CPP	600	13.7	1965	$37,670
16696	CPP	600	8.6	1965	$23,587
16726	CPP	600	95.2	1965	$261,923
16734	CPP	600	12.9	1965	$35,449
16735	CPP	600	19.6	1965	$53,851
16738	CPP	600	30.5	1965	$83,807
16745	CPP	600	37.3	1965	$102,502
16751	CPP	600	152.6	1965	$419,625
16761	CPP	600	14.3	1965	$39,407
16798	CPP	600	20.1	1965	$55,302
16832	CPP	600	77.7	1965	$213,738
16866	CPP	600	6.7	1965	$18,310
16871	CPP	600	104.8	1965	$288,280
16907	CPP	600	126.1	1965	$346,792
16928	CPP	600	37.3	1965	$102,504
16976	CPP	600	42.1	1965	$115,652
16992	CPP	600	78.2	1965	$215,063
17060	CPP	600	5.6	1965	$15,477
17079	CPP	600	34.4	1965	$94,488
17112	CPP	600	7.1	1965	$19,400
17159	CPP	600	14.8	1965	$40,831
17162	CPP	600	7.8	1965	$21,328
17169	CPP	600	15.7	1965	$43,233
17243	CPP	600	7.7	1965	$21,051
17247	CPP	600	60.0	1965	$164,908
17260	CPP	600	3.1	1965	$8,483
17267	CPP	600	20.4	1965	$56,131
17276	CPP	600	25.9	1965	$71,186
17278	CPP	600	47.7	1965	$131,293
77197	CPP	600	4.0	1964	$11,080
80366	CPP	600	40.2	1963	$110,423
82527	CPP	600	13.6	1964	$37,431
82528	CPP	600	7.5	1964	$20,671
82573	CPP	600	4.8	1965	$13,221
82601	CPP	600	12.2	1965	$33,540
82602	CPP	600	11.9	1965	$32,816
84031	CPP	600	5.2	1965	$14,319
84074	CPP	600	1.8	1964	$4,963
89805	CPP	600	37.7	1965	$103,640
89822	CPP	600	9.3	1965	$25,654
89823	CPP	600	15.0	1965	$41,250
89824	CPP	600	53.0	1965	$145,848
89825	CPP	600	33.3	1965	$91,580
89826	CPP	600	34.0	1965	$93,400
89827	CPP	600	11.8	1965	$32,511
89828	CPP	600	41.4	1965	$113,806
89838	CPP	600	110.4	1965	$303,539
89840	CPP	600	4.6	1965	$12,667
89841	CPP	600	16.5	1965	$45,507
89844	CPP	600	7.1	1965	$19,597

Watermain ID	Type	Diameter (mm)	Length (mm)	Install Year	Total Cost
91453	CPP	600	2.4	1974	$6,477
91455	CPP	600	67.3	1974	$184,974
91456	CPP	600	5.6	1974	$15,514
91457	CPP	600	3.8	1974	$10,526
91458	CPP	600	3.4	1974	$9,285
91459	CPP	600	3.8	1967	$10,423
94708	Thermoplastic Opportunistic Sampling	600	89.3	1964	$245,472
94709	Thermoplastic Opportunistic Sampling	600	396.3	1964	$1,089,725
103965	Thermoplastic Opportunistic Sampling	600	17.7	1965	$48,586
109787	Thermoplastic Opportunistic Sampling	600	19.7	1965	$54,222
109788	Thermoplastic Opportunistic Sampling	600	6.8	1965	$18,645
109789	Thermoplastic Opportunistic Sampling	600	0.1	1965	$386
127758	Thermoplastic Opportunistic Sampling	600	2.9	1964	$8,087
152368	Thermoplastic Opportunistic Sampling	750	2.4	1963	$7,431
155688	Thermoplastic Opportunistic Sampling	600	1.4	1963	$3,749
180462	Thermoplastic Opportunistic Sampling	600	24.3	1974	$66,699
813	Thermoplastic Opportunistic Sampling	250	5.9	1995	$9,498
847	Thermoplastic Opportunistic Sampling	250	3.6	1995	$5,769
955	Thermoplastic Opportunistic Sampling	250	22.1	1995	$59,655
1225	Thermoplastic Opportunistic Sampling	100	4.8	1999	$7,684
7363	Thermoplastic Opportunistic Sampling	200	10.0	1995	$16,000
7374	Thermoplastic Opportunistic Sampling	200	17.0	1995	$27,265
7410	Thermoplastic Opportunistic Sampling	200	11.5	1997	$18,395
7469	Thermoplastic Opportunistic Sampling	200	110.2	1997	$176,374
7768	Thermoplastic Opportunistic Sampling	200	40.0	1997	$64,036
7944	Thermoplastic Opportunistic Sampling	200	68.5	1997	$109,679
7997	Thermoplastic Opportunistic Sampling	200	60.0	1995	$96,080
8046	Thermoplastic Opportunistic Sampling	200	22.0	1995	$35,209
8191	Thermoplastic Opportunistic Sampling	200	5.3	1995	$8,430
8372	Thermoplastic Opportunistic Sampling	200	63.1	1995	$101,000
8406	Thermoplastic Opportunistic Sampling	200	18.9	1997	$30,288
8464	Thermoplastic Opportunistic Sampling	200	7.0	1995	$11,199
8590	Thermoplastic Opportunistic Sampling	200	20.0	1996	$31,988
8592	Thermoplastic Opportunistic Sampling	200	52.9	1996	$84,655
8595	Thermoplastic Opportunistic Sampling	200	25.8	1996	$41,219
8641	Thermoplastic Opportunistic Sampling	200	37.0	1995	$59,189
8684	Thermoplastic Opportunistic Sampling	200	16.7	1995	$26,768
8809	Thermoplastic Opportunistic Sampling	200	6.3	1995	$10,137
8860	Thermoplastic Opportunistic Sampling	200	7.0	1996	$11,213
9117	Thermoplastic Opportunistic Sampling	200	22.0	1996	$35,206
9273	Thermoplastic Opportunistic Sampling	200	19.0	1996	$30,405
9291	Thermoplastic Opportunistic Sampling	200	15.5	1996	$24,731
9379	Thermoplastic Opportunistic Sampling	200	51.4	1996	$82,248
9479	Thermoplastic Opportunistic Sampling	200	13.5	1996	$21,528
9501	Thermoplastic Opportunistic Sampling	200	10.9	1995	$17,381
9538	Thermoplastic Opportunistic Sampling	200	55.1	1995	$88,193
9551	Thermoplastic Opportunistic Sampling	200	36.3	1996	$58,098
9668	Thermoplastic Opportunistic Sampling	200	139.0	1997	$222,462
9697	Thermoplastic Opportunistic Sampling	200	36.3	1997	$58,113
9816	Thermoplastic Opportunistic Sampling	200	14.6	1995	$23,326
9820	Thermoplastic Opportunistic Sampling	200	22.6	1995	$36,106
9873	Thermoplastic Opportunistic Sampling	200	5.5	1995	$8,726
9885	Thermoplastic Opportunistic Sampling	200	39.0	1995	$62,404
10048	Thermoplastic Opportunistic Sampling	200	2.4	1998	$3,779
10080	Thermoplastic Opportunistic Sampling	200	0.6	1998	$977
10128	Thermoplastic Opportunistic Sampling	200	6.9	1998	$11,049
10352	Thermoplastic Opportunistic Sampling	150	77.9	1998	$124,618
10430	Thermoplastic Opportunistic Sampling	150	14.2	1998	$22,761
10444	Thermoplastic Opportunistic Sampling	150	16.5	1998	$26,337
10454	Thermoplastic Opportunistic Sampling	150	6.7	1998	$10,735
10461	Thermoplastic Opportunistic Sampling	150	1.8	1998	$2,922
10464	Thermoplastic Opportunistic Sampling	150	2.6	1998	$4,140

Watermain ID	Type	Diameter (mm)	Length (mm)	Install Year	Total Cost
10494	Thermoplastic Opportunistic Sampling	150	10.4	1998	$16,712
10525	Thermoplastic Opportunistic Sampling	150	94.8	1998	$151,695
10573	Thermoplastic Opportunistic Sampling	150	13.9	1998	$22,221
10584	Thermoplastic Opportunistic Sampling	150	11.2	1998	$17,952
10592	Thermoplastic Opportunistic Sampling	150	9.3	1998	$14,850
10665	Thermoplastic Opportunistic Sampling	150	7.0	1998	$11,222
10687	Thermoplastic Opportunistic Sampling	150	5.5	1998	$8,778
10690	Thermoplastic Opportunistic Sampling	150	14.3	1998	$22,832
10722	Thermoplastic Opportunistic Sampling	150	2.4	1998	$3,916
10902	Thermoplastic Opportunistic Sampling	150	76.2	1998	$121,863
10903	Thermoplastic Opportunistic Sampling	150	39.1	1998	$62,633
11127	Thermoplastic Opportunistic Sampling	150	13.8	1998	$22,126
11133	Thermoplastic Opportunistic Sampling	100	59.1	1993	$94,489
11147	Thermoplastic Opportunistic Sampling	150	3.2	1998	$5,117
11201	Thermoplastic Opportunistic Sampling	150	10.9	1913	$17,456
11227	Thermoplastic Opportunistic Sampling	150	1.3	1913	$2,000
11271	Thermoplastic Opportunistic Sampling	150	2.4	1998	$3,870
11396	Thermoplastic Opportunistic Sampling	100	14.2	1993	$22,740
11563	Thermoplastic Opportunistic Sampling	200	22.3	1992	$35,676
11571	Thermoplastic Opportunistic Sampling	200	4.7	1993	$7,579
11580	Thermoplastic Opportunistic Sampling	150	2.5	1993	$3,996
11584	Thermoplastic Opportunistic Sampling	200	14.9	1992	$23,817
11888	Thermoplastic Opportunistic Sampling	150	141.0	1998	$225,530
12224	Thermoplastic Opportunistic Sampling	150	7.9	1998	$12,669
12255	Thermoplastic Opportunistic Sampling	150	0.9	1998	$1,472
12306	Thermoplastic Opportunistic Sampling	150	70.1	1998	$112,193
12320	Thermoplastic Opportunistic Sampling	200	35.1	1998	$56,139
15735	Thermoplastic Opportunistic Sampling	200	34.5	1992	$55,201
15760	Thermoplastic Opportunistic Sampling	200	129.8	1992	$207,691
15786	Thermoplastic Opportunistic Sampling	200	22.5	1992	$35,993
15794	Thermoplastic Opportunistic Sampling	200	14.3	1992	$22,926
15905	Thermoplastic Opportunistic Sampling	200	75.9	1992	$121,469
15929	Thermoplastic Opportunistic Sampling	200	5.0	1992	$8,003
15981	Thermoplastic Opportunistic Sampling	200	28.5	1992	$45,594
16050	Thermoplastic Opportunistic Sampling	200	72.0	1992	$115,199
16088	Thermoplastic Opportunistic Sampling	200	20.0	1992	$31,952
16094	Thermoplastic Opportunistic Sampling	200	22.7	1992	$36,345
16098	Thermoplastic Opportunistic Sampling	200	22.5	1992	$36,007
16119	Thermoplastic Opportunistic Sampling	200	51.0	1992	$81,593
16123	Thermoplastic Opportunistic Sampling	200	58.8	1992	$94,101
16157	Thermoplastic Opportunistic Sampling	200	12.0	1992	$19,207
16165	Thermoplastic Opportunistic Sampling	200	52.0	1992	$83,205
16172	Thermoplastic Opportunistic Sampling	200	12.2	1992	$19,504
16174	Thermoplastic Opportunistic Sampling	200	21.4	1992	$34,187
16187	Thermoplastic Opportunistic Sampling	200	14.5	1992	$23,128
16204	Thermoplastic Opportunistic Sampling	200	41.0	1992	$65,596
16208	Thermoplastic Opportunistic Sampling	200	49.5	1992	$79,200
16219	Thermoplastic Opportunistic Sampling	200	19.0	1992	$30,407
16236	Thermoplastic Opportunistic Sampling	200	57.8	1992	$92,450
16241	Thermoplastic Opportunistic Sampling	200	1.3	1992	$2,139
16276	Thermoplastic Opportunistic Sampling	200	5.0	1992	$8,037
16282	Thermoplastic Opportunistic Sampling	200	2.0	1992	$3,164
16285	Thermoplastic Opportunistic Sampling	200	25.2	1992	$40,268
16373	Thermoplastic Opportunistic Sampling	200	21.0	1992	$33,678
16730	Thermoplastic Opportunistic Sampling	150	15.8	1999	$25,359
16752	Thermoplastic Opportunistic Sampling	150	2.0	1999	$3,197
46781	Thermoplastic Opportunistic Sampling	150	145.8	1999	$233,238
79805	Thermoplastic Opportunistic Sampling	200	12.3	1997	$19,706
94513	Thermoplastic Opportunistic Sampling	150	1.4	1998	$2,162
161313	Thermoplastic Opportunistic Sampling	150	2.0	1998	$3,219

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