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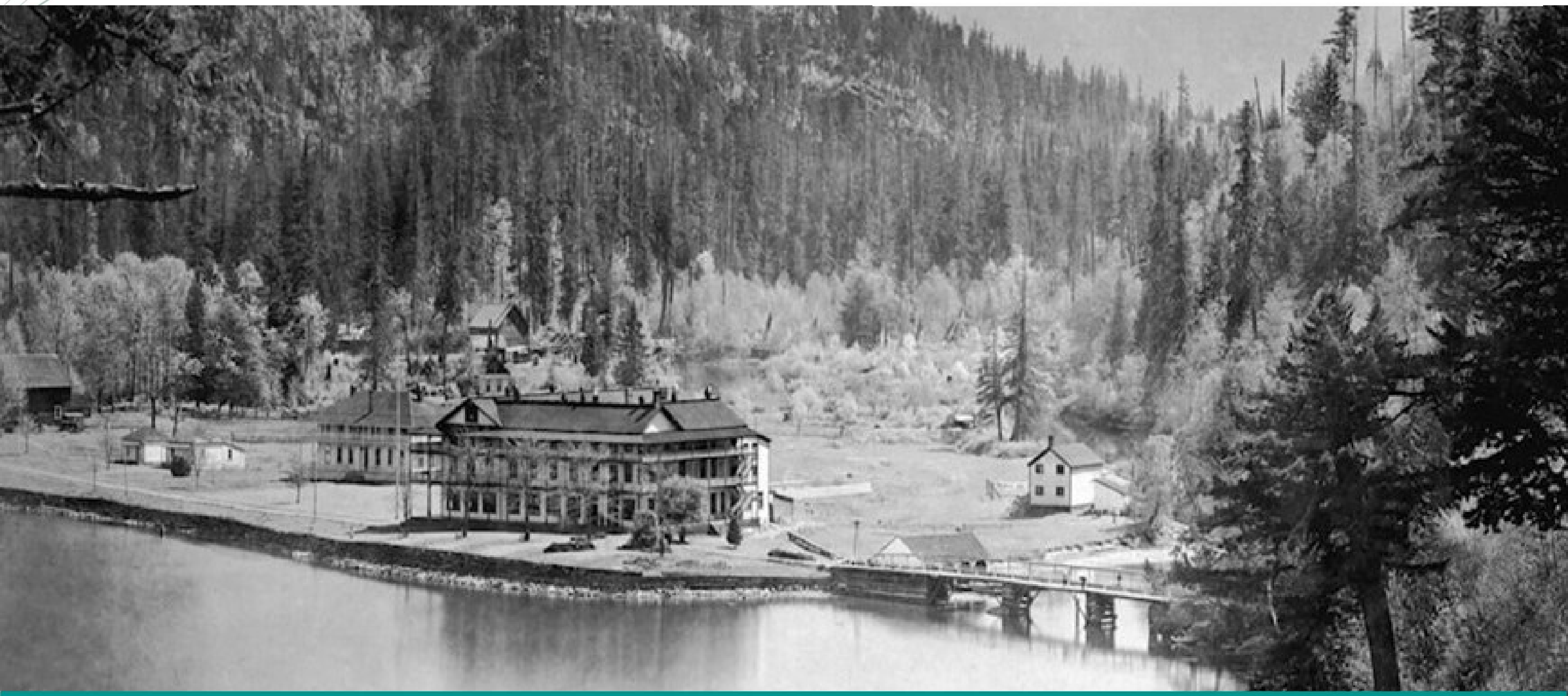
BEST MANAGED COMPANIES



Harrison Hot Springs

Water Treatment Plant - Master Plan - FINAL Revision 1

August 7, 2026

Submitted to: Village of Harrison Hot Springs
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Our file: 2241-25029-00

Your Challenge.
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Executive Summary

INTRODUCTION

As part of their objective of maintaining and improving their water treatment infrastructure both now and for the future, the Village of Harrison Hot Springs (VHHS) commissioned McElhanney to prepare a Master Plan for their Water Treatment Plant (WWTP).

The Harrison Hot Springs WTP is a membrane-based ultrafiltration facility that feeds a steel bolted reservoir located on Agassiz Mountain. This reservoir provides gravity-fed potable water to the Village of Harrison Hot Springs. A comprehensive assessment of the WTP was conducted to evaluate the condition, capacity, and resiliency of major process units, with the goal of identifying risks and informing capital planning over a 10-year horizon.

PLANT FLOWS

The review included analysis of historical and projected water demand, seasonal variations, and the ability of the system to meet future needs. While the current system meets current water demands, future demand—such as from potential connections like the Harrison Hot Springs Resort and Holiday Park—will challenge the system's capacity. A future maximum day demand (MDD) of 50.6 L/s was selected as the design basis for capacity planning.

Based on annual ADD (base) projections, the Village is expected to reach its water licence limit (454,609 m^3/year under licence C114223) by 2030. This timeline would be shortened further should the Resort or campground connect to the water system. To prepare, the Village should consider applying for a licence amendment a few years in advance of meeting permit limits while monitoring annual water use.

CONDITION AND CAPACITY ASSESSMENT

Capacity assessments revealed that while some components (e.g., intake pipe and lake pumps) can meet future demands, others—such as the ultrafiltration system, break tank, and distribution pumps—will require upgrades. The existing reservoir has sufficient volume to meet future storage requirements, but its protection remains a priority.

Key findings for each process area are detailed in Section 4. Summary of system capacities are detailed in Section 5. Summary of recommendations and an implementation plan are provided in Section 6.

PROJECT COST ESTIMATE AND POTENTIAL FUNDING SOURCE

A prioritized capital planning schedule was developed to guide infrastructure upgrades over the next decade. Upgrades were identified and grouped into two major categories-based funding source:

1. Funded using the existing annual operating reserves. Some projects would be undertaken in-house (by Operations Staff) to reduce overall costs, whereas some projects might require engineering design services.

2. Grant funding candidate. These are typically larger complex projects which require engineering design services.

Some projects in both categories might also be candidates for Development Cost Charges (DCC) funding, if upgrades also result in treatment capacity increases.

Note that if grant funding is not available, some projects may require financing if the timing of the project cannot be delayed, either due to the process or component being at capacity due to increased influent flows or equipment being at the end of its life.

Assumptions:

- Capital cost estimates were prepared for all projects.
- Based on the level of detail at the time of preparing the estimates, the cost estimate should be considered Class D. **Thus, 40% should be added as a contingency to the capital cost to cover unknown details.**
- Engineering fees were estimated at 15% of the capital costs and are identified in a separate column. For small capital value projects (<$100K), engineering fees were estimated at 20%.
- Projects that VHHS deemed could be undertaken in-house did not included engineering fees.
- Escalation costs were not included in the estimates as the exact timing of most projects is unknown and will depend on other factors such as funding availability. **An annual escalation fee (~3%) should be added to the project costs on top of the contingency and engineering percent estimates, depending on the final timing of the project.**
- All costs and fees are rounded up to the closest $1000.

The projects were also grouped into three timeframes as follows:

- Short-term: 0-5 years
- Medium-term: 5-10 Years
- Long-term: 10-20 Years

The proposed cost estimates and project schedule based on these time frames is presented in the figure below. The detailed cost estimates are provided in the appendices of this report.

Capital Costs and Project Schedule

Village of Harrison Hot Spring

WTP - Master Plan - Capital Improvements

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Class D Estimate. 40% contingency not included & to be added to all projects.

Project No.	TASK DESCRIPTION	DCC Eligibility	Short-Term 0 - 5 years		Medium-Term 5 - 10 years		Long-Term 10 - 20 years	
	Water Treatment Plant							
	ANNUAL OPERATING PROJECTS		Engineering	Capital	Engineering	Capital	Engineering	Capital
WP#2 Phase 1 (See Note 4)	*Construct a new building, building extension or lean-to, to house additional membrane trains, the break tank and distribution pumps (as applicable). Include site civil to decommission water main under the existing building. Tear down existing masonry/storage building behind existing WTP.	✓	$ 193,000	$ 919,000				
WP#2 Phase 2 (See Note 4)	*Relocate the distribution pumps to connect with a relocated break tank. Allocate space for 4th pump. Simultaneously address concern with pump discharge piping. *Install new break tank in a relocated location.	✓			$ 136,000	$ 645,000		
WP#3	*Electrical surge protection *Segregate electrical/controls equipment into small electrical room		$ 13,000	$ 46,000				
WP#4	*Add third UF train in future to meet future demand. Includes CIP system and piping modifications. *Upgrade the control system for the membrane trains and the WTP master control system	✓					$ 180,000	$ 855,000
WP#5	*Install a pressure relief valve at the WTP inlet		$ 14,000	$ 49,000				
WP#6	*Complete Phase 3 rockfall hazard mitigation				$ -	$ 146,000		
WP#7	*Train #2 membrane replacement				$ 55,000	$ 259,000		
WP#8	*Conduct a detailed study on UF membrane performance *Conduct lake pump testing to confirm max flows & assess impact to WQ				$ 70,000			
WP#9	*Add improved secondary containment for hypochlorite drums and dosing system.		$ 2,000	$ 6,000				
WP#10	*Conduct a lake intake extension and protection study						$ 20,000	
	SUBTOTAL		$	1,242,000	$	1,311,000	$	1,055,000
	GRANT OPPORTUNITY PROJECTS							
WP#1	* Relocate critical electrical equipment to kiosk at higher elevation (Option 4) * Replace lake pump VFDs and PLC.VFDs to suit new pumps. * Replace lake pumps, check valves and address vault alarm/electrical concerns		$ 132,000	$ 628,000				
WP#11	*New permanent generator (incl. capacity for future upgrades)	✓			$ 32,000	$ 148,000		
	SUBTOTAL		$	760,000	$	180,000	$	-
	TOTAL ESTIMATED COSTS PER TIME FRAME		$	2,002,000	$	1,491,000	$	1,055,000
	FURTHER INVESTIGATION REQ'D							

	Assumptions (See report for more details)
1	Inflation: Inflation is not included. Suggest using 3% / year after 2025 or actual value, if known. Future grant funding applications should account for rise in cost based on inflation.
2	Engineering: 15% for projects which require engineering, 20% for smaller projects <$100k. In-house projects do not include engineering.
3	Class D Estimate: 40% contingency should be added to all projects. Engineering is based on the estimated project cost + contingency.
4	WP#2 Option A refers to the break tank being located inside the building, and therefore a larger building footprint is required. WP#2 Option B refers to the break tank being located outside the building, and therefore a smaller building footprint is required. Costing assumes worst-case cost between WP#2 Option A vs. #2 Option B. The worst case total project cost is Option B, but note this option has less upfront cost for the building. Note: As requested by the VoHHS, work package 2 has been separated out as two separate project phases (Phase 1 and Phase 2). This may incur greater costs and construction challenges than combining them into one delivery. McElhanney recommends that Phase 1 and Phase 2 are delivered under a single contract. A single-contract delivery approach for Phase 1 and Phase 2 would provide greater flexibility to incorporate design refinements and optimize coordination between the building and process equipment throughout the project.
5	Values exclude tax.
6	The generator upgrade for the WTP (WP#11) should be planned in conjunction with WP#2. As requested by VoHHS, if the implementation of WP#2 is postponed beyond the next 1 to 3 years, VoHHS would like the generator upgrade to proceed independently and be completed within the next couple of years.
7	No engineering fees apply to the rockfall hazard mitigation, as the scope of work has already been fully defined by a professional service provider.
8	No additional engineering fees apply to scope of works that are engineering / desktop studies
9	WP#9 budgets for an engineered concrete curb. A polyethylene containment may be a suitable, more cost-effective option.
10	Most of the projects presented herein are stand-alone projects and can be undertaken when funding is available or based on other factors. Work packages #2 and #4 would need to be undertaken sequentially as the additional building/ building extension would be required to house new membrane equipment. Work package #8 should also be completed in advance of work package #4 to further inform the design requirements of the third membrane train. Work package #11 should be planned in coordination with work package #4, to align generator/standby power needs with various WTP upgrades.

Contents

1. Introduction

The Village of Harrison Hot Springs (the Village), as part of their objective of maintaining and improving their water treatment infrastructure both now and for the future, has requested McElhanney to prepare a Master Plan for their Water Treatment Plant (WTP).

McElhanney conducted several site visits to review the existing system and meet with the Village staff in person to discuss their specific concerns. The Village expressed its commitment to assessing the resiliency of the existing water treatment infrastructure and prioritizing future upgrades. Numerous upgrades for the long-term betterment of the Water Treatment Plant (WTP) were identified by the Village with a focus on allocating space for future treatment process trains, assessing electrical upgrades at both the WTP and lake pumphouse, and reviewing long term water security.

McElhanney recognizes that the Village of Harrison Hot Springs would like a Master Plan to identify opportunities for improvement at the WTP, including a prioritized list of recommended upgrades including Class D cost estimate.

The objectives of this Master Plan are to:

- Review existing and forecast future water demands.
- Provide design information of existing infrastructure.
- Recommend infrastructure improvements to meet future demand (**Capacity**).
- Identify opportunities for improvement in the condition of existing infrastructure (**Condition**)
- Assess water security risks and propose mitigation options (**Resiliency**). This task primarily covers a review of 1) the lake intake & VFD location with flood zone mapping; 2) reservoir maintenance and bypass; 3) the raw water intake pipeline elevation; and 4) feasibility of future groundwater supply.
- Prioritize recommended infrastructure upgrades and estimate costs for key improvement packages.

Note that based on historical discussions with the Village, treatment compliance of the existing water system is not currently a concern, and thus treatment performance is not reviewed in this report. McElhanney recommend that the Village continue monitoring raw water quality over time to observe and trend changes in the watershed.

2. Background

2.1. SYSTEM OVERVIEW

The existing water treatment plant (WTP) consists of the following major process elements:

- Lake intake pipe with fish screens. Water enters the VHHS system through a 350 mm intake line which extends just over one kilometer north into Harrison Lake.
- Lake pumpstation containing three 40 HP Berkeley centrifugal pumps with VFD control. These pumps are located inside a pumpstation vault near the Harrison Lake shoreline and transport water from the intake to the Water Treatment Plant. The VFDs are located in an electrical room near the Harrison Lake shoreline with the generator housed nearby outside the electrical building.
- Water treatment building facility, constructed in 2014 and located on the west side of Hot Springs Road at Balsam Avenue, containing:
    - Ultrafiltration membrane trains; two trains operated in parallel and equipped with a clean-in-place (CIP) system.
    - Chlorine disinfection via a dedicated sodium hypochlorite dosing system.
    - A polyethylene break tank for distribution pump supply.
    - Three 40-HP booster pumps to lift water to the steel bolted reservoir housed on Agassiz Mountain.
- A steel bolted water reservoir (total volume 2,678 m^3).
- Treated water is delivered to consumer via gravity flow via a network of distribution piping. Analysis of the distribution system is excluded from this report.

A process flow diagram of the treatment process from record drawings is shown in Figure 1 below and the Piping and Instrumentation Diagram (P&ID) is attached in Appendix B. The diagram also shows the previous chlorine building, which is currently used for general storage. Note that three booster pumps are currently in place, which differs to the two noted in the diagram below.

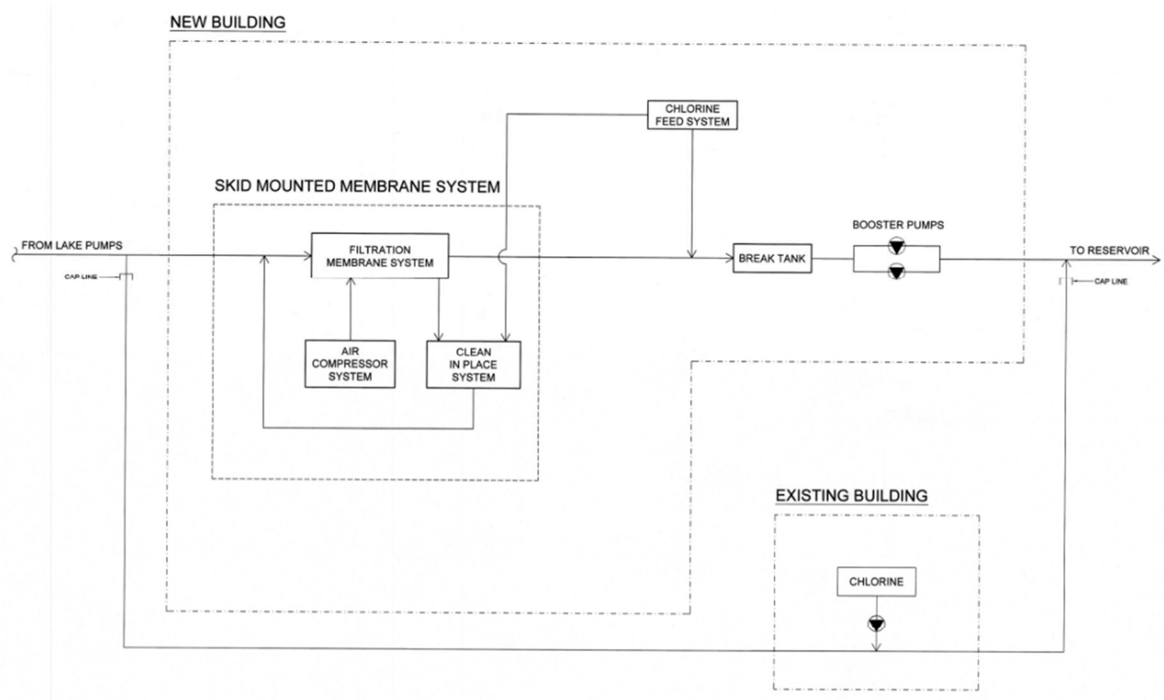


Figure 1: Process Flow Diagram (Hatch Mott MacDonald, 2014)

2.2. SITE VISITS

On February 26, 2025, McElhanney's Christina Saxvik met with Tyler Simmonds and conducted a site visit to discuss current concerns and to better define the scope of work for a full assessment of the WTP. A second site visit was conducted by Michael Barnes on April 24, 2025 where additional observations were made particularly on the electrical systems at the Lake Pumpstation and at the WTP. A third site visit was conducted by Christina Saxvik on July 21st, 2025 to complete the site condition assessment.

2.3. REFERENCE INFORMATION

The following documentation has been made available to the McElhanney team to complete this assessment:

- 1999 Conditional Water License (Ministry of Environment, Lands and Parks, 1999)
- 2000 Water Supply Pump Station Record Drawings (Paragon Engineering, 2000)
- 2009 Harrison Steel Water Reservoir Issued for Construction Drawings (Dayton & Knight Ltd., 2009
- 2010 HHS Beach Pumps Operations & Maintenance Manual (Precision Pumps, 2010)
- 2014 HHS Water Treatment Design Build Project Drawings (Hatch Mott MacDonald, 2014)
- HHS Main Control System Installation & Operation Manual (Aslan Technologies, n.d.)
- HHS Ultrafiltration Membrane System Installation & Operation Manual (Aslan Technologies, n.d.)
- 2015 Village of Harrison Hot Springs Water Master Plan (CTQ, 2015)
- 2021 Complete Inspection Report (Greatario Services, 2021)
- 2022 Annual Inspection of Beach Booster Pumphouse Report (Precision Pumps, 2022)
- 2022 and 2023 Rockfall Hazard Review Reports (GeoWest Engineering Ltd., 2023)
- Other water studies assessing water demand and treatment dated between 1992 and 2010.

3. Design Criteria

The design criteria applicable to the WTP are discussed in the following sections.

3.1. EXISTING WATER LICENSE

The existing conditional surface water licence (C114223) for VHHS allows for diversion of 454,609 m^3/year (1,246 m^3/day over 365 days) from Harrison Lake. The total annual raw water volumes pumped from 2020 to 2024 are shown in Table 2 below.

Table 2: Annual Raw Water Volume Pumped (2020 - 2024)

Year	Raw Water Volume (m^3)	% of Allowable Usage
2020	305,743	67%
2021	355,673	78%
2022	339,346	75%
2023	378,760	83%
2024	356,268	78%

The projected future water demand and expected date at which the demand reaches 100% of the allowable licence volume is discussed in Section 3.3 below.

3.2. CURRENT WATER DEMAND

The Village of Harrison Hot Springs is a destination community with a small full-time population. During the summer months, demands on infrastructure increase significantly with seasonal residents and tourist visits. This fluctuation puts immense pressure on the water system.

The VHHS records the raw and treated water volume every day; this daily data was provided from 2020 to 2024. From these volumes, the Average Day Demand (ADD) and Maximum Day Demands (MDD) can be calculated, and a peaking factor is used to determine Peak Hour Demand (PHD) in lieu of distribution flow records. The flow volumes varied by up to 5% between raw and treated water volumes each day, likely due to water wasted by the membranes, particularly during the cleaning processes. The treated daily water demand can be seen in Figure 2 below. Note that only daily values are recorded, and thus fluctuations in reservoir volumes could not be accurately accounted for in the treated water demand assessment.

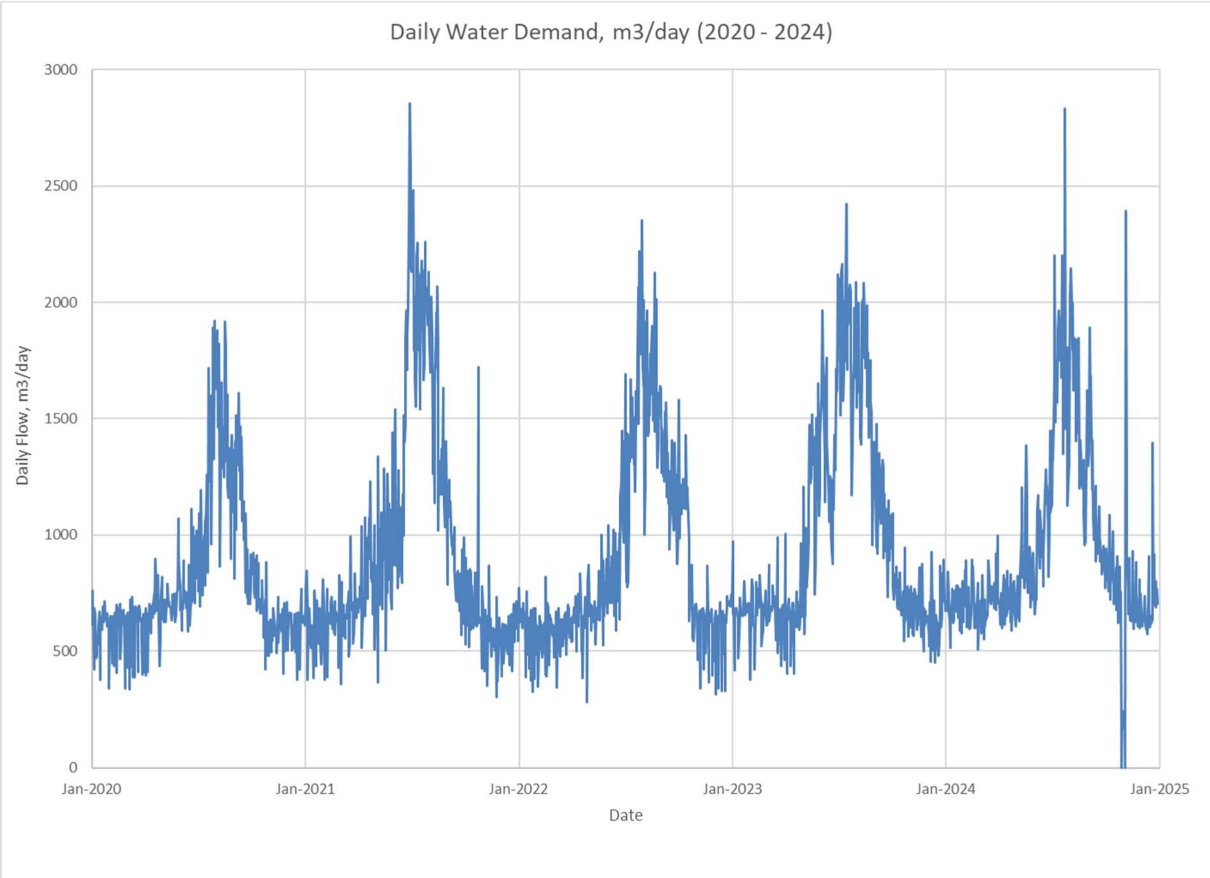


Figure 2: Daily Treated Water Demand (2020 - 2024)

For each year, the MDD (incl. the 95th and 99th percentile flows to exclude outlier data), the ADD during warmer weather months (May – September), ADD during the colder weather months, or “off-season” for tourism (January to April and October to December), and minimum daily flows (expressed as 5th percentile data) can be seen in Figure 3 below.

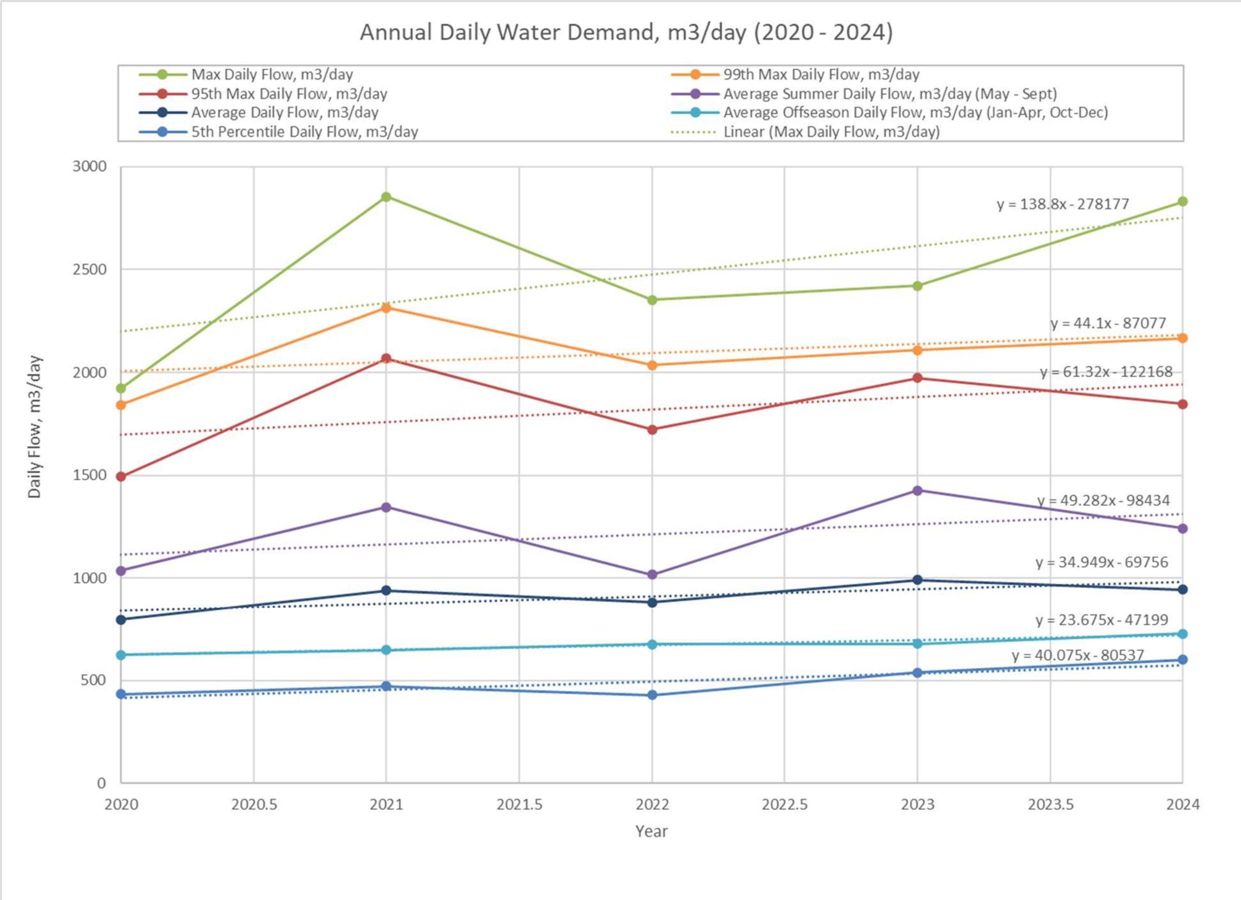


Figure 3: Existing Average Daily Demands (ADD) and Maximum Daily Demands (MDD, 2020 - 2024)

Figure 3 shows the annualized maximum, 99th percentile, 95th percentile, average (all seasons), average (summer), average (offseason), and minimum (expressed as 5th percentile) daily flows are all trending upwards. There is an elevated maximum daily flow in 2021; this peak of 2,854 m^3/day occurred on June 28, 2021, which coincided with the province-wide heat dome event. The MDD 95th and 99th percentiles are also elevated for 2021.

The treated daily flow values are shown in Table 3 below. The MDD (using the 99th percentile values) listed below relatively align with the current MDD value of 2,494 m^3/day used in the Population, Base Sanitary Flows and Base Water Demands Technical Memorandum (Water Street Engineering, 2025).

Table 3: Current Treated Minimum, Average and Maximum Daily Flow from 2020 to 2024

Annual Daily Flows	2020 (m^3/day)	2021 (m^3/day)	2022 (m^3/day)	2023 (m^3/day)	2024 (m^3/day)	2024[1] (L/s)
Minimum Day Demand (as 5th Percentile)	433	472	429	539	600	6.9
ADD, Off Season (Oct. – April)	625	648	676	679	727	8.4
ADD (All Year)	797	939	882	992	945	10.9

Annual Daily Flows	2020 (m^3/day)	2021 (m^3/day)	2022 (m^3/day)	2023 (m^3/day)	2024 (m^3/day)	2024[1] (L/s)
ADD, Summer (May – September)	1037	1345	1017	1428	1242	14.4
MDD, 99th Percentile (All Year)	1842	2315	2035	2108	2166	25.1
MDD (All Year)	1922	2854	2353	2422	2832	32.8

Note 1: Data from 2024 is also shown in L/s, for ease of comparison to other flows in the report.

Raw water from Harrison Lake is pumped to the water treatment plant by three pumps in a pump station at Harrison Lake. From the operating data it appears that the pumps are typically operating with one pump on duty and two pumps on standby. The 2020 to 2024 data was analyzed to determine how many days per year had high pump run hours, indicating which days the WTP equipment was operating most hours of the day. A benchmark value of 20 hours or greater was selected for review purposes, with the pump runtimes shown below in Table 4. On average between 2020 and 2024, the pumps operate about 8 hours per day.

Table 4: Number of Days Per Year with High Pump Hours (> 20 hours)

	Number of Days Per Year				
Hours Pumped Per Day	**2020**	**2021**	**2022**	**2023**	**2024**
20	0	4	1	3	0
21	0	4	2	0	1
22	0	0	0	1	0
23	0	2	0	0	0
24	0	2	1	0	1
Total Days Per Year with High Pump Run Hours (> 20 hrs)	**0**	**12**	**4**	**4**	**2**

There were no days with high pump run hours > 20 hours in 2020, likely due to travel restrictions on visitors due to COVID-19. As discussed previously, the June 2021 heat dome resulted in high water usage; five of the days with high pump run times > 20 hours occurred during this event. Although 2021 had the highest number of days with over 20 pump hours, the twelve days only accounts for 3.3% of the year. The period from 2022 to 2024 averaged 3.3 days per year of high pump run times; this accounts for only 0.9% of the year.

3.3. WATER USE PROJECTIONS

3.3.1. Community Water Use Trends

Future water use projections are difficult to estimate because of the large variation in water user demographics due to the resort nature of the Village. Rather than analyzing population projections, the future water use was determined by trending the current water demand over time. The trendlines are focused on the average and 99th percentile daily flows and are shown in the figure below. In addition, the expected flow (m^3/day) in 2045 is shown at the end of each trendline.

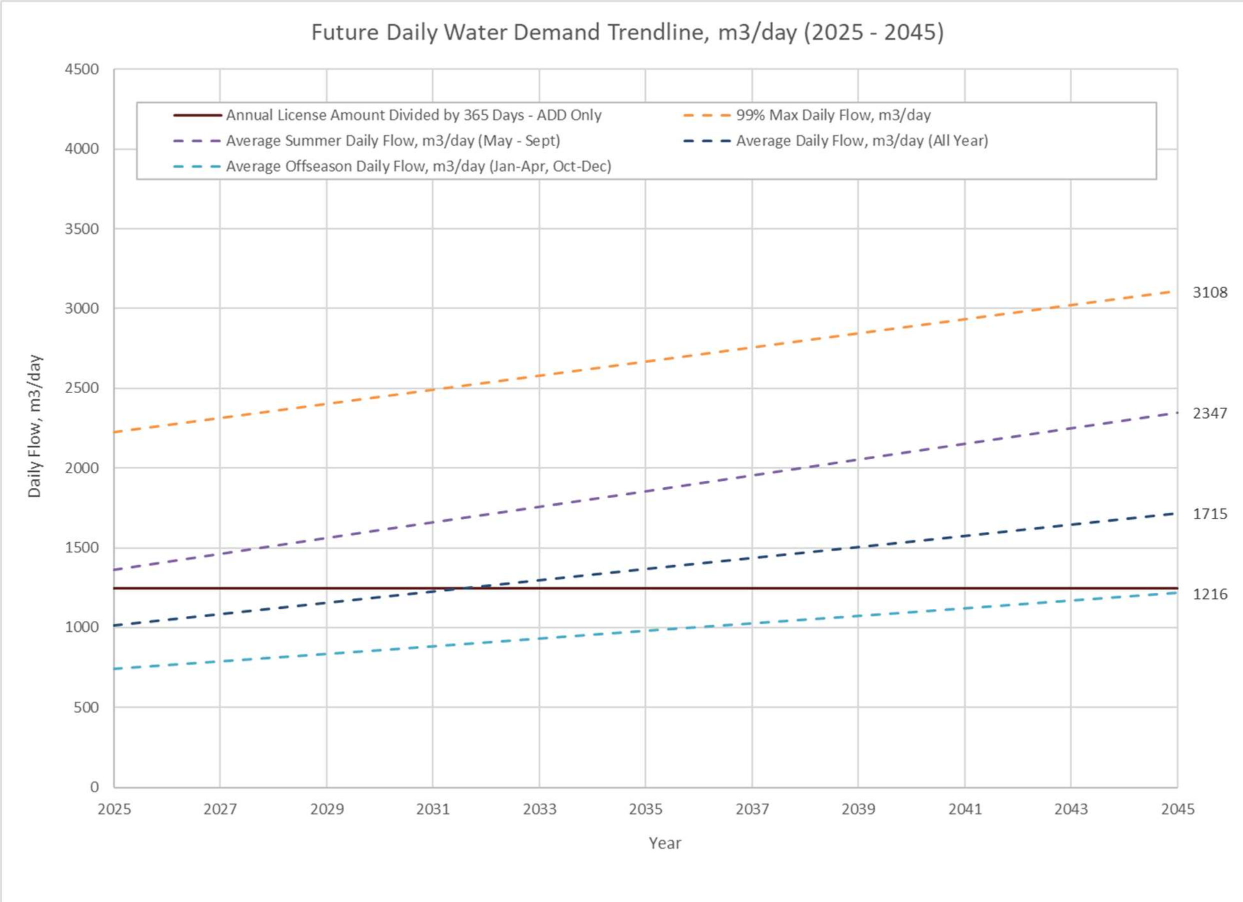


Figure 4: Projected Average Daily Demand (ADD) and Maximum Daily Demand (MDD) based on 99th Percentile Data. Refer to Section 3.3.2 on comparisons with water license amount.

The future "base" treated water demands and annual growth rates are shown in Table 5. "Base" demands solely account for community water use trending, and do not account for known developments like the Harrison Hot Springs Resort and Spa, that may require water in the future.

Table 5: Future Base Treated Water Demand (Current VoHH Water System Only)

	Annual Growth Rate	Projected 2045 Demand (m^3/day)	Projected 2045 Demand (L/s)
ADD, Off Season	3.5%	1,216	14.1
ADD, All Year	3.8%	1,715	19.8
ADD, Summer	4.1%	2,347	27.2
MDD, 99th Percentile	2.1%	3,108	36.0

Note 1:: Future base treated water demands do not include known developments that may require water in the future.

Per above, the current peak MDD from 2020 to 2024 was 2,854 m^3/day experienced in 2021 but is an outlier in comparison to the 99th percentile data. This value is very comparable to the future projected 99th percentile MDD of 3,108 m^3/day for 2045. Therefore, a future design MDD of 3,200 m^3/day (37 L/s) was selected as the “base” design demand. This value relatively aligns with the OCP MDD value of 3,161 m^3/day used in the Population, Base Sanitary Flows and Base Water Demands Technical Memorandum (Water Street Engineering, 2025) but is based on year 2050. Refer to the section below for an assessment of the impact on water demand resulting from servicing additional developments.

3.3.2. Other Developments

There are several large developments are currently serviced by their own private water system but the Village anticipates they may request water supply from the Village in the future. The Harrison Hot Springs Resort and Spa (HSS Resort) is the single largest user of water in the Village area (estimated 400 m^3/day at full occupancy) and is currently supplied by Harrison Lake with a private intake, reservoir, and treatment. Holiday Park is another private water supplier with an RV resort with 409 lots, currently supplied by groundwater wells.

The 2015 Water Master Plan (2015 WMP) (CTQ, 2015) estimated the demands from the Holiday Park and the HSS Resort. This section evaluates the potential impact on water production requirements should either or both developments be connected to the Village of HHS (VoHHS) water system in the future. According to the Village, the water demand estimates from the 2015 WMP remain valid, as there have been no changes to the capacity of the Resort or the campground. The projected flows from these developments have been added to the base water demand, as shown in Table 6 below. The 2015 WMP values are slightly more conservative to the values in the Water Street Technical Memorandum and are therefore used below.

Table 6: Future Total Treated Water Demand

DESCRIPTOR	Off-Season ADD (L/s)	Summer ADD (L/s)	MDD (L/s)
2045 Projected Based Demands - VoHH	**14.1**	**27.2**	**36.0**
HHS Resort & Spa	4.4	4.4	8.8
Holiday Park	- [1]	2.9	5.8
2045 Projected Total Demands – VoHH + HHS Resort + Holiday Park	**18.5**	**34.5**	**50.6**

Note 1 - Holiday Park is closed from November to March and therefore, excluded from the off-season ADD.

A future MDD of 50.6 L/s in year 2045 is the basis for the capacity review of each process in this report. This equates to 4,372 m^3/day.

Based on annual ADD (base) projections, the Village is expected to reach its water licence limit (454,609 m^3/year under licence C114223) by 2030. This timeline would be shortened further should the Resort or campground connect to the water system. To prepare, the Village should consider applying for a licence amendment a few years in advance of meeting permit limits while monitoring annual water use.

3.3.3. Comparison to 2015 Water Master Plan

The 2014 demands and projected demands presented in the 2015 Water Master Plan (2015 WMP) (CTQ, 2015) are shown in Table 7 below. It appears there has not been significant growth in demands in the last ten years. The 2014 ADD was 13.4 L/s while the 2024 ADD decreased to 11.5 L/s. The 2014 MDD was 26.7 L/s compared to the 2024 MDD of 28.0 L/s and 2024 MDD (99th percentile) of 25.8 L/s.

The future "Full Development PLUS Resort" demands from the 2015 WMP are calculated as 50.4 L/s (ADD) and 100.8 L/s (MDD). These are significantly higher than the future demands calculated in Table 6. Given the lack of growth in the last ten years, the CTQ future demands may be conservative, but the Village should continue to analyze actual water use, population growth and new development in the Village on a regular basis to ensure trending is per Section 3.3.1.

Table 7: 2015 Water Master Plan Demands (CTQ, 2015)

		ADD L/sec	MDD L/sec	PHD L/sec	System Capacity* L/sec
2014	**Existing System**	13.4	26.7	40.1	176.7
FUTURE	**2014 PLUS Unserviced Properties**	25	50	75	200
	Full Development	46	92	138	288
	Full Development PLUS Resort	50.4	100.8	151.2	250.8

*System Capacity is the greater of MDD + Fire Flow (max 150L/sec for VHS) or PHD

3.3.4. Reservoir and Break Tank – Peak Hourly

As the reservoir should contain storage for a two-hour fire flow event and the peak hour demand (PHD), the WTP capacity has not been assessed to meeting fire flows or PHDs in this report. However, the PHD is needed to determine the required capacity of the break tank for situations where the reservoir is bypassed, such as during maintenance. Distribution flow meter records or fluctuating reservoir levels over the course of a day were not available to determine the peak hour demand (PHD). As maintenance will occur during the off-season during periods of lower demand, the PHD can be determined by applying a peaking factor to the off-season ADD.

A peaking factor of 4 x the off-season ADD was applied, in alignment with the Design Guidelines for Rural Residential Community Water Systems (BC Ministry of FLNRORD, 2012) for a population of less than 5000 people. **This results in a future projected off-season PHD of 74 L/s in 2045, including future connection to the HHS Resort and Holiday Park.** Break tank capacity is discussed in Section 4.5 and fire flows and reservoir capacity are discussed in Section 4.8 below.

3.4. WATER QUALITY

While this report does not include an evaluation of treatment performance in alignment with the Canadian Drinking Water Quality Guidelines, it is important to acknowledge that the effectiveness and operational stability of ultrafiltration (UF) membrane systems are highly influenced by the quality of raw water supply. During periods of degraded raw water quality – such as elevated turbidity or increased level of organics – UF membranes may experience increased fouling, reduced permeability, and shorter filtration cycles.

These conditions can lead to more frequent chemical cleaning, higher operational costs, and over time, a reduction in the effective treatment capacity of the WTP. This issue is evidenced by the installation of membranes in 2015, followed by an additional membrane train installed only three years later, due to membrane fouling, with both trains operating below their “nameplate” capacity.

It is important that the Village continues to monitor raw water chemistry routinely to observe trends over time. Particular attention should be paid to parameters that influence membrane fouling such as total organic carbon (TOC), colour, turbidity, and temperature.

4. Existing System Assessment

The components of the existing water treatment and storage system, as listed in Section 2.1, are detailed further below. Each section is divided into three key subsections:

- **Condition** of the existing equipment and discussion on asset age vs. typical design life.
- **Capacity** of the infrastructure in comparison to current and future water demands; and
- **Resiliency** of the infrastructure to provide long term water security. For example, with respect to environmental factors, changing water quality, or process upset.

Also described in each section below are recommendations for upgrades. These recommendations have been summarized in Section 5 for ease of reference.

4.1. LAKE INTAKE PIPE

The 350 mm HDPE DR17 lake intake extends approximately 1050 m into Harrison Lake. The intake structure is located at approx. 5.0 m elevation. At the lowest historical water level of Harrison Lake, the intake only had 3.2 m of submergence, per the table below. Based on the lake level data provided by the Village, the annual lake level minimum has ranged between 8.211 – 9.235 m depending on the year, for data between 1933 and 2023. A fish screen is visible from inspection photos videos, but no technical details of the screen were provided. The screen appears to be stainless steel wedge wire screen type from the photos, with a mesh fine enough to prevent large objects from entering the intake.

Table 8: Low Harrison Lake Levels

	Elevation	Source
Inlet Elevation at Screen	5.0 m	Water Supply Study, Civic Consultants, 2007
Lowest Water Level (1979)	8.2 m	Water Supply Study, Civic Consultants, 2007

Condition:

The Village of Harrison Hot Springs advised that inspections of the lake intake are undertaken yearly. Photos and videos of the intake were provided for reference, including diver-recorded footage. Although formal inspection reports were not made available, the Village indicated that the intake pipe has consistently been reported to be in good condition. Note this report does not intend to provide an independent assessment of the intake condition.

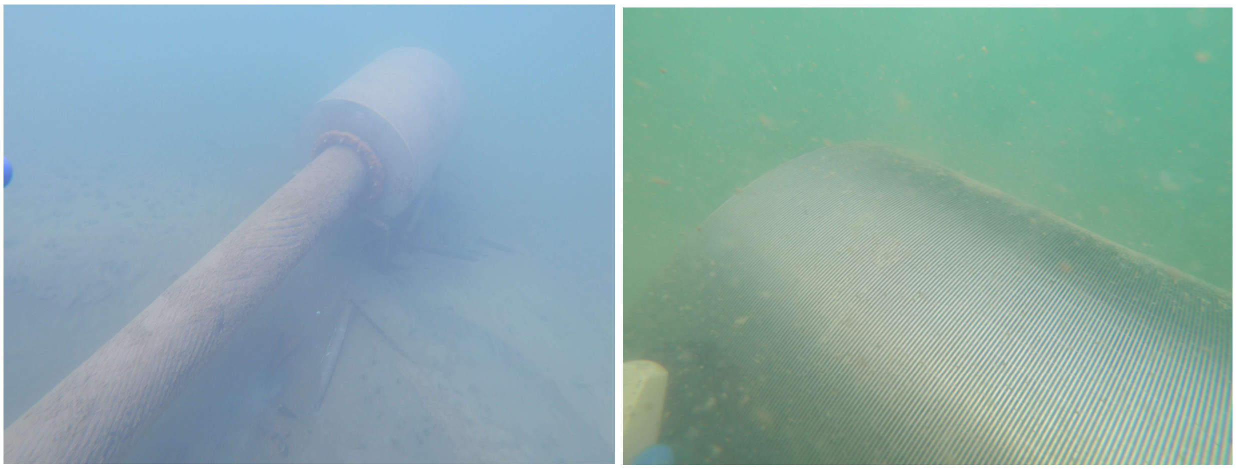


Figure 5: Lake Intake Inspection Photos

Capacity:

The 350 mm HDPE DR17 intake pipe has a capacity of 13,144 m^3/day (152 L/s) at a maximum design velocity of 2.0 m/s for pump supply, as per the VHHS Subdivision & Servicing Bylaw No. 1179, 2022. This is greater than the current WTP capacity, the future maximum day demand per Section 3.3, and the estimated daily water license amount (based on the annual license divided by 365 days). Technical details for the intake screen were not provided.

Resiliency:

With only a few meters of coverage at the intake's shallowest point, there is an opportunity to enhance protection against potential risks such as boating activity, contamination such as a fuel or chemical spill, or changes to raw water quality due to lakebed disturbances, lake turnover or other seasonal impacts. A past incident involving a tugboat damaging the wastewater outfall pipe highlights the importance of proactive measures.

A recommendation was made in the Upgrade of Water Supply, Treatment and Distribution System Phase II Report (NovaTec Consultants Inc., 2000), drafted just after the lake intake was installed, to extend the lake intake to a depth of 35 m. In this same report, a lakebed assessment was completed and summarized the following:

- The thickness of algal cover of the lakebed appeared to increase towards the shoreline.
- The sediment grain size appeared to increase from fine to medium sand at the nearshore station to medium to coarse sand at the offshore stations.
- The compaction of the lakebed sediments appeared to increase with distance away from the shore.

A lake intake extension could provide some protection to the risks noted above, however it would not eliminate all risks. The pipe at the shallowest point would not be protected from surface-level risks. Some options to alert boaters to the intake location include buoying and marking, establishing a “No-Wake” or “Restricted Area” zone, or installing signage on nearby docks informing public about the protected intake zone. However, posting signage that clearly identifies a lake or intake area as a drinking water source can be a double-edged sword — it improves public awareness and protection, but may also inadvertently increase the risk of vandalism or intentional contamination.

Budget pricing was requested from GreatPacific Consulting Ltd. for a desktop lake intake study, refer to the cost estimate in Section 7.

Recommendations:

1. Complete a lake intake extension and protection study, with a focus on potential improvements to long term water quality and reducing risk of intake damage or vandalism.

4.2. LAKE INTAKE PUMPSTATION

The lake pumpstation was installed in 2000 and is located in a park adjacent to Harrison Lake near Harrison Lake Plaza, as shown in the photos below. The pumpstation contains three pumps, located in a deep vault, approximately 7.4 m deep below ground level.

The existing lake pump control panels and variable frequency drives (VFDs) are housed within a separate room of the public washroom building, with the building located between the Harrison Lake shoreline and an existing dike along Esplanade Ave, as shown in Figure 6 below. This is referred to as the pumpstation electrical room in this report.

The WTP calls for water production based on the ‘Start Fill Level’ and ‘Stop Fill Level’ setpoints of the reservoir, and the lake intake pumps start/stop based on this level.

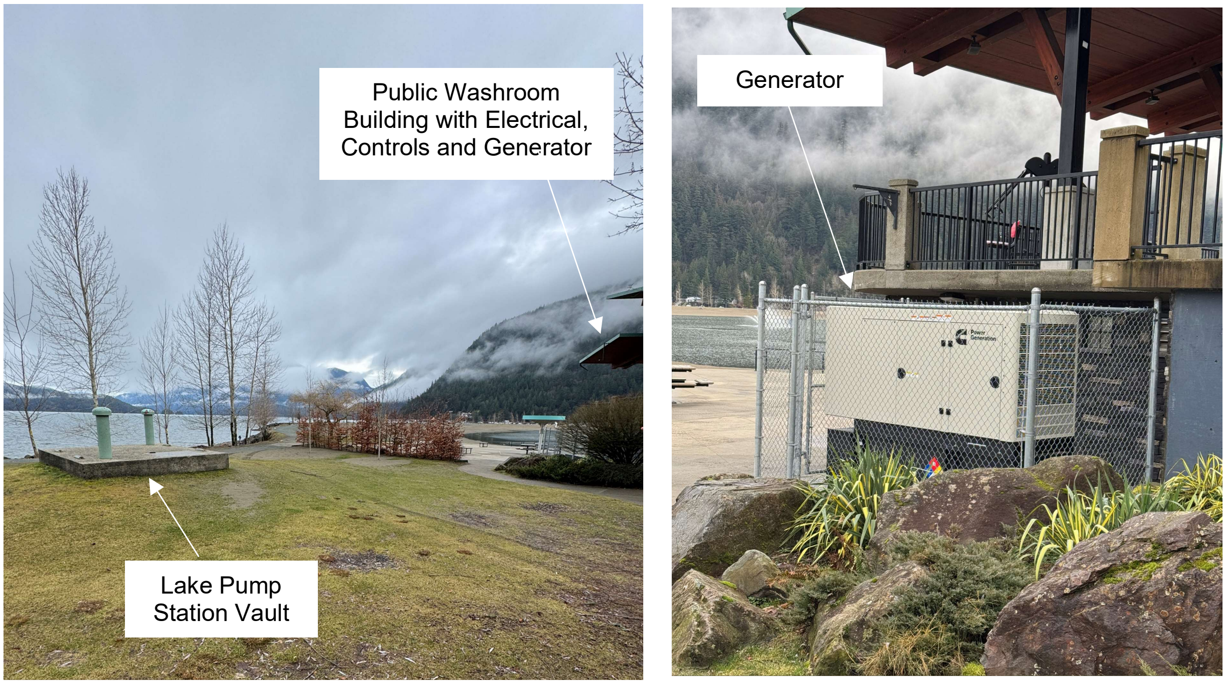


Figure 6: Lake Pump Station and Public Washroom

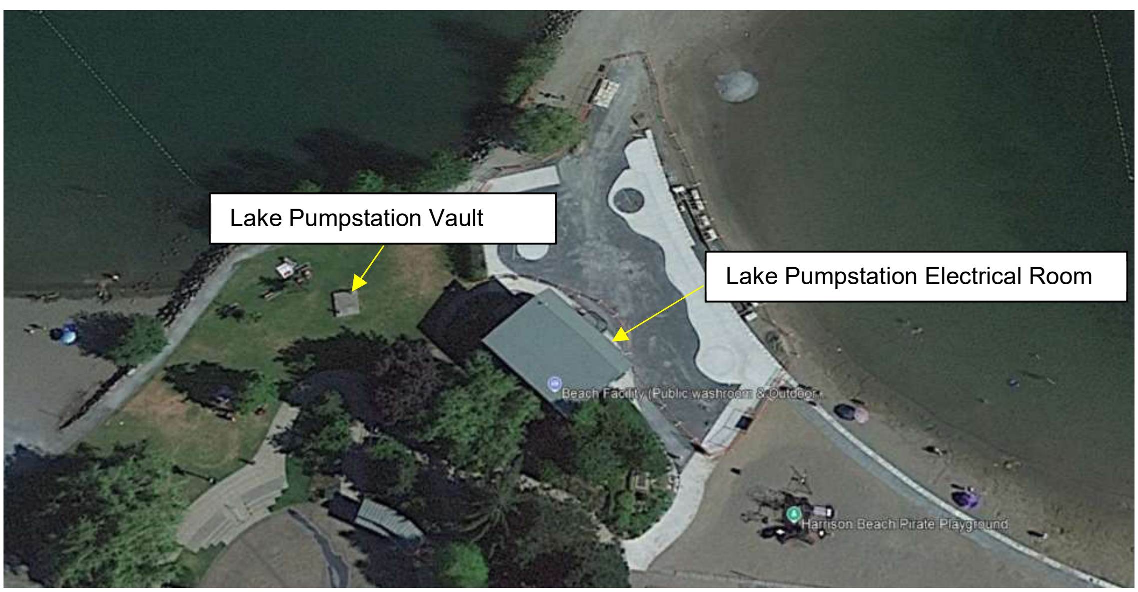


Figure 7: Lake Pumpstation Aerial View (Google Earth, 2025)

The raw water supply from the lake intake enters the pump station vault in a 300 mm PVC pipe. The original pumpstation station vault (with record drawings dated 2000) housed two centrifugal pumps installed with a blind flange for a future third pump; the third pump was installed around 2010. The pump details are shown in Table 9. A Singer surge anticipating relief valve and a 0.5 HP Goulds sump pump are also installed. A top view of the lake pump station vault and schematic of the layout is shown in Figure 8 and Figure 9 below.

Table 9: Equipment Summary – Lake Intake Pumps

Equipment	Manufacturer	Configuration	Theoretical Design Capacity	Estimated Actual Capacity
Lake Pump #1 (2000), Lake Pump #2 (2000), Lake Pump #3 (2010)	Berkley Model B3ZPL, 8.75" Impeller. 40 HP pumps.	Lead / Lag / Lag	39 L/s @ 72 m TDH each at full speed (based on pumping to reservoir, not to WTP)	Refer to "Capacity" section below.

Note 1: Based on originally pumping up to the reservoir, not through a WTP.
Note 2: Motors for pumps #1 and #2 upsized from 30 HP to 40 HP in 2007.

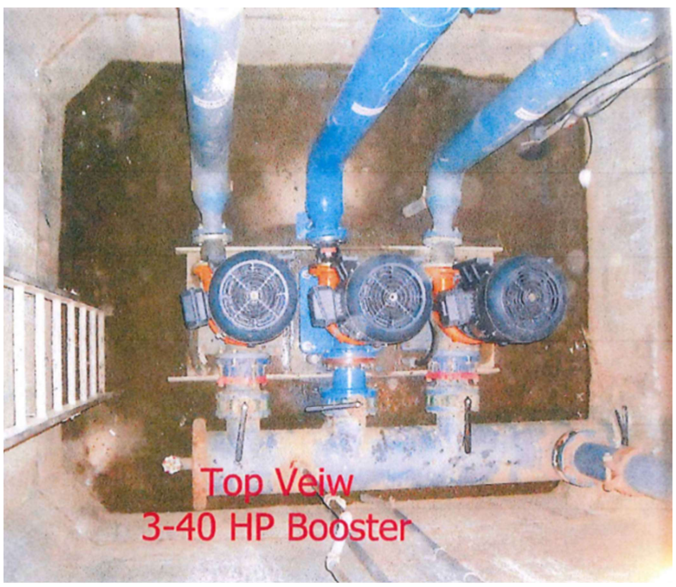


Figure 8: Lake Pump Station Vault

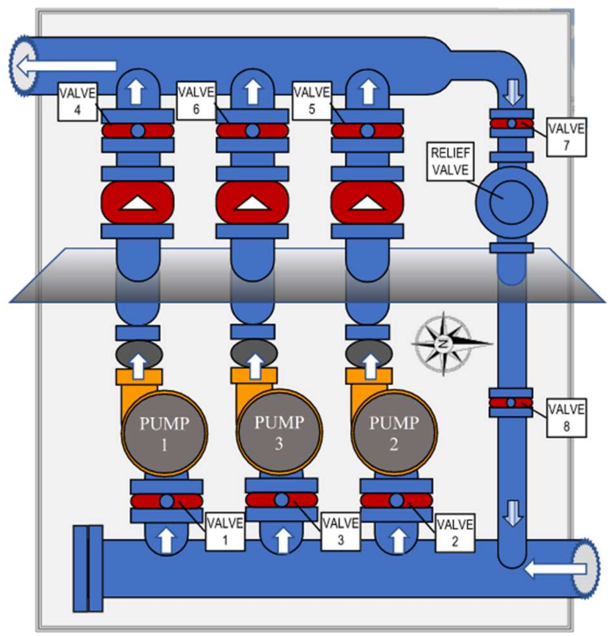


Figure 9: Schematic of the Lake Pump Station (2022 Annual Inspection by Precision Service & Pumps)

Condition:

The 2022 Annual Inspection of Beach Booster Pumphouse Service reports (Precision Service & Pumps Inc, 2022) noted that the pumps are in reasonable operating condition, with good integrity of the pumps, motors, pipes and support structures. The motors were observed as rusty but otherwise in good shape. Since the inspection, the following has been observed:

- The Singer surge anticipator valve has historically presented operational challenges. Although repair efforts were made, the resulting configuration introduced unintended airflow into the intake system, which affected pump performance. As a precaution, the valve has been isolated.

- In scenarios where a valve remains closed at the water treatment plant, pump protection for pressure relief may be limited. However, the presence of VFDs and soft-start capabilities on the pumps helps mitigate the risk of pressure transients. Village operations is exploring the installation of a pressure relief valve at the WTP inlet.

- The hatch tamper alarm is now connected to SCADA and functional. A few other alarms that should be reviewed in future for functionality are the high water level alarm, lower pit area lighting, and lower pit area ventilation fan (at low speed).

Figure 10: Pumpstation Vault (2025)

During the site visit on July 21, 2025, the Village also advised on:

- Periods of pressure loss at the WTP inlet, anticipated to be caused by the check valves.

- According to the Village's SCADA integration contractor, the lake pumpstation PLC and pump VFDs are approaching end of life, presenting an opportunity for planned replacement.

- The existing pumps, ranging from 15 to 25 years old, may be approaching the end of their service life soon. The Village has expressed interest in replacing the pumps and VFDs with slightly oversized units, operated at reduced capacity, to accommodate future increases in water demand.

- The current flow control valve at the WTP limits variable flow functionality. This presents an opportunity to enhance operational flexibility, as further discussed in Section 4.34.3.

Commentary regarding WTP power quality and voltage imbalances has been provided in Section 4.8.3. It should be noted that the lake pumpstation is also at risk of electrical surges and voltage imbalances, and therefore similar protective measures and conclusions apply. The root cause of voltage imbalance faults originates externally from BC Hydro. As noted above, correcting these issues directly at the pump intake is difficult; instead, mitigation efforts should focus on equipment protection through installation of phase-voltage monitoring relays, with the control system (PLC) interlocking pump operation during imbalances to safeguard motors and VFDs. Installation of voltage monitoring relays and control system integration for equipment protection has been considered in work package costing.

Capacity:

The current mode of operation is one or two pumps running based on water demand, with two or one pumps on standby. The pumps were originally designed to pump to the old reservoir (42.7 m static head + piping friction losses), then operated to an increased head with the new higher reservoir (66.5 m static head + piping friction losses), then a significant drop after the WTP was commissioned (to 6.2 m static head + piping friction losses + additional head losses across WTP components, including ~18 m (25 psi) across membranes prior to a CIP clean). The system curves for these scenarios are likely to vary significantly and the lake pumps may not be currently operating at optimal efficiency. When the existing lake pumps reach end of life, lower-head pumps to save on operating costs may be worth exploring, following a hydraulic review of the WTP components.

Prior to commissioning the Water Treatment Plant, historical field testing indicated reduced pump performance. The 2015 Water Master Plan projected that one, two, and three pumps would deliver 39 L/s at 72 m TDH, 68 L/s at 78 m TDH, and 84 L/s at 83 m TDH, respectively. However, a 2013 field test showed significantly lower outputs—only 38 L/s with two pumps and 44 L/s with three—highlighting a performance shortfall.

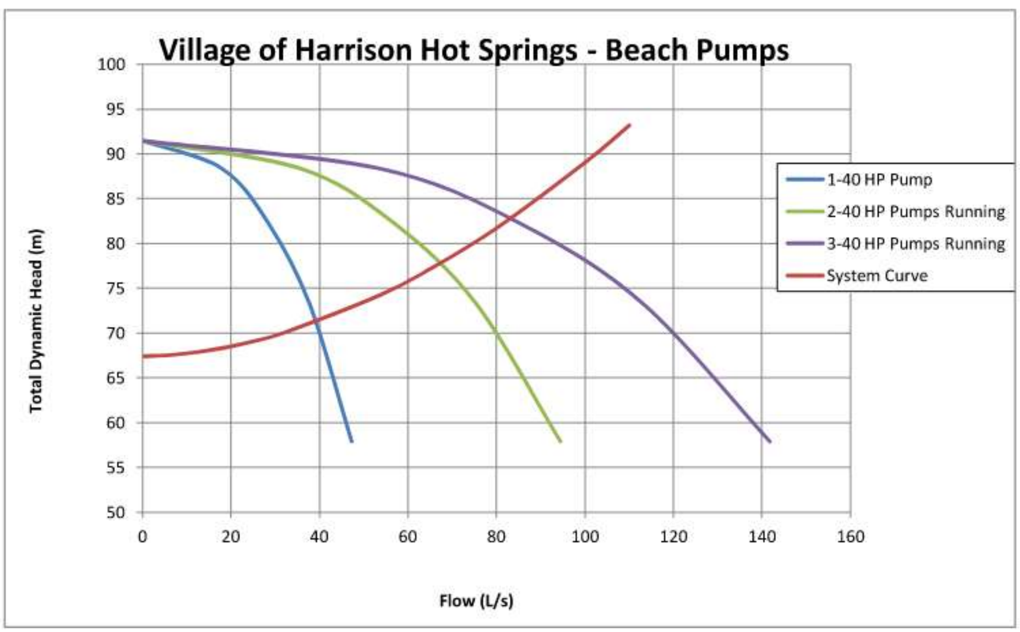


Figure 11: Lake Pumps Capacity, 2015 Master Plan (CTQ)

The 2022 Annual Inspection of Beach Booster Pumphouse Report (Precision Service & Pumps Inc, 2022) tested pumps at 50 Hz (reduced speed):

- Deadhead test (@ 50 Hz): Expected flow 0 m^3/min (0 L/s) @ 90 PSI (63 m). Result 0 m^3/min (0 L/s) @ 49 psi (34 m)
- Running test (@ 50 Hz): Expected flow 2.08 m^3/min (34.7 L/s) @ 50 PSI (35 m). Result 2.04 – 2.09 m^3/min (34.0 - 34.8 L/s) @ 45 – 49 psi (32-34 m).

It is not probable two pumps operating in parallel would be able to produce ~69 L/s (2 x 34.7 L/s) @ 50 PSI. The pump curves provided in the 2015 Water Master Plan do not correspond to observed performance and it is suspected the system curve may be steeper than what was previously evaluated. Based on discussion with the Village on June 27th, 2025, the WTP has been able to operate up to 3.5 m^3/min (58 L/s) with two pumps running. A historical electrical overloading concern has reportedly been addressed by Aslan. Given that the WTP is not typically operated with two duty lake pumps, electrical capacity and system performance under dual-pump operation should be reviewed in future.

Proven short-term operation of two pumps at 58 L/s exceeds the projected MDD of 50.6 L/s as discussed in Section 3.3, allowing one pump on standby, enhancing system reliability. The Village has advised on potential long-term impact on raw water quality and amount of sediment intake impacting membrane performance, should the WTP be operated at a higher flow rate. Raw water quality testing at higher pumping rates should be performed to assess this further.

Resiliency:

The elevations of the pumpstation and various flood or flood construction elevations can be seen in Table 10 below. The top of the station vault elevation is 0.55 m above the 200-year Harrison Lake flood elevation, but just slightly below the current flood construction level by 0.05 m. It is likely the pumpstation vault would be adequately protected during a flood event, based on the historical 1:200 year flood elevation. A Waterfront Flood Mitigation Plan is currently being developed for VHHS by Northwest Hydraulic Consultants (NHC), with a dike for the waterfront at 15.1 m elevation (Figure 13). Note that the preliminary plans show the dike on the south side of the pump station vault and electrical room, such that these areas could become flooded.

Table 10: High Harrison Lake Levels

Description	Elevation	Source
High Water Level	12.84 m	Paragon Engineering, Pump Station Record Drawing, 2000
Estimated Pumpstation Electrical Room and Generator/Fuel Tank Elevation	~13.0 m	Paragon Engineering, Pump Station Record Drawing, 2000
Existing Dike Crest	13.9 m	NHC Waterfront Flood Mitigation Presentation, 2025
1:200 Year Flood Elevation	13.95 m	Paragon Engineering, Pump Station Record Drawing, 2000
Flood of Record (1894)	14.1 m	NHC Waterfront Flood Mitigation Presentation, 2025
Lake Pump Station Vault	14.50 m	Paragon Engineering, Pump Station Record Drawing, 2000
Flood Construction Level	14.55 m	VHHS Bylaw No. 1179, 2022

Description	Elevation	Source
Proposed Dike Elevation	15.1 m	NHC Waterfront Flood Mitigation Presentation, 2025

Using lake level data between 1933 and 2023, lake levels have exceeded the estimated pumpstation electrical room & generator base elevation over a 13 day duration in 1948, and over a 4 day duration in 1950.

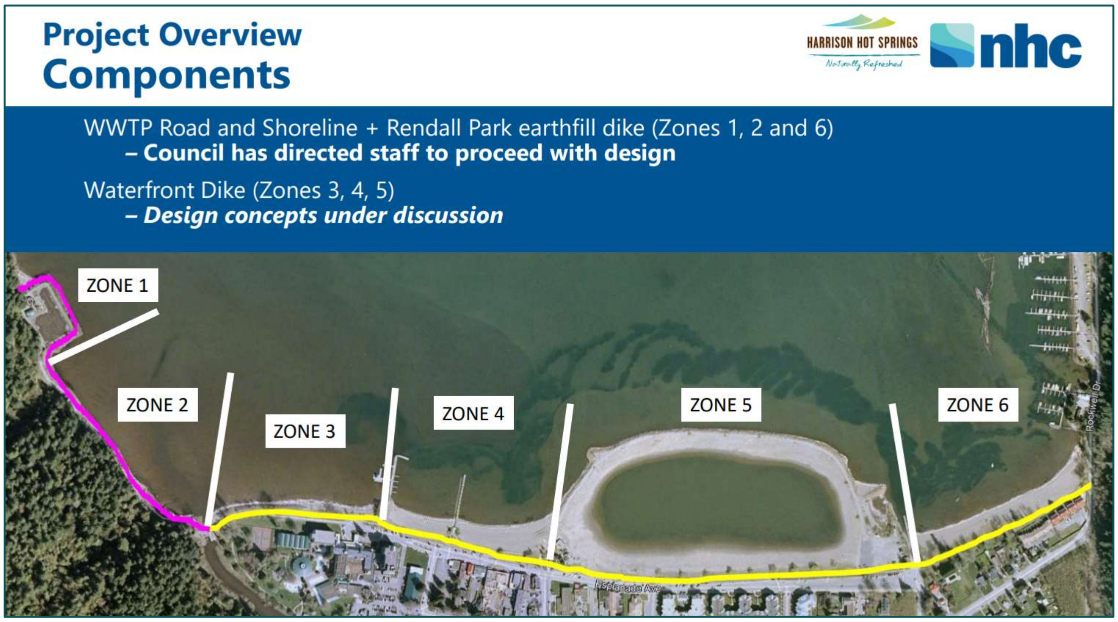


Figure 12: Harrison Hot Springs Waterfront Flood Mitigation Public Posting (Village of Harrison Hot Springs, 2025) with Lake Pumpstation Electrical Room Identified

The floor elevation of the pump electrical room is below the 1:200 Year Flood Elevation, presenting risk of wetting critical infrastructure during extreme flood events. The elevations around the lake pumpstation building can be seen in Figure 13 below.

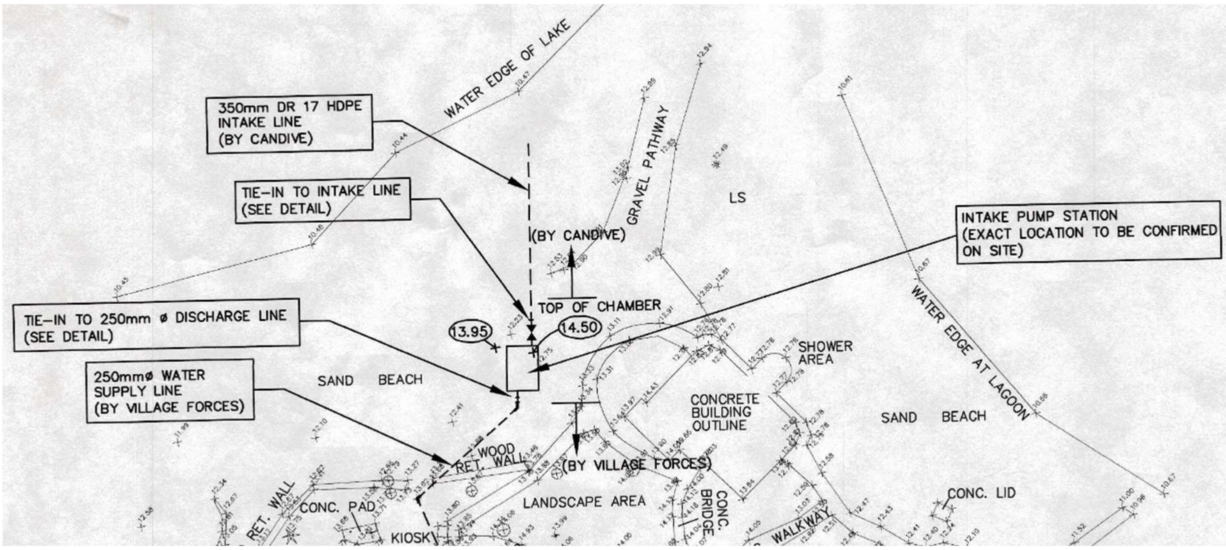


Figure 13: Elevations around the Lake Pumphouse Station (Paragon Engineering, 2000)

Options to protect the pumpstation electrical room include the following:

1. Temporary flood protection deployment measures around the building, to protect the north side of the pump station and electrical room.

2. Relocate all electrical equipment into a separate structure above the flood zone.

3. Relocate only critical electrical components above the flood elevation to service the pumpstation.

The complexity and cost associated with re-aligning the dike were considered but, following discussions with the Village and with consideration of other available options, this approach was not evaluated further in this report.

4.2.1. Option 1: Temporary Flood Protection Deployment

This option focuses on the temporary deployment of flood protection measures, which may include:

- Strategically placed gabion baskets—wire mesh containers filled with sand—can be used to form a robust, semi-permanent barrier against floodwaters. These structures are stacked in a staggered, interlocking pattern to enhance stability and reduce water seepage. Gabions offer a reusable and environmentally friendly alternative to sandbags and their modular design allows for rapid deployment and easy customization to suit varying terrain and flood risk levels.

- Sealing of entry points: Doors can be temporarily sandbagged, while vents, and conduits could be temporarily sealed using waterproof covers or expandable foam to prevent water ingress.

- Pump deployment: Auxiliary pumps could be staged nearby to remove any water that breaches the temporary barriers.

4.2.2. Option 2: Electrical Equipment Relocation

Various electrical components currently reside in and around the building located within the flood zone:

- BC Hydro Service disconnect and Hydro Meter.
- Automatic Transfer Switch (ATS) to initiate load transfer to the generator during a BC Hydro outage.
- Standby diesel generator and diesel fuel tank.
- Washroom building electrical distribution panels and feeders.
- Pumpstation Variable Frequency Drive (VFD) panels.

The BC Hydro service feed, ATS and sub-feeders are currently housed in a small room adjacent to the washrooms. The generator and ATS are configured to supply all the loads supplied by the BC Hydro service and so critical vs non-critical loads have not been separated or segregated.

If all main distribution equipment, including the BC Hydro service, is relocated to a Kiosk or building above the flood zone, the washroom electrical equipment and distribution panels would still be at risk of being flooded. However, these components could be safeguarded by temporary flood mitigation measures, as outlined in Option 1. These electrical items should be isolated during a flood event, and carefully inspected following a flood event, before re-energization.

The size of the kiosk required, and the relocation of the BC Hydro service infrastructure, presents a costly and potentially complex undertaking, and so still presents significant challenges.

This option will also not be without visual impacts to the lake views but could be partially mitigated by potential location to the South-East of the Washroom building.

4.2.3. Option 3: Critical Electrical Equipment Relocation

The option is similar to Option 2, however focuses only on critical electrical components to ensure continued supply and service to the pump station to ensure continuity of water supply to the WTP. The equipment that would be relocated to a higher elevation would be the following:

- Standby diesel generator and diesel fuel tank.
- Automatic Transfer Switch (ATS)
- Pump station VFD Panels

As the BC Hydro service, washroom electrical equipment and distribution panels are still at risk of being flooded, isolation of the washroom distribution would be required and sand-bagging and other mitigation measures would need to be undertaken to protect the BC Hydro Service equipment from flooding (the main service disconnect and Hydro Meter are ≈1m above floor grade but the pull box would be at risk at floor level which could flood BC Hydro ducts feeding the pull box).

If deployment of temporary flood protection was not effective, isolation of the BC Hydro service at the main service disconnect, would then initiate the generator to supply power to the pump station as required. At this point, diesel fuel could be saved by manually initiating the generator start and shutdown from the ATS when the WTP / reservoir requires water from the intake pumps – this will save the generator from idling between calls for the pumps.

This option requires a smaller kiosk / building to house the relocated equipment but would still not be without visual impacts to the lake views. Requiring less equipment relocation and no relocation of the BC Hydro service connection, would be less costly. The management of the equipment, isolation of electrical during flooding, sand-bagging and other measures, does present more complex situational management during events.

Another advantage of this option is the opportunity to mitigate a risk associated with an existing 2” SCH40 pipe that runs beneath the VFDs and supplies water to the washroom building. This line currently has a failed pressure-reducing valve (PRV), resulting in 90 psi water pressure directly under the VFDs. Given that the pipe is subject to vibration, there is a risk of failure, which could lead to high-pressure water spraying directly onto the VFDs. While replacing the plumbing components is ultimately the most robust solution, if the VFDs are already being relocated, this approach effectively addresses both issues—lake flood risk and mitigating the water line risk —in a single coordinated effort.

Given the above discussion and description of the options, the recommendation is Option 3 – to relocate critical equipment to a higher elevation to avoid flooding and ensure supply to critical equipment with the standby generator.

A possible location for the kiosk / building to house the relocated equipment was discussed on site on July 21, 2025 with Village operations preference to locate it near the pumpstation chamber.

Recommendations:

2. Install a pressure relief valve at the WTP inlet, rather than modifying the pumpstation surge anticipator valve. This is the preference of the Village.

3. Undertake Option 3 for protecting the pumphouse electrical and VFD equipment by relocating critical equipment.

4. Conduct pump tests at the lake pump station to confirm the maximum flow of two pumps running simultaneously and assess impact to raw water quality.

5. Develop a plan to replace the lake pump in the near future due to the asset's age. Simultaneously address other opportunities for improvement at the lake pump station, including the check valve and vault alarm/electrical system.

6. Consider replacing the lake pump VFDs and PLC, with the Village preferring this to be completed at the same timing as the kiosk construction.

4.3. WTP ULTRAFILTRATION SYSTEM

On the raw water feed to the ultrafiltration (UF) treatment trains is an air relief/combo valve, a raw water flow meter, a pressure reducing valve, a pressure transmitter and a raw water turbidity meter.

The water treatment plant currently has two UF treatment trains, consisting of 11 individual membrane banks, with each bank containing two membranes. This differs from the Ultrafiltration Membrane System Installation & Operation Manual (Aslan, n.d.), which shows one UF treatment train equipped with 12 membrane banks. Train #2 has an older style membrane while Train #1, with membranes that were replaced in 2023, has more surface area.

In forward mode, lake water is pumped through the UF system, producing permeate sent to the break tank. The system includes automatic backwash and flush cycles. Feed pressure is regulated to 38–40 psi by the inlet pressure reducing valve, with a required range of 40–60 psi. Flow rate is controlled downstream of the membranes via a flow control valve, and filtered water turbidity is monitored online.

Figure 14: Ultrafiltration Membranes, Two Trains

Backwashing uses distribution pump water, with waste sent to the municipal sewer. The cycle is timer-based and operator adjustable. A daily integrity test introduces pressurized air a specified amount of time (30 mins according to the O&M manual, automatically set) to ensure a minimum pressure of 22 psi; no water is produced during this test. Differential pressure is monitored to trigger operator-initiated CIP cleaning once 25 psi is reached. It was originally estimated this process is required every three months; about twice a year is currently undertaken.

Table 11: Equipment Summary – WTP Ultrafiltration System

Equipment	Make	Model	Configuration	Theoretical Design Capacity	Estimated Actual Capacity
Ultrafiltration Membrane Train 1	DOW / DuPont	IntegraFlux Ultrafiltration Module SFD 2880XP installed after 2022.	Duty	Note 3; Original system design capacity (pre-membrane upgrade) 31.6 L/s [1]	Refer to “Capacity” section below.
Ultrafiltration Membrane Train 2	DOW / DuPont	IntegraFlux Ultrafiltration Module SFD-2880 (10380866)	Duty	Note 2; 31.6 L/s; Original system design capacity 31.6 L/s [1]	Refer to “Capacity” section below.

1: Design capacity according to the Ultrafiltration Membrane System Installation & Operation Manual (Aslan, n.d.).
2: According to the DuPont SFD-2880 specification sheet, the flow range per module is approximately 8.8 – 30.4 USGPM (0.6 - 1.9 L/s), depending on the operating conditions. For a total of 22 parallel modules in a single train, the anticipated operating range is approximately 13.2 – 41.8 L/s for a single train.
3: According to the DuPont SFD-2880XP specification sheet, the flow range per module is approximately 2.0 – 8.5 m^3/hr (0.6 – 2.4 L/s), depending on the operating conditions. For a total of 22 parallel modules in a single train, the anticipated operating range is approximately 13.2 – 52.8 L/s for a single train.

Condition:

From the site visit on July 21, 2025, the membrane casings appear in good condition. According to the DuPont website, ultrafiltration membranes have a service life of three to seven years (and potentially longer). As it is not possible to review the condition of the membranes without a visual inspection or a lab autopsy, the passing of a routine integrity test completed daily should provide adequate indication that the membranes are in reasonable condition. The membranes in Train #1 were replaced recently in 2023 and are likely to have several years of life left in them. The membranes in Train #2 are the original from 2018 and depending on performance, should be considered for replacement in the next few years.

According to the Village’s SCADA integration contractor, the control system for the membranes is outdated and was difficult to work with for the SCADA integration. The Village is interested in an overhaul of the membrane control system for all trains. Since the third membrane train will likely feature a more modern control system, upgrading the existing systems at the same time would ensure compatibility and similarity. Therefore, the upgrade work packages (refer to Section 6) of adding a third membrane train and upgrading the WTP’s control systems have been grouped together.

Capacity:

According to the Main Control System Installation & Operation Manual (Aslan Technologies), the UF membrane train was designed for a nominal flow of 31.5 L/s (500 USgpm), expandable to 63 L/s (1,000 USgpm) with a second train. The first train was installed in 2015, and the second train was installed only three years later in 2018, to address membrane fouling challenges. The membranes in train 1 were then upgraded from the SFD-2880 to the SFD-2880XP model sometime after 2022. The membranes in train 2 are the original installed. Operations now run both trains together at 33 L/s, through short-term flows of up to 58 L/s (3.5 m^3/min) have been achieved. This means that the “actual” single-train capacity is likely between 16.5 – 29 L/s. It is recommended that flow trials be conducted across the current operating range of approximately 16.5 to 29 L/s per train to identify the flow threshold at which membrane fouling accelerates and to assess potential impacts on membrane performance and service life. This may help determine whether the installation of a third train can be deferred. In August 2026, Operations indicated that the distribution pumps were tested up to 66 L/s under emergency conditions. However, for the purposes of this assessment, 58 L/s has been assumed as the maximum feasible combined membrane capacity, as the impacts of higher flows on membrane performance are not yet known.

To meet a future maximum day demand (MDD) of 50.6 L/s, three trains operating at 16.9 L/s each (slightly above current rates) would be needed. Again, flow trials are recommended to confirm operating above 16.5 L/s per train is sustainable for membrane performance.

The 2018 P&ID drawing (DWG No. 13354) shows the downstream flow control valve set for 31.5 L/s, but operations have adjusted the fixed orifice in the pilot control system for dual-train flow. A modulating flow control valve is recommended for better flow regulation, and the existing valve will need replacement with a third train anyway.

Wastewater is currently sent to the municipal sewer without issue according to operations, and they are aware the 4” drain line may need upsizing for future wastewater flows.

Each train has a dedicated CIP chemical pump; a third pump would be required for an additional train. The compressor may also need upgrading due to limited current capacity.

Resiliency:

While this report does not assess raw or treated water quality, future membrane performance may be impacted by changing environmental conditions. A study analyzing historical raw water quality trends and their effect on membrane fouling is recommended to inform long-term planning and potentially defer the need for additional trains.

To support future increases in water demand, planning for membrane system expansion is essential. A third UF membrane train will be required to meet the projected maximum day demand (MDD) of 50.6 L/s. Identifying a suitable location for this train is a priority for Village operations.

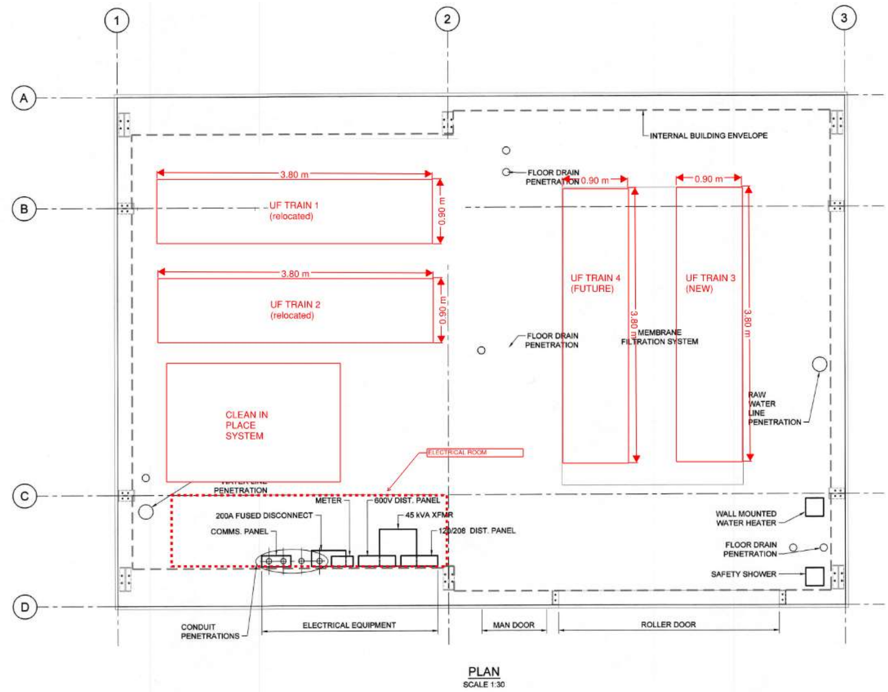
Further discussion regarding reservoir bypass mode, including break tank and distribution pump sizing to accommodate peak hourly flow, is provided in Sections 4.5 and 4.6. In the described scenario, the break tank was intentionally oversized to accommodate peak hourly flow without upsizing the WTP membrane system. If the Village wishes to operate in reservoir bypass mode without an oversized break tank, additional membrane trains may be required.

Operations have emphasized the desire to expand the building only once, with enough space to accommodate a third membrane train and footprint for a fourth. Aslan Technologies specifies a UF membrane train footprint of 0.9 m x 3.8 m (36” x 148”).

Several location options are available:

- Option 1: Relocate the break tank and distribution pumps into a small new structure or lean-to, allowing space for the third—and possibly fourth—train within the existing building. Electrical systems may need to be moved to a protected room, the lean-to, or the existing storage building behind the WTP. Refer to Figure 15.

- Option 2: Build a second structure to house the third and fourth trains, along with the relocated break tank and pumps. Available space is limited to the south-west, south, and south-east sides of the existing building. The north side borders the property line, and access/parking must be maintained on the south and west sides for trail users. Active water mains near the building (highlighted in Figure 16) would need to be rerouted or avoided. Electrical relocation options are the same as in Option 1.



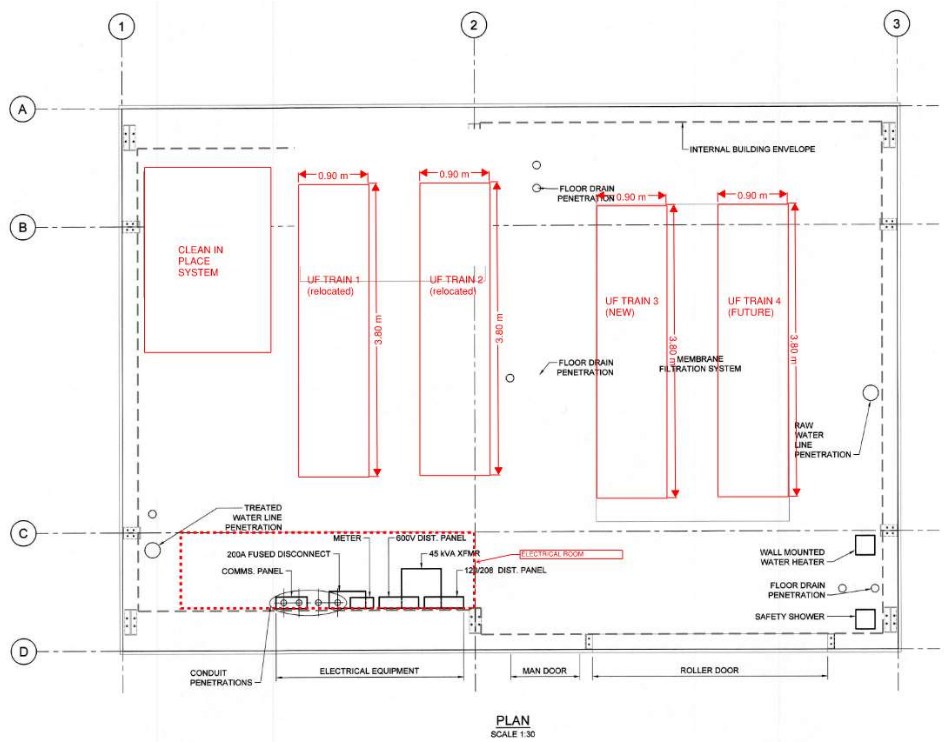


Figure 15: Potential Membrane Train Locations – Option 1 (Note, Booster pumps and break tank relocated.)

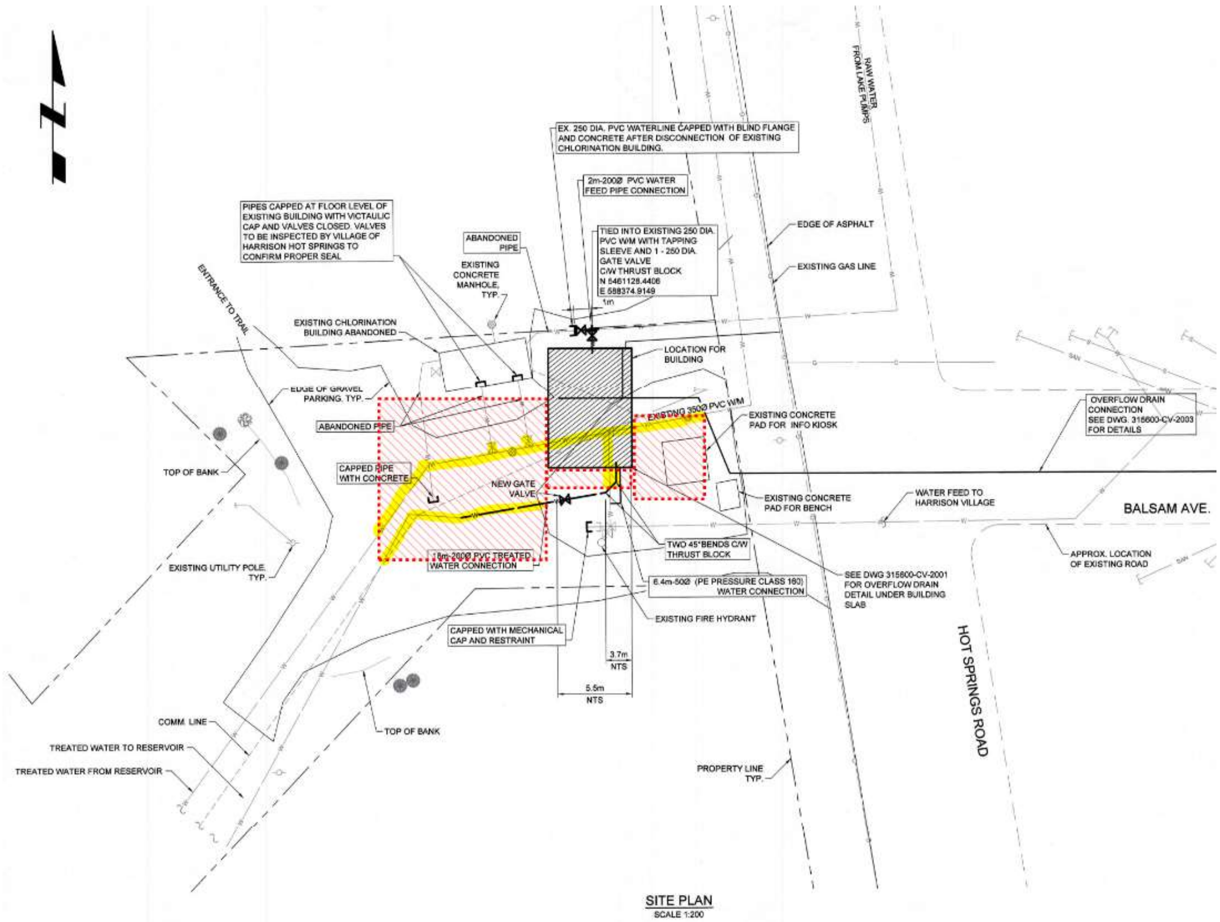


Figure 16: Possible Future Building or Lean-To Locations

Recommendations:

7. Construct a new building, building extension or lean-to, to house additional membrane trains (trains #3 and 4), the break tank and distribution pumps (as applicable).

8. Install 3rd membrane train in future to meet future demand, and plan for additional infrastructure upgrades to support flow increase, including:

    a. The downstream flow control valve, currently set for dual-train operation, may require replacement. A modulating flow control valve should be considered for improved regulation.
    b. The 4” drain line to sanitary may need upsizing to handle increased wastewater volumes.
    c. Each membrane train requires a dedicated CIP dosing pump; a third pump will be needed.
    d. The existing compressor may require replacement due to limited capacity. Consider installing an air dryer to reduce risk of corrosion or damage to pneumatic components.

9. Prepare a contingency plan for train #2 membrane replacement, as the membranes have been in operation since 2018. Establishing a rapid replacement strategy will help ensure continued full-capacity operation of the plant and avoid potential reductions—down to approximately 50%—in the event of membrane failure.

10. Conduct a membrane performance study. Analyze historical raw water quality and operational data to assess membrane performance under varying conditions (e.g., high turbidity events, varying flow). This may help defer the timeline for when a third train needs to be installed.

11. Consider upgrading the control system for the membrane trains at the timing of the new train installations, and consider upgrading the WTP master control system at the same time also.

4.4. CHLORINE DOSING SYSTEM (DISINFECTION)

Chlorine (sodium hypochlorite) is added to the process by duty/duty chlorine dosing pumps that are paced to the water flow as determined by flowmeter located upstream of the break tank. The dosing pumps are both operated when flow is detected, with each providing half of the chlorine demand requirements. In the event of one pump failure, this ensures at least some chlorine is being added to the system. Free chlorine residual is measured online by a chlorine analyzer. No low chemical tank level alarming is present and is recommended. According to the Harrison Hot Springs Main Control System Installation & Operation Manual (Aslan Technologies, n.d.) a “low level indicator alert for the need of more liquid chlorine” was already programmed for. Therefore, only a physical switch would need to be installed as one is not present. As this is a maintenance-related improvement that can be implemented at low cost by Operations, it is not discussed further in this report.

Table 12: Equipment Summary – Chlorine Dosing System

Equipment	Make	Model	Configuration	Design Capacity
Chlorine Dosing Pump 1	ProMinent	GMXa 0708	Duty	7.6 L/h at 102 psi
Chlorine Dosing Pump 2	ProMinent	GMX	Duty	7.6 L/h at 102 psi
Chlorine Dosing Tank	BARR Plastics	Not listed - Polyethylene tank	Duty	250 L

Condition:

The dosing pumps were replaced recently. One of the pumps experienced a circuit board failure and was repaired under warranty. The dosing tank shows no signs of cracking, bulging, or discoloration, and the dosing panel also appears to be in good shape.

There is an opportunity to improve chemical safety and environmental protection by installing improved secondary containment for the dosing tank and chemical drums stored on site. Currently, spilled hypochlorite drains directly to the sanitary system via the floor drain, which could pose a health and safety risk if pooling occurs around the drain. The original containment was removed due to its bulkiness and placed in storage. An improved containment solution should be installed to mitigate this risk.

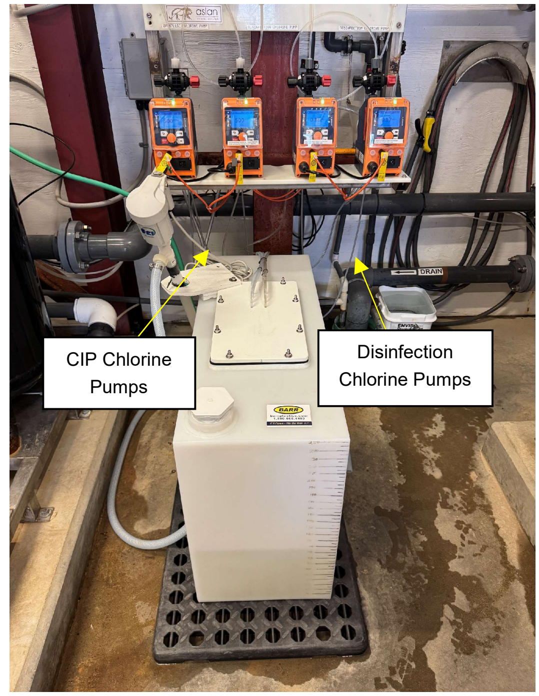


Figure 17: Chlorine Dosing Pumps

Capacity:

According to the Village, operators try to maintain residual chlorine of 0.45 to 0.55 mg/L leaving the plant during average demand, and up to 0.6 mg/L in summer. At the future MDD Of 50.6 L/s, the dosing pumps would need to deliver approximately 11.2 L/h of 12% hypo product to the dosing point. If both pumps are online, they should be able to deliver this dose, so long as the dosing point is located on the common main between all membrane trains. However, an additional pump is recommended as a common standby (by 2 duty + 1 standby). The Village has a shelf spare on hand.

The chlorine dosing day tank is refilled from 210 L hypochlorite barrels. The peak monthly chlorine usage was 843 L in June 2021, with operators refilling the day tank seven times averaging 120 L per fill. At the future summer ADD (2045), operations would need to top up the day tank with about two 208-L drums (55 gal) every month. During periods of high demand, more frequent top ups are likely, however the anticipated frequency is considered acceptable, and a larger day tank is not required to meet future demand.

Resiliency:

At current WTP flows, sufficient chlorine contact time (CT) is achieved during reservoir bypass mode, as outlined in the CT Value Calculation – Water Disinfection with Chlorine memorandum (CTQ Consultants, 2019). The bypass valve is located uphill near the reservoir. The report confirms that a chlorine dose of 1 mg/L at 41 L/s meets the required CT of 8 mg·min/L. Dosage is currently adjusted based on grab sample readings.

As water demand increases in the future, chlorine contact time (CT) will decrease. Section 3.3.4 estimates a future off-season peak hourly flow of 74 L/s. To maintain the required CT at this higher flow, the chlorine dose must be increased to roughly 1.8 mg/L or additional break tank storage is required. A temporary chlorine pump—such using a CIP dosing pump—may be needed to ensure adequate disinfection. This requirement would not apply until the equipment needed to feasibly operate in reservoir bypass mode are planned for installation.

Recommendations:

12. Install a secondary containment system for the chlorine dosing tank that minimizes interference with operations. No presence of containment poses a health and safety risk.

4.5. BREAK / TRANSFER TANK

The chlorinated water is directed to the 7500 L break tank to provide a reservoir for the booster pumps. The high- and low-level set points in the break tank are the start and stop set points for the distribution / transfer pumps. The overflow is the manhole located at the top of the tank, and water discharges directly on the floor.

Condition:

The break tank appears to be in good condition, with no visible signs of cracking, bulging, or discoloration. Operations have confirmed there are no integrity concerns. At the time of the July 21, 2025 site visit, there was a leak noted in the stainless-steel spool just upstream of the break tank. This section of piping should be repaired. As this is a maintenance-related improvement that can be implemented by Operations, it is not discussed further in this report.

Figure 18: Break Tank

Operations have also identified an opportunity to improve flood resilience inside the WTP by addressing the tank's proximity to the WTP's electrical equipment. In the event of a discharge pipe leak, there is a potential risk of flooding near sensitive infrastructure. Operations are interested in relocating the tank outside the building.

The upstream turbidity analyzer was also replaced recently.

Capacity:

Correspondence from Operations noted that the break tank has a 7,500 L capacity with a diameter of 1.6 metres and height of 4.11 metres. The spring line elevations of the inlet and outlet pipes are 3.63 metres and 0.20 metres respectively, while the pump start and stop control levels are 1.2 metres and 1.0 metres respectively. The operating range of 0.2 metres is quite small, resulting in an operating volume of only 402 litres. When the treatment system operates at current flow (33 L/s), the break tank operating volume fills in 12 seconds and the total volume would overflow in 4 minutes. This is likely leading to issues with pump cycling. Operations note that the pump stop level is kept low because otherwise the tank will overflow.

In the event of reservoir maintenance or an unplanned event where the reservoir needs to be taken offline and the reservoir bypass is opened, the break tank should be able to store the difference between off-season peak hourly demand (PHD) (74 L/s) and maximum day demand (50.6 L/s, supplied by the water treatment plant) for one hour. This future required storage volume is calculated to be 84,000 L, which exceeds the current capacity of 7,500 L. These values do not consider volume required for two hours of fire flow.

Resiliency:

Options for the reservoir bypass mode:

- Option 1: Install additional polyethylene break tanks housed in a new WTP building. Based on products available online, it appears the largest polyethylene tank that can be ordered is around 12,000 – 15,000 USgal (45,425 – 56,781 L), and therefore two would be required. An example 45,425 L tank from BARR Plastics has dimensions of roughly 141” diameter x 193” height. Refer to Section 4.3 for discussion on a building extension to house new break tanks.

- Option 2: Construct a single new steel bolted break tank directly outside of the WTP building. Note that the pumps are end suction pumps and a buried tank would not be feasible unless all distribution pumps were replaced.

- Option 3: Construct a new second reservoir on the top of the hill. This option has been considered in this report; however, if implemented, would likely be done in the distant future. While it may provide additional storage capacity, it does not address operational concerns related to break tank sizing or the frequency of pump cycling. As such, it is not viewed as a near-term solution to current system limitations. The capital cost associated with constructing a reservoir of similar capacity, excluding geotechnical works such as rock blasting and retaining wall construction, is approximately $1.2M for a steel bolted tank, insulation and ring beam concrete foundation. Further engineering investigation would be required to verify the costing of the geotechnical and other construction works.

- Option 4: Reinstate the old reservoir on the top of the hill for the reservoir bypass mode. However, due to the long period of inactivity, further assessment would be required to confirm the feasibility of refurbishment. Additionally, this option does not address current operational goals related to optimizing break tank sizing and reducing pump cycling frequency. The elevation of this reservoir does not provide enough water pressure to the Village, according to operations. This option has not been considered further.

Increasing the break tank size presents an opportunity to enhance system resilience and reduce the potential impact of external risks, such as falling rocks near the reservoir. Refer to Section 4.7 for further comment.

During reservoir bypass mode, the distribution pumps and associated variable frequency drives (VFDs) must continue to operate based on feedback from the pressure transmitter located on the distribution main. Reservoir maintenance activities should be scheduled during the off-season when system demand is lower to minimize operational impacts. Under bypass conditions, the treatment plant will be limited to supplying up to the maximum day demand. To manage peak hourly demands, the break tank and distribution pumps should be sized to provide temporary buffering capacity.

As a short-term temporary measure during a reservoir maintenance period, close coordination between the fire department and Village operations will be required, as the fire department will be limited in the amount of firewater they can extract while ensuring the break tank is not depleted too quickly. If firewater is drawn during periods of high peak hourly demand, the available volume will be significantly restricted. Upsizing the break tank does not resolve this limitation, as the primary constraints are the treatment plant's production capacity and the distribution pump capacity. Note that reservoir maintenance is planned and should be scheduled during low demand periods (i.e., outside of summer) to minimize operational impacts.

Demand management will be essential during reservoir maintenance. In advance of reservoir maintenance, the Village should implement public awareness campaigns to encourage water conservation and consider temporary restrictions on non-essential water uses (e.g., lawn irrigation) to reduce peak demand.

Recommendations:

13. Install a larger break tank (capacity 86,000 L) in a relocated location to eliminate distribution pump cycling issues and to meet peak hourly demand during a reservoir bypass scenario. Review chlorine contact time (CT) at future peak flows with respect to break tank operating levels, for the reservoir bypass scenario.

4.6. DISTRIBUTION PUMPING

The distribution pumps receive water from the break tank and supply water up to the elevated treated water reservoir. Pump #1 is the original from 2015, Pump #2 is 1 to 2 years old, and Pump #3 was replaced last year in 2024 from warranty. The pumps are equipped with VFDs. According to operations, the WTP start/stops is controlled by reservoir level but distribution pump speed is controlled by the distribution pressure transmitter.

Table 13: Equipment Summary – Distribution Pumps

Equipment	Manufacturer	Configuration	Theoretical Duty Point	HP
Booster Pumps (3)	KSB Movitec VCF 90/3-2 B, 60 Hz, 3,550 rpm, Brook Crompton motor	Lead / Lag / Lag	24.0 L/s @ 86.5 m according to pump nameplate	40

Condition:

The distribution pumps are reported to be in good condition, with Pumps 2 and 3 having been replaced recently. There is also a spare pump casing and spare motor available on site. There is an opportunity to improve the system by addressing vibration experienced in the discharge piping, particularly the 90-degree elbow, which has been identified as a potential flooding risk in the building. To mitigate this risk, operations recommend relocating both the discharge piping and pumps, particularly away from the electrical components, to reduce flooding risk and the likelihood of equipment damage.

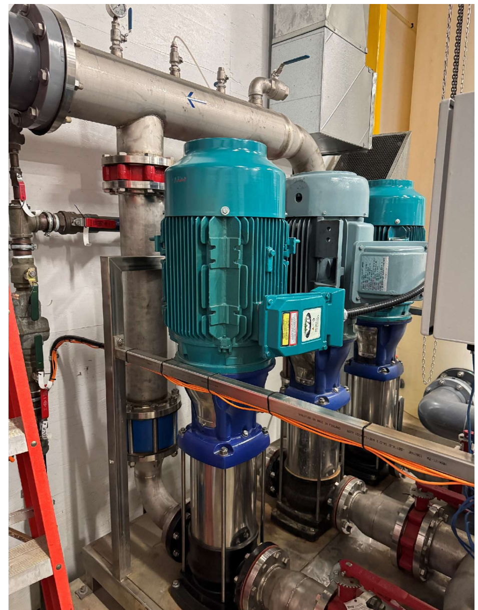


Figure 19: Distribution Pumps

Capacity:

With the existing nameplate pump capacity at 24 L/s, two duty pumps are sufficient to operate at the current WTP flow rate. The actual maximum capacity of the current distribution pumping system is uncertain, as flow meters are not installed on the distribution pumps and historical pumping rates have not been directly measured.

To operate the distribution pumps to the future MDD of 50.6 L/s (pumps only, refer to comments on the membranes and break tank in Sections 4.3 and 4.5), three duty pumps may be required for long term operation, depending on the system curve and the multi-pump curve. Operations have indicated that one or two pumps are typically operated at a time and estimate that approximately 66 L/s can be achieved by the pumps under emergency conditions. However, note that the feasibility of operating at this rate is dependent on the upstream process. At least one standby pump should always be present to maintain existing level of service.

During the reservoir bypass mode, four duty pumps (pumps only, refer to comments on the membranes and break tank in Sections 4.3 and 4.5) may be required to meet a 74 L/s peak hourly flow rate during the low demand season, again depending on the system curve and multi-pump curve. There is currently limited room available to install a fourth pump, therefore pump relocation would need to be considered. A standby pump may not be required during planned reservoir maintenance, depending on the Village's level of risk tolerance.

Confirmation of system capacity would reduce uncertainty in forecasting future pump upgrades. A distribution pumping flow test could be undertaken to establish actual capacity. However, flow testing is limited by the throughput of the membranes. As flow testing can be carried out in-house by Operations, a dedicated work package has not been scoped in this report.

Resiliency:

Refer to Section 4.3 for discussion on a building extension to house the distribution pumps.

Recommendations:

14. Relocate the distribution pumps to connect with a relocated break tank. Refer to the discussion in Section 4.3 on location options. Allocate space for a 4th pump (to plan for both WTP capacity increase and future reservoir bypass pumping). Simultaneously address concern with pump discharge piping.

4.7. RESERVOIR STORAGE

The existing steel reservoir was constructed in 2009, approximately 175 m southwest from the water treatment plant, on Agassiz Mountain. This reservoir was constructed at a higher elevation than the old concrete reservoir to improve low pressure issues in the distribution system. The steel reservoir slab is at elevation 65.0 m while the top water level is at 74.7 m.

The old concrete reservoir, located adjacent to the existing steel bolted reservoir, has been abandoned in place. Its potential for future refurbishment remains uncertain. However, due to its low elevation, the reservoir cannot maintain adequate distribution pressure and would require booster pumps if reinstated. Re-lining the tank could be considered as part of a rehabilitation strategy, but further assessment is needed to determine its feasibility and cost-effectiveness.

The existing steel bolted reservoir is approximately 2,778 m^3 (734,000 usgal) in total capacity according to the name plate shown in the 2021 Reservoir Inspection Report (Greatario, 2021). The start and stop levels are at 95% and 99% in summer, and 90% and 99% in winter. The 200 mm inlet is equipped with a Tideflex mixing system. The outlet is located within the floor slab of the reservoir; it is equipped with a steel reducer that protrudes slightly above the slab elevation of 65.0m.

The reservoir has a 200 mm drain and a 300 mm overflow which flow to a 1.35 metre storm manhole. Two swales surrounding the reservoir flow in catch basins which also flow into the storm manhole. The manhole outlet is a 300mm corrugated steel pipe, which terminates into a ditch adjacent to the reservoir access road. The supply and distribution watermains from the water treatment plant to the abandoned reservoir were previously located above ground; these segments were replaced in 2018 and relocated under the new reservoir access road. The new supply line is 200 mm PVC watermain, approximately 240 m long. The new distribution line is a 300 mm PVC watermain, approximately 200 mm in length. The record drawings (CTQ, 2018) show a 200 mm connection between the supply and distribution lines with a gate valve (normally closed) to bypass the reservoir for maintenance purposes.

Condition:

The 2021 Reservoir Inspection Report (Greatario, 2021) found that the reservoir's exterior components—including the domed roof, manways, tank wall panels, glass-fused-to-steel coating, and concrete curb/foundation—are generally in good condition. While the sealer on some sheet edges is thin and a few edges are exposed, Greatario did not consider this a concern at the time of report writing. They recommended a fine mesh insect screen be installed on the vent as it is missing, replacing one of the sidewall’s access manway plate hardware, and they observed a crack at the edge of the concrete curb likely due to falling rock.

The report found the reservoir's interior components – including the walls, glass fused to steel coating, interior piping and concrete floor – are also generally in good condition. One small area showed minor glass loss, possibly caused by an external impact such as a falling rock or tree, and should be cleaned and sealed. The sealer on sheet edges throughout the interior was reported to be thin, with some staining observed along the exposed edges.

According to operations, the reservoir anodes were replaced recently.

While this report does not assess linear infrastructure, operations advised that there are several opportunities for improvement including improving isolation valve functionality (difficult to close), enhancing valving redundancy, and addressing leaking flanges. This should be investigated further.

Capacity:

As stated above, the existing reservoir name plate capacity is 2,778 m^3.

The current and future requirements for reservoir storage was determined using the MMCD Design Guidelines:

Total Storage Volume = A + B + C

Where: A = Fire Storage
B = Equalization Storage (25% of Maximum Day Demand)
C = Emergency Storage (25% of A + B)

To determine fire storage, a fire flow demand must be selected. According to the VHHS Subdivision & Development Servicing Bylaw No. 1179, the minimum fire flow rates are as follows:

- Single Family & Two Dwelling Residential at 60 L/s
- Modular / Mobile Home at 60 L/s
- Three & Four Plex Housing at 150 L/s
- Apartments, Townhouses at 150 L/s
- Commercial at 150 L/s
- Institutional at 150 L/s
- Industrial at 225 L/s

Although Bylaw No. 1179 lists fire flow for industrial developments (225 L/s), correspondence with Village staff noted that there are no current or future plans for industrial developments. Therefore, the maximum fire flow used for calculating reservoir capacity is 150 L/s.

The current and future reservoir capacities are calculated in Table 14 below. The table below shows that the available reservoir storage to meet current and future (2045) demand is sufficient.

Table 14: Reservoir Capacity

Description	Current Demand	Future Demand (2045)
Scenario	99th percentile demand with fire flow at 150 L/s for 2 hours	With fire flow at 150 L/s for 2 hours
MDD (L/s)	25.1	50.6
MDD (m^3/day)	2169	4372
A: Fire Storage (m^3)	1080	1080
B: Equalization storage (25% of MDD)	542	1093
C: Emergency storage (25% of A + B)	406	543
Total volume	2028	2716
Existing storage	2778	2778
Available Storage (- if Deficit)	**750**	**62**

Resiliency:

Given the steep slopes around the reservoir and access road, rockfall has been an ongoing issue. GeoWest Engineering Ltd. (GeoWest) visited the site in 2022 and provided recommendations for rock scaling along the access road (June 20, 2023 memo), which was completed by Power Shotcrete Shoring Ltd. in May to September 2023.

From the 2022 report, a visual review of the rock cut around the reservoir indicated evidence of rock weathering and development of cracks in the rock mass. Localized overhanging, potentially unstable blocks were observed on the rock cut. Further recommendations were made by GeoWest to mitigate rockfall around the reservoir (November 10, 2023 memo). Budget pricing for this work (Phase 3 Slope Stabilization) was provided by Power Drilling and Stabilization for a total of $91,400 in November 2023 (excluding waste rock disposal and danger tree removal). The Village noted that this work has not yet been completed.

While the immediate risk to the reservoir is considered low, its protection remains a critical priority to maintain water security. Currently, the Village does not have infrastructure to bypass the reservoir for an extended period, making its protection critical.

Refer to the commentary in Section 4.5, under Option 3, for estimated costing for a new steel bolted reservoir.

Recommendations:

15. Undertake the rockfall mitigation scope near the reservoir, as proposed by Power Drilling and Stabilization.

4.8. WTP ELECTRICAL, POWER SUPPLY AND GENERATOR

4.8.1. Standby Generator Power

The existing WTP fixed (non-portable) standby diesel generator was decommissioned due to extensive repair needs and associated costs. As a result, it was sold. With the installation of the permanent standby diesel generator at the lake intake pumps, the portable generator has been semi-permanently connected to the WTP Automatic Transfer Switch for standby power at the WTP. This generator is reported by operations to be in good condition.

The 125kW portable diesel generator has been tested and proven to supply the necessary standby power to the WTP. Upgrades and changes to the WTP, like the addition of a third membrane train would need to be evaluated against this generator size. Operations have suggested that the portable generator is likely undersized.

Recommendation:

16. Plan for purchase of new permanent generator to include capacity for future upgrades, if required.

4.8.2. WTP Electrical Distribution

The WTP electrical distribution panels and transformer is currently exposed to spray from burst pipes, leaks or other occurrences. The highest risk of leaks and spray arise from the high-pressure distribution lines in close proximity to the electrical panels and transformer.

If the distribution pumps and break tank are moved outside the building, and a third membrane train is added to the process / building, the risk of damaging the electrical equipment is reduced. However, consideration should still be made for segregating the electrical equipment into a small electrical room.

The Village has also observed that the north-west corner of the building is particularly prone to leaks. Designing the flooring to slope toward this area would help direct water away from the electrical zone, further mitigating potential hazards.

The Village has already implemented flood detection sensors monitored by the control system and SCADA on the floor to detect flooding and alert operators before extensive damage is done. This philosophy should be followed with any future upgrades and process expansions. However, in the event of a major break, the sensors will only indicate that flooding has already begun—by which point it may be too late to prevent significant damage, as the building could rapidly fill with water.

Recommendation:

17. Segregate electrical/controls into a separate room.

4.8.3. WTP Power Quality and Voltage Imbalances

The WTP is susceptible to large voltage imbalances, which has negatively impacted electrical equipment (particularly the breakers). The root cause of these seem to stem from a long single-phase BC Hydro line along Rockwell Drive outside Harrison Hot Springs. The voltage imbalances are worst around the middle of winter presumably when winter heating loads peak along Rockwell Drive.

Mitigating these at or inside the WTP is very difficult, with the one potential solution being a large in-line UPS type system which would cost in the region of $180k for the electrical equipment hardware only and would require further building footprint and engineering to house.

A more cost-effective approach does not mitigate the problem but rather minimizes the effects of the problem by mitigating against equipment damage. This would involve the installation of voltage monitoring relays such as the Schneider Harmony Control Relays (Eg. RM35UB330) with the change-over contacts monitored by the WTP PLC, which would interlock pumping and operation of the 3-phase pumps during events of voltage imbalance, over-voltage or under-voltage.

A further consideration and general electrical equipment protection consideration would be installation of main hydro service surge protection. As the Main Service is classified as a Category C exposure, and given the service size, a Surge Protection Device (SPD) having a short-circuit current rating (SCCR) of 200kA should be specified and which includes an Enhanced Transient Filter (ETF). Total Protection Solutions Service Track ST200 could meet these requirements and has a 30-year unlimited free replacement warranty.

In future, potential investigation of a large UPS system is recommended to mitigate system voltage imbalances (also known as a Power Conditioner). This can be done at the timing of the WTP and building upgrade to house the additional equipment/membrane trains.

Recommendation:

18. Installation of voltage monitoring control relays to interlock equipment operation during upset conditions. Specification and installation of electrical surge protection devices.

4.9. WATER TREATMENT PLANT BUILDING

The Water Treatment Plant (WTP) building is approximately 10 m x 7 m. The former chlorination building is now used for site storage, with the east room (approx. 3.0 m × 4.8 m interior) housing general equipment and the west room (approx. 3.0 m × 2.0 m interior) used for chemical storage.

The exterior and interior walls of the building appear in good condition with no signs of corrosion. No cracks in the floor slab were visible. There is no bathroom present on site; however, operations would like one in future especially if a building expansion is required. There are several floor drains and flood level cleanouts that drain under the building to a 150 mm PVC overflow pipe. The overflow pipe drains into a sanitary manhole, approximately 67 metres away on Balsam Avenue. The WTP building was also constructed over existing water mains, both active and abandoned, according to record drawings.

There is a safety shower present on site, and section 4.4 provides chemical secondary containment recommendations.

Discussion on building expansion is detailed in Section 4.3, as it pertains to the membrane train expansion.

The Water Treatment Plant is located approximately 40 m from the Miami Slough, which is connected to the Miami River. The Miami River level is controlled by pumping water back into the lake. The elevation of the WTP is 14.35 m, which is above the flood of record (1894) level at 14.1 m, but below the current flood construction level of 14.55 m. Any future expansion of the building may require construction at a slightly higher elevation than the existing building.

4.10. GROUNDWATER CONSIDERATIONS

According to the 2015 Water Master Plan (CTQ, 2015), a deep, non-GARP test well drilled to 31 m depth in March 2010 by VHS showed elevated hardness, manganese and sulfides. In addition, the report also classified the aquifer as "highly vulnerable", with a considerable number of wells within the aquifer that could serve as a conduit for contamination.

According to the Upgrade of Water Supply, Treatment and Distribution System Report (NovaTec Consultants Inc., 1999), the Village of Harrison Hot Springs used to be served by three shallow wells, drilled in 1982. Each had a rated capacity of 450 m^3/day when they were developed, but over the years the capacity of the wells were reduced and later abandoned. The report also noted the Village attempted to develop additional wells, with several hydrogeological studies undertaken, and several wells drilled with no water yields. The Harrison Hot Springs Hotel also drilled down to 300-400 ft and found virtually no water.

According to the above report, a summary of historical problems with the groundwater supplying the Village of Harrison Hot Springs included:

- Manganese concentrations up to 0.2 mg/L
    - Note that the current maximum allowable concentration and aesthetic guideline value per the Guidelines for Canadian Drinking Water Quality are 0.12 and 0.02 mg/L respectively.
    - Manganese is likely to foul the existing ultrafiltration membrane filtration system, and therefore pretreatment at the WTP (such as greensand filtration) could be required for manganese removal if groundwater was implemented.
- Insufficient supply to keep up with summer demand.
- Shallow wells with risk of surface contamination.

With incomplete groundwater quality characterization increasing the risk of an inadequate treatment process, unpredictability of groundwater yields, and quality risks associated with a highly vulnerable aquifer, it is not recommended that the Village of Harrison Hot Springs explore groundwater as an economically suitable long term water source at this time.

Recommendation:

Should the Village of Harrison Hot Springs be interested to explore groundwater feasibility as a backup to lake water supply, to address concerns with climate resiliency, the cost of a desktop level groundwater feasibility study is detailed in Section 7.

5. Summary of System Capacities

The existing and future demands, as well as the capacities of each water treatment component are summarized in Table 15 below. The system components that are not adequate to meet the future projected demands are highlighted in red.

Table 15: Summary of System Demands and Capacities

Description	Value 1	Value 2	Notes
Demands	**Demand (m^3/day)**	**Demand (L/s)**	**-**
Historical Max of 2020 - 2024 Demands (VoHH)			
Existing ADD (Off Season)	727	8.4	
Existing ADD (Summer)	1,428	16.5	
Existing MDD (99th percentile)	2,315	26.8	
Future 2045 Demands (VoHH Base Demand + HHS Resort + Holiday Park)			
Future ADD (Off Season)	1,598	18.5	Refer to Section 3.3.3.
Future ADD (Summer)	2,981	34.5	Refer to Section 3.3.3.
Future MDD (99th percentile)	4,372	50.6	Refer to Section 3.3.3.
WTP Components	**Capacity (m^3/day or other)**	**Capacity (L/s or other)**	**-**
Existing System Capacities			
Intake Screen	-	-	No specification available
350 mm HDPE DR17 Intake Pipe	13,144	152	
Lake Pumps One pump running Two pumps running Three pumps running	 3,024 5,011 -	 35 58 -	Flows shown have been proven in operation. Flow of three pumps has not been tested as it exceeds the capacity of the WTP.
UF Membranes One train Two trains	 1,426 - 2,506 2,851 - 5,011	 16.5 - 29 33 - 58	Typical operation is between 33 - 58 L/s with both trains running together. Max. flow of 58 L/s only trialed for a short duration.
Chlorine Pumps (each)	0.18 m^3/day	7.6 L/h	Future dose estimated around 11.2 L/h total
Break Tank Operating Capacity Total Capacity	 0.4 m^3 7.5 m^3	 402 L 7,500 L	Future storage required based on reservoir bypass scenario = 84 m^3 (84,000L)
WTP Booster Pumps One pump running Two pumps running	 2,074 4,147	 24.0 <48.0	Theoretical value listed, assuming 2 pumps duty + 1 pump on standby. Actual capacity of multiple pumps running is unknown.
Existing Reservoir Capacity			
Existing Reservoir Capacity	2,678 m^3	2,678,000 L	Future storage required = 2,716 m^3 (2,716,000 L). Existing reservoir has a minor surplus of 62 m^3 to meet 2045 recommendations.

6. Summary of Recommendations and Implementation Plan

Capacity is defined as the asset's ability to meet current and future demand. Condition is defined as the physical state of the asset, typically based on visual inspection, age or wear. Functionality is defined as the ability of an asset to perform its intended purpose or function. In this report, these are defined as the **likelihood** of asset failure.

Risk to water security is defined as the potential impact, or **consequence**, of poor equipment condition, insufficient capacity, or inadequate system functionality on the availability of potable water to the public. The consequence score represents the severity of impact to water security should an asset fail or underperform.

The recommendations suggested throughout the technical memo are consolidated in Table 17 below for ease of reference. The recommendations have been prioritized with the higher priority items at the top of the list.

Prioritization of upgrades have been rated in terms of the priority, which equals the likelihood of the risk (asset condition, capacity, operational function) multiplied by the consequence of the risk materializing (risk to water security). Line items have been grouped together as stand alone work packages based on likely construction sequencing.

Refer to Appendix C for a detailed breakdown of the work packages, definitions for condition, capacity and function, and the scoring used for each metric used to define the priority ranking values listed below. In general, the scores assigned are based on the following definitions.

Table 16: Scoring Definitions for Condition, Capacity, Functionality and Risk to Water Security

Category	Definition
Condition	Excellent (1): Asset is in like-new condition with no defects or deterioration. Good (2): Minor defects or wear, but no significant impact on performance. Fair (3): Moderate defects or wear that may affect performance but are manageable. Poor (4): Significant defects or deterioration that impact performance and require attention. Very Poor (5): Severe defects or deterioration, asset is near or at the end of its useful life and requires immediate action
Capacity	Exceeds Requirements (1): Asset capacity significantly exceeds current and projected demands. Adequate (2): Asset capacity meets current and projected demands with some margin. Marginal (3): Asset capacity meets current demands but may struggle with projected increases. Inadequate (4): Asset capacity is insufficient for current demands, leading to frequent issues. Critically Inadequate (5): Asset capacity is far below current demands, causing severe and frequent issues.
Function	Fully Functional (1): Asset performs all intended functions optimally with no issues. Mostly Functional (2): Minor issues present but no significant impact on performance. Moderately Functional (3): Noticeable performance issues; asset still operates but with reduced effectiveness.

Category	Definition
	Poor Functionality (4): Major issues; asset struggles to perform its function. Non-Functional (5): Asset cannot perform its intended function at all.
Risk to Water Security	Minor Consequence (1): A localized or short-duration impact that does not interrupt overall potable water supply and can be managed through normal operations, existing storage, or system redundancy. Moderate Consequence (2): A partial or temporary reduction in water availability that may affect a portion of the system, require increased operational controls, or reduce system redundancy, but does not result in prolonged or widespread service outages. Major Consequence (3): A significant or sustained interruption to potable water availability, where the system is unable to meet demand through normal operations, redundancy, or storage, and emergency response measures may be required to maintain supply to the public.

An item is designated with a ranking of “Critical” if the priority score is >12, a ranking of “High” if the priority score is >9, a ranking of “Medium” if the priority score is >6 and otherwise designated a ranking of “Low.”

Table 17: Prioritized List of Recommended Replacements, Upgrades and Activities

Work Package Group	Item	Area	Recommendation	LIKELIHOOD Condition (1-5)	Capacity (1-5)	Function (1-5)	Average (1-5)	CONSEQUENCE Risk to Water Security (1-3)	Risk (Likelihood x Consequence)	Priority	Comments
1	6	Lake	Replace lake pump VFDs and PLC. VFDs to suit new pumps.	4	2	4	3.3	3	10.0	HIGH	
1	3	Lake	Relocate critical electrical equipment to kiosk at higher elevation (Option 4)	4	2	4	3.3	2	6.7	MEDIUM	Modified from a Risk to Water Security score of "3" to a score of "2" as emergency/ temporary flood protection measures can be deployed and are planned for by the VoHHS.
1	5	Lake	Replace lake pumps, check valves and vault alarm/electrical concerns	4	2	4	3.3	2	6.7	MEDIUM	Risk to Water Security score designated a "2", based on the check valves causing periods of pressure reduction at the WTP inlet. There are currently three pumps, and each pump can meet current maximum day demand and two pumps can meet future projected MDD year 2045. Redundancy is available.

Work Package Group	Item	Area	Recommendation	LIKELIHOOD Condition (1-5)	Capacity (1-5)	Function (1-5)	Average (1-5)	CONSEQUENCE Risk to Water Security (1-3)	Risk (Likelihood x Consequence)	Priority	Comments
2.1 (Phase 1)	7	WTP	Construct a new building, building extension or lean-to, to house additional membrane trains, the break tank and distribution pumps (as applicable). Include site civil to decommission water main under the existing building. Tear down existing masonry/storage building behind existing WTP.	4	2	4	3.3	3	10.0	HIGH	Consequence is based on requirement to house the distribution pumps and break tank, which have a Risk to Water Security score of 3.
2.2 (Phase 2)	14	WTP	Relocate the distribution pumps to connect with a relocated break tank. Allocate space for 4th pump. Simultaneously address concern with pump discharge piping.	2.5	3	3.5	3.0	3	9.0	MEDIUM	Risk to Water Security score designated as a "3" based on VoHHS concerns with pump discharge piping integrity.
2.2 (Phase 2)	13	WTP	Install new break tank in a relocated location.	1	4	4	3.0	3	9.0	MEDIUM	
3	18	WTP	Electrical surge protection.	3	3	3	3.0	3	9.0	MEDIUM	
3	17	WTP	Segregate electrical/controls equipment into small electrical room	3	3	3	3.0	3	9.0	MEDIUM	
4.1 (Phase 1)	11	WTP	Upgrade the control system for the membrane trains and the WTP master control system	3	3	3	3.0	3	9.0	MEDIUM	
4.2 (Phase 2)	8	WTP	Add third UF train in future to meet future demand. Includes CIP system and piping modifications.	1.5	3	2	2.2	2	4.3	LOW	

Work Package Group	Item	Area	Recommendation	LIKELIHOOD				CONSEQUENCE	Risk (Likelihood x Consequence)	Priority	Comments
				Condition (1-5)	Capacity (1-5)	Function (1-5)	Average (1-5)	Risk to Water Security (1-3)			
5	2	WTP	Install a pressure relief valve at the WTP inlet	3	1	5	3.0	3	9.0	MEDIUM	
6	15	Reservoir	Complete Phase 3 rockfall hazard mitigation	2	2	4	2.7	3	8.0	MEDIUM	
7	9	WTP	Train #2 membrane replacement	2	3	2	2.3	2	4.7	LOW	
8	10	WTP	Conduct a detailed study on UF membrane performance	2	3	2	2.3	2	4.7	LOW	
8	4	Lake	Conduct lake pump testing to confirm max flows & assess impact to WQ	3	2	3	2.7	1	2.7	LOW	
9	12	WTP	Add secondary containment for hypochlorite drums and dosing system.	1	3	2	2.0	2	4.0	LOW	
10	1	Lake	Conduct a lake intake extension and protection study	1	1	2	1.3	3	4.0	LOW	
11	16	WTP	New permanent generator (incl. capacity for future upgrades)	1	3	1	1.7	2	3.3	LOW	

*Priority ranking is defined as the average score, out of 5, between condition, capacity and function, multiplied by the risk to water security score. Definitions for each category and their score are available in Appendix C.

***Note: As requested by the VoHHS, work package 2 has been separated out as two separate project phases (Phase 1 and Phase 2). There is inherent risk in delivering the WTP building as a first, separately funded phase, followed by equipment supply and installation under a later phase. This phased approach limits the ability to dynamically address design changes or refinements between the building and process equipment, increasing the potential for rework, constructability challenges, or interface issues.**

7. Cost Estimate

The following section describes the expected capital construction costs associated with the proposed upgrades.

7.1. CONSTRUCTION COSTS

McElhanney has prepared an opinion of probable capital cost estimate based on historical pricing and current trends in pricing work. The costs provided cover only the probable capital costs, at the conceptual detail level. It should be noted that even 3-month-old pre-tender Class A cost estimates are falling short of keeping up with the current market price increases, with two recent project tender submissions coming in between 10-50% higher than initial estimates.

A Class "D" cost estimate was prepared for the scope of works, following the Budget Guidelines for Consulting Engineering Services (ACEC, 2009), and is based on the below definition. McElhanney has applied a 40% contingency to each cost summary, as an allowance for unforeseen elements of cost that generally covers small design changes, small quantity changes, central bank target inflation rate, and small estimating changes which cannot be identified prior to construction.

- *<u>Class "D" estimate:</u> A preliminary estimate which, due to little or no site information, indicates the approximate magnitude of cost of the proposed project, based on the client's broad requirements. This overall cost estimate may be derived from lump sum or unit costs for a similar project. It may be used in developing long term capital plans and for preliminary discussion of proposed capital projects.*

7.2. ENGINEERING ALLOWANCE

The engineering allowance applied to each of the options is an estimate of the level of effort required to further develop the preferred option through detailed design to issuance of construction drawings and includes allowances for the typical levels of effort involved with contract management, construction supervision, record drawings and commissioning, which are typically completed by the owner/contractor with support from the engineering firm of record. The allowance is based on approximate costs as witnessed on similar projects, as well as the Association of Consulting Engineering Companies British Columbia Fee Guidelines.

Typical engineering fee allowance as a percentage of project capital cost can vary from 20% for smaller projects to 13.3% for large scale water projects. A 15% Engineering Fee Allowance has been included in this estimate, and up to 20% for small projects < $100k.

7.3. COST ESTIMATE

The projects identified in this report are summarized in Table 18. Projects were divided based on funding with small projects being funded through operational reserves and larger complex projects being likely funded through grants. In addition, projects likely to be eligible for DCC funding were identified.

Cost estimates in Table 18 do not include a contingency allowance; a 40% contingency allowance should be added to all costs plus a suggested annual 3% escalation fee, depending on the final timing of the project. If engineering is required for the project, a separate column is included based on an estimated fee of 15% engineering. All costs and fees are rounded up to the closest $1000.

The detailed cost estimates for the projects are provided in Appendix D and show 2025 cost estimates.

Key assumptions related to the cost estimate are as follows:

- Quotes have been solicited from equipment suppliers key process components.
- Other estimates were based on recent tenders for other projects and pro-rated based on relative flows.
- Most of the projects presented herein are stand-alone projects and can be undertaken when funding is available or based on other factors. Work packages #2 and #4 would need to be undertaken sequentially as the additional building/ building extension would be required to house new membrane equipment. Work package #8 should also be completed in advance of work package #4 to further inform the design requirements of the third membrane train. Work package #11 should be planned in coordination with work package #4, to align generator/standby power needs with various WTP upgrades.

As requested by VoHHS, **costs are based on present day pricing only, and engineering and contingency has been separated out accordingly. Future grant funding applications should account for rise in cost based on inflation, engineering, and contingency amounts.**

Capital Costs and Project Schedule

Village of Harrison Hot Spring

WTP - Master Plan - Capital Improvements

McElhanney

Class D Estimate. 40% contingency not included & to be added to all projects.

Project No.	TASK DESCRIPTION	DCC Eligibility	Short-Term 0 - 5 years		Medium-Term 5 - 10 years		Long-Term 10 - 20 years	
	Water Treatment Plant							
	ANNUAL OPERATING PROJECTS		Engineering	Capital	Engineering	Capital	Engineering	Capital
WP#2 Phase 1 (See Note 4)	*Construct a new building, building extension or lean-to, to house additional membrane trains, the break tank and distribution pumps (as applicable). Include site civil to decommission water main under the existing building. Tear down existing masonry/storage building behind existing WTP.	✓	$ 193,000	$ 919,000				
WP#2 Phase 2 (See Note 4)	*Relocate the distribution pumps to connect with a relocated break tank. Allocate space for 4th pump. Simultaneously address concern with pump discharge piping. *Install new break tank in a relocated location.	✓			$ 136,000	$ 645,000		
WP#3	*Electrical surge protection *Segregate electrical/controls equipment into small electrical room		$ 13,000	$ 46,000				
WP#4	*Add third UF train in future to meet future demand. Includes CIP system and piping modifications. *Upgrade the control system for the membrane trains and the WTP master control system	✓					$ 180,000	$ 855,000
WP#5	*Install a pressure relief valve at the WTP inlet		$ 14,000	$ 49,000				
WP#6	*Complete Phase 3 rockfall hazard mitigation				$ -	$ 146,000		
WP#7	*Train #2 membrane replacement				$ 55,000	$ 259,000		
WP#8	*Conduct a detailed study on UF membrane performance *Conduct lake pump testing to confirm max flows & assess impact to WQ				$ 70,000			
WP#9	*Add improved secondary containment for hypochlorite drums and dosing system.		$ 2,000	$ 6,000				
WP#10	*Conduct a lake intake extension and protection study						$ 20,000	
	SUBTOTAL		$	1,242,000	$	1,311,000	$	1,055,000
	GRANT OPPORTUNITY PROJECTS							
WP#1	* Relocate critical electrical equipment to kiosk at higher elevation (Option 4) * Replace lake pump VFDs and PLC.VFDs to suit new pumps. * Replace lake pumps, check valves and address vault alarm/electrical concerns		$ 132,000	$ 628,000				
WP#11	*New permanent generator (incl. capacity for future upgrades)	✓			$ 32,000	$ 148,000		
	SUBTOTAL		$	760,000	$	180,000	$	-
	TOTAL ESTIMATED COSTS PER TIME FRAME		$	2,002,000	$	1,491,000	$	1,055,000
	FURTHER INVESTIGATION REQ'D							

	Assumptions (See report for more details)
1	Inflation: Inflation is not included. Suggest using 3% / year after 2025 or actual value, if known. Future grant funding applications should account for rise in cost based on inflation.
2	Engineering: 15% for projects which require engineering, 20% for smaller projects <$100k. In-house projects do not include engineering.
3	Class D Estimate: 40% contingency should be added to all projects. Engineering is based on the estimated project cost + contingency.
4	WP#2 Option A refers to the break tank being located inside the building, and therefore a larger building footprint is required. WP#2 Option B refers to the break tank being located outside the building, and therefore a smaller building footprint is required. Costing assumes worst-case cost between WP#2 Option A vs. #2 Option B. The worst case total project cost is Option B, but note this option has less upfront cost for the building. Note: As requested by the VoHHS, work package 2 has been separated out as two separate project phases (Phase 1 and Phase 2). This may incur greater costs and construction challenges than combining them into one delivery. McElhanney recommends that Phase 1 and Phase 2 are delivered under a single contract. A single-contract delivery approach for Phase 1 and Phase 2 would provide greater flexibility to incorporate design refinements and optimize coordination between the building and process equipment throughout the project.
5	Values exclude tax.
6	The generator upgrade for the WTP (WP#11) should be planned in conjunction with WP#2. As requested by VoHHS, if the implementation of WP#2 is postponed beyond the next 1 to 3 years, VoHHS would like the generator upgrade to proceed independently and be completed within the next couple of years.
7	No engineering fees apply to the rockfall hazard mitigation, as the scope of work has already been fully defined by a professional service provider.
8	No additional engineering fees apply to scope of works that are engineering / desktop studies
9	WP#9 budgets for an engineered concrete curb. A polyethylene containment may be a suitable, more cost-effective option.
10	Most of the projects presented herein are stand-alone projects and can be undertaken when funding is available or based on other factors. Work packages #2 and #4 would need to be undertaken sequentially as the additional building/ building extension would be required to house new membrane equipment. Work package #8 should also be completed in advance of work package #4 to further inform the design requirements of the third membrane train. Work package #11 should be planned in coordination with work package #4, to align generator/standby power needs with various WTP upgrades.

8. Closure

McElhanney is pleased to provide this Water Treatment Plant Master Plan to assess current condition, capacity and resiliency and address future water requirements for the Village of Harrison Hot Springs.

If there are any questions or concerns, please contact the undersigned.

Sincerely,

Prepared by:

2026-08-07

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PERMIT TO PRACTICE
McElhanney Ltd.

PERMIT NUMBER: 1003299
Engineers and Geoscientists of BC

APPENDIX A

Statement of Limitations

Appendix A - Statement of Limitations

Use of this Report. This report was prepared by McElhanney Ltd. ("**McElhanney**") for the particular site, design objective, development, and purpose (the "**Project**") described in this report and for the exclusive use of the client identified in this report (the "**Client**"). The data, interpretations and recommendations pertain to the Project and are not applicable to any other project or site location and this report may not be reproduced, used, or relied upon, in whole or in part, by a party other than the Client, without the prior written consent of McElhanney. The Client may provide copies of this report to its affiliates, contractors, subcontractors, and regulatory authorities for use in relation to and in connection with the Project provided that any reliance, unauthorized use, and/or decisions made based on the information contained within this report are at the sole risk of such parties. McElhanney will not be responsible for the use of this report on projects other than the Project, where this report or the contents hereof have been modified without McElhanney's consent, to the extent that the content is in the nature of an opinion, and if the report is preliminary or draft. This is a technical report and is not a legal representation or interpretation of laws, rules, regulations, or policies of governmental agencies.

Standard of Care and Disclaimer of Warranties. This report was prepared with the degree of care, skill, and diligence as would reasonably be expected from a qualified member of the same profession, providing a similar report for similar projects, and under similar circumstances, and in accordance with generally accepted engineering, planning, and scientific judgments, principles and practices. McElhanney expressly disclaims any and all warranties in connection with this report.

Information from Client and Third Parties. McElhanney has relied in good faith on information provided by the Client and third parties noted in this report and has assumed such information to be accurate, complete, reliable, non-fringing, and fit for the intended purpose without independent verification. McElhanney accepts no responsibility for any deficiency, misstatements or inaccuracy contained in this report as a result of omissions or errors in information provided by third parties or for omissions, misstatements or fraudulent acts of persons interviewed.

Effect of Changes. All evaluations and conclusions stated in this report are based on facts, observations, site-specific details, legislation and regulations as they existed at the time of the report preparation. Some conditions are subject to change over time and the Client recognizes that the passage of time, natural occurrences, and direct or indirect human intervention at or near the site may substantially alter such evaluations and conclusions. McElhanney should be requested to re-evaluate the conclusions of this report and to provide amendments as required prior to any reliance upon the information presented herein upon any of the following events: a) any changes (or possible changes) as to the site, purpose, or development plans upon which this report was based, b) any changes to applicable laws subsequent to the issuance of the report, c) new information is discovered in the future during site excavations, construction, building demolition or other activities, or d) additional subsurface assessments or testing conducted by others.

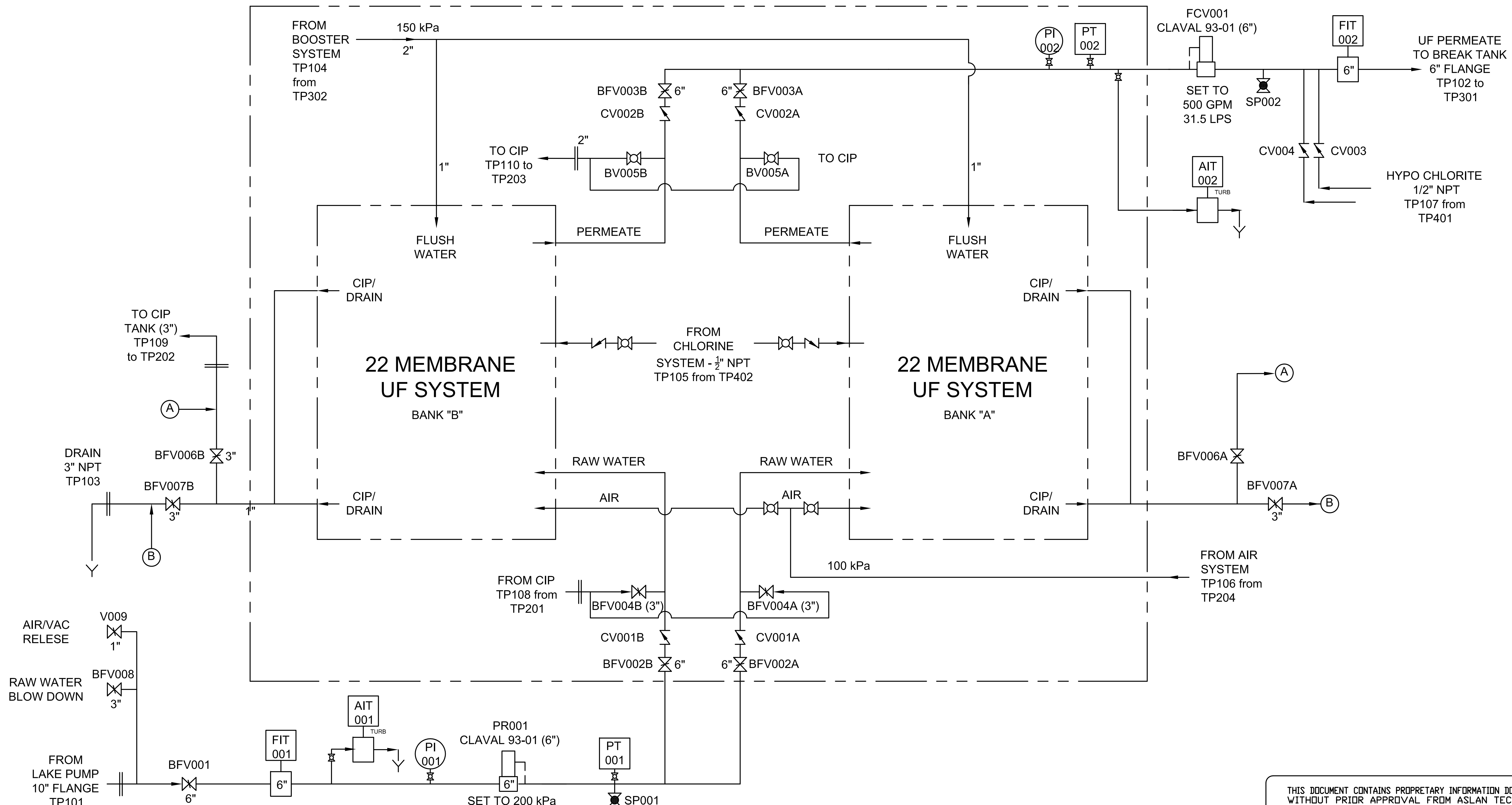
Independent Judgments. McElhanney will not be responsible for the independent conclusions, interpretations, interpolations and/or decisions of the Client, or others, who may come into possession of this report, or any part thereof. This restriction of liability includes decisions made to purchase, finance or sell land or with respect to public offerings for the sale of securities.

Construction Cost Estimates. This construction cost estimate has been prepared using the design and technical information currently available, and without the benefit of Survey, Geotechnical, Environmental, or other disciplines, information. Furthermore, McElhanney cannot predict the competitive environment, weather or other unforeseen conditions that will prevail at the time that contractors will prepare their bids. The cost estimate is therefore subject to factors over which McElhanney has no control, and McElhanney does not guarantee or warranty the accuracy of such estimate.

APPENDIX B

Record Drawing - Piping & Instrumentation Diagram (P&ID)

Ultrafiltration System (44 Membrane Capacity)



REV. NO.	DATE	INT.	
5	1Jun18	JD	Expaned to 44 membranes
4	16Jun14	JD	As Built
3	27Nov13	JD	Issued for Approval
2	05/Nov/13	MM	Pre-construction
1	25OCT13	JD	22 installed and 22 future membranes

REVISIONS

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HARRISON HOT SPRINGS
PROCESS DIAGRAM – UF SKID

SCALE NTS	DISC v12	DRAWN BY JD	
DATE 08/SEP/13	APPROVED	DWG NO.1 OF 5	REV.#
PROJECT 13354		13354 P&ID	5

APPENDIX C

Condition, Capacity, Function and Water Security

Work Package Group	Item	Area	Recommendation	LIKELIHOOD				CONSEQUENCE	Risk (Likelihood x Consequence)	Priority (Critical, High, Medium, Low)	Comments
				Condition (1-5)	Capacity (1-5)	Function (1-5)	Average (1-5)	Risk to Water Security (1-3)			
1	6	Lake	Replace lake pump VFDs and PLC. VFDs to suit new pumps.	4	2	4	3.3	3	10.0	HIGH	
1	3	Lake	Relocate critical electrical equipment to kiosk at higher elevation (Option 4)	4	2	4	3.3	2	6.7	MEDIUM	Modified from a Risk to Water Security score of "3" to a score of "2" as emergency/temporary flood protection measures can be deployed and are planned for by the VoHHS.
1	5	Lake	Replace lake pumps, check valves and vault alarm/electrical concerns	4	2	4	3.3	2	6.7	MEDIUM	Risk to Water Security score designated a "2", based on the check valves causing periods of pressure reduction at the WTP inlet. There are currently three pumps, and each pump can meet current maximum day demand and two pumps can meet future projected MDD year 2045. Redundancy is available.
2.1	7	WTP	Construct a new building, building extension or lean-to, to house additional membrane trains, the break tank and distribution pumps (as applicable). Include site civil to decommission water main under the existing building. Tear down existing masonry/storage building behind existing WTP.	4	2	4	3.3	3	10.0	HIGH	Consequence is based on requirement to house the distribution pumps and break tank, which have a Risk to Water Security score of 3.
2.2	14	WTP	Relocate the distribution pumps to connect with a relocated break tank. Allocate space for 4th pump. Simultaneously address concern with pump discharge piping.	2.5	3	3.5	3.0	3	9.0	MEDIUM	Risk to Water Security score designated as a "3" based on VoHHS concerns with pump discharge piping integrity.
2.2	13	WTP	Install new break tank in a relocated location.	1	4	4	3.0	3	9.0	MEDIUM	
3	18	WTP	Electrical surge protection.	3	3	3	3.0	3	9.0	MEDIUM	
3	17	WTP	Segregate electrical/controls equipment into small electrical room	3	3	3	3.0	3	9.0	MEDIUM	
4.1	11	WTP	Upgrade the control system for the membrane trains and the WTP master control system	3	3	3	3.0	3	9.0	MEDIUM	
4.2	8	WTP	Add third UF train in future to meet future demand. Includes CIP system and piping modifications.	1.5	3	2	2.2	2	4.3	LOW	
5	2	WTP	Install a pressure relief valve at the WTP inlet	3	1	5	3.0	3	9.0	MEDIUM	
6	15	Reservoir	Complete Phase 3 rockfall hazard mitigation	2	2	4	2.7	3	8.0	MEDIUM	
7	9	WTP	Train #2 membrane replacement	2	3	2	2.3	2	4.7	LOW	
8	10	WTP	Conduct a detailed study on UF membrane performance	2	3	2	2.3	2	4.7	LOW	
8	4	Lake	Conduct lake pump testing to confirm max flows & assess impact to WQ	3	2	3	2.7	1	2.7	LOW	

9	12	WTP	Add secondary containment for hypochlorite drums and dosing system	1	3	2	2.0	2	4.0	LOW	
10	1	Lake	Conduct a lake intake extension and protection study	1	1	2	1.3	3	4.0	LOW	
11	16	WTP	New permanent generator (incl. capacity for future upgrades)	1	3	1	1.7	2	3.3	LOW	

DEFINITIONS

In asset management, **functionality**, **condition**, and **capacity** are distinct but interrelated concepts. Here's how they differ, with examples from **water treatment plant components**:

1. Functionality

Definition: The ability of an asset to perform its **intended purpose** or function.

- **Focus**: *Is it doing what it's supposed to do?*
- **Example**: A chemical dosing pump is in good condition and has enough capacity, but if it's not calibrated correctly and is underdosing chlorine, it's **not functional** for disinfection.

2. Condition

Definition: The **physical state** of the asset, typically based on visual inspection, age, or wear.

- **Focus**: *What shape is it in?*
- **Example**: A clarifier tank may be **corroded** or have cracks (poor condition), but it might still be **functional** and meet capacity needs—for now.

3. Capacity

Definition: The asset's ability to meet **current and future demand**.

- **Focus**: *Can it handle the required volume or load?*
- **Example**: A filtration unit may be in excellent condition and fully functional, but if it was designed for 10 ML/day and demand has grown to 15 ML/day, it's **under-capacity**.

Example Table

Component	Functionality Issue	Condition Issue	Capacity Issue
Chemical Dosing Pump	Incorrect dosing due to faulty sensor	Rusted housing	Can't dose enough for peak flow
Clarifier	Sludge not settling properly	Cracked concrete walls	Too small for current flow rate
UV Disinfection Unit	UV lamps not reaching required intensity	Aging ballast and wiring	Can't treat full volume during peak hours

Comparison Table: Functionality vs Condition vs Capacity

Aspect	Definition	Focus Question	Example (Water Treatment)
Functionality	Ability of the asset to perform its intended purpose or role	*Is it doing what it's supposed to do?*	A chemical dosing pump is working but underdosing due to a faulty sensor → **Not functional**
Condition	Physical state of the asset (wear, damage, age)	*What shape is it in?*	A clarifier tank has visible cracks and corrosion → **Poor condition**
Capacity	Ability of the asset to meet current and future demand	*Can it handle the required load?*	A filtration unit designed for 10 ML/day is now required to treat 15 ML/day → **Undersized**

Condition

1. **Excellent (1)**: Asset is in like-new condition with no defects or deterioration.
2. **Good (2)**: Minor defects or wear, but no significant impact on performance.
3. **Fair (3)**: Moderate defects or wear that may affect performance but are manageable.
4. **Poor (4)**: Significant defects or deterioration that impact performance and require attention.
5. **Very Poor (5)**: Severe defects or deterioration, asset is near or at the end of its useful life and requires immediate action.

Capacity

1. **Exceeds Requirements (1)**: Asset capacity significantly exceeds current and projected demands.
2. **Adequate (2)**: Asset capacity meets current and projected demands with some margin.
3. **Marginal (3)**: Asset capacity meets current demands but may struggle with projected increases.
4. **Inadequate (4)**: Asset capacity is insufficient for current demands, leading to frequent issues.
5. **Critically Inadequate (5)**: Asset capacity is far below current demands, causing severe and frequent issues.

Function

1. **Fully Functional (1)**: Asset performs all intended functions optimally with no issues.
2. **Mostly Functional (2)**: Minor issues present but no significant impact on performance.
3. **Moderately Functional (3)**: Noticeable performance issues; asset still operates but with reduced effectiveness.

4. **Poor Functionality (4)**: Major issues; asset struggles to perform its function.
5. **Non-Functional (5)**: Asset cannot perform its intended function at all.

RESULTS & OBSERVATIONS FROM JULY 21, 2025 SITE VISIT

Component	Condition Rating (1-5)	Capacity (1-5)	Intended Function	Function Rating (1–5)	Observations	Risk if Non-Functional (Major/ Moderate/ Minor)	Action Required
Lake Intake	1	1	Draws raw water from the lake to supply the intake pumps.	2	VoHHS operations note screen is in good condition. Function scoring does not consider lake depth issue – refer to WTP Master Plan.	Major (3)– cannot produce potable water if non-functional.	
Lake Intake Pump 1 / 2 / 3	3 for all	2	Pump lake water to the WTP.	3	Functionality ranked 3 by VoHHS operations as they want better performance out of them, for example improved ability for flow control. 25-year-old based on the 2000 record drawings – motors for pump 1 & 2 were reportedly replaced in 2007.	Minor (1) – WTP can operate using redundant units.	
Lake Pumpstation Piping and Valving	3	1	Transports lake water to/from intake pumps to the supply main connecting the WTP.	5	Given a function rating of 5 as surge anticipator not functioning and no pressure relief, however it has never worked. Issues with check valve.	Major (3) – cannot produce potable water if non-functional.	
Lake Pumpstation Electrical and Instrumentation	4	2	Provides power, control, and monitoring for lake	4	Capacity rated 2 by VoHHS operations, they would like the VFDs/electrical equipment to be upsized.	Major (3) – cannot produce potable water if non-functional.	

Component	Condition Rating (1-5)	Capacity (1-5)	Intended Function	Function Rating (1–5)	Observations	Risk if Non-Functional (Major/ Moderate/ Minor)	Action Required
			pumpstation operations.				
Lake Generator	1	1	Supplies emergency backup power to the lake pumpstation.	1	Capacity rated 1 by VoHHS operations, oversized.	Moderate (2) – cannot produce potable water during short or long term power outage.	
UF Membrane Train 1	1	3	Filters raw water through ultrafiltration membranes to remove particulates and pathogens.	2	Outdated controls.	Moderate (2) – can only produce water at half capacity if train goes down.	
UF Membrane Train 2	2	3	Filters raw water through ultrafiltration membranes to remove particulates and pathogens.	2	Older membranes (inside the modules) than train #1.	Moderate (2) – can only produce water at half capacity if train goes down.	
UF Train 1 mechanical/piping	2	3	Supports UF Train 1 with mechanical components and piping for water	2	Leaks in the valves and poor piping connections. Operations can’t identify the locations of the leaking. There is leaking during integrity testing. 55	Moderate (2) – can only produce water at half capacity if train goes down.	

Component	Condition Rating (1-5)	Capacity (1-5)	Intended Function	Function Rating (1–5)	Observations	Risk if Non-Functional (Major/ Moderate/ Minor)	Action Required
			flow and pressure control.		valves on each train make it difficult to identify leak point.		
UF Train 2 mechanical/piping	2	3	Supports UF Train 2 with mechanical components and piping for water flow and pressure control.	2	See item above.	Moderate (2) – can only produce water at half capacity if train goes down.	
Membrane CIP System	2	3	Cleans UF membranes using chemical cleaning processes to maintain performance.	3	Manual CIP. Operations note troubles with compressor, should be larger.	Minor (1) – CIP maintains membrane performance. Could operate for short term without it.	
Break Tank	1	4	Temporarily stores filtered water to manage flow and pressure between process stages.	4	Break tank too small – frequent pump cycling.	Major (3) – cannot produce potable water if non-functional.	
Booster Pumps 1 / 2 / 3	1	3	Pressurize treated water for distribution to the reservoir or network.	2	Issues with distribution pressure control during reservoir bypass. Pump 1 is the original, Pump 2 is 1-2 years old, and Pump 3 was replaced last year from warranty.	Minor (1) – WTP can operate using redundant units.	

Component	Condition Rating (1-5)	Capacity (1-5)	Intended Function	Function Rating (1–5)	Observations	Risk if Non-Functional (Major/ Moderate/ Minor)	Action Required
Booster Pump Mech/Piping	4	3	Facilitates mechanical operation and water conveyance for booster pumps.	5	Issues with the elbow downstream of the distribution pumps, risk of major leakage according to VoHHS operations.	Major (3) – cannot produce potable water if non-functional.	
WTP General Piping/ Fittings/ Valves	1	3	Distributes water throughout the WTP and connects treatment components.	2	VoHHS would like to add a pressure relief valve at the WTP inlet. There is a leakage at the break tank inlet. Minor leaks from membrane piping.	Major (3) – cannot produce potable water if non-functional.	
Chlorine Disinfection Dosing System (Incl. Tank & Pumps)	1	3	Doses filtered water with chlorine for final disinfection before distribution	2	Minor leaks noted. Operations would like a spare ordered.	Moderate (2) – can only produce water at half capacity if a dosing pump goes down (they operate duty + duty).	
WTP General Electrical, Instrumentation and Controls	3	3	Provides power, automation, and monitoring for the entire WTP.	3	Capacity ok for now – not future. Capacity rating by VoHHS operations. Major surge issues. Would like an overhaul of the WTP control system. Breakers burnt out. Damage to pump motors historically.	Major (3) – cannot produce potable water if non-functional.	

Component	Condition Rating (1-5)	Capacity (1-5)	Intended Function	Function Rating (1–5)	Observations	Risk if Non-Functional (Major/ Moderate/ Minor)	Action Required
WTP Generator	1	3	Supplies backup power to the WTP during outages.	1	Currently using the portable lake pump generator. Undersized for future, but good for interim according to VOHHS.	Moderate (2) – cannot produce potable water during short or long term power outage.	
Reservoir	2	2	Stores treated water for distribution to the community.	4	Major issues with outlet piping configuration; leak on one of the flanges. Isolation valves very hard to close.	Major (3) – cannot produce potable water if non-functional. Minor (1) for non-critical reservoir maintenance items nominated in 2021 Greatario Report.	

APPENDIX D

Cost Estimates

Subheading	Description	No. units	Unit	Unit cost	Cost (Excl GST)	Comments
WORKPACKAGE #1						
	* Relocate critical electrical equipment to kiosk at higher elevation (Option 4)					
	* Replace lake pump VFDs and PLC. VFDs to suit new pumps.					
	* Replace lake pumps, check valves and address vault alarm/electrical concerns					
1	***Front End***				***$ 71,000***	
	Insurance/Bonding	1.5%	%	$ 557,000	$ 9,000	
	Mobilization and Demobilization	3.0%	%	$ 557,000	$ 17,000	
	General Requirements	5.0%	%	$ 557,000	$ 28,000	
	Start-up and Commissioning	3.0%	%	$ 557,000	$ 17,000	
2	***Civil Site Works***				***$ 56,000***	
	Kiosk foundation (concerete pad)	1	LS.	$ 10,000	$ 10,000	Including excavation & base prep, supply of pad and labour.
	Relocate generator	1	LS.	$ 10,000	$ 10,000	
	Trenching for electrical conduits	50	LM	$ 715	$ 36,000	
3	***Process Mechanical***				***$ 177,000***	
	New lake pumps	3	LS.	$ 50,000	$ 150,000	
	New check valves	3	LS.	$ 4,000	$ 12,000	
	Remove surge anticipator	1	LS.	$ 5,000	$ 5,000	
	Vault piping allowances	1	LS.	$ 10,000	$ 10,000	
4	***Structural***				***$ -***	
	N/A					
5	***Electrical and Controls Upgrades***				***$ 287,000***	
	New VFDs (hardware)	3	LS.	$ 21,800	$ 66,000	40 HP pump motor currently
	New PLC Panel (hardware)	1	LS.	$ 30,000	$ 30,000	
	PLC & VFD programming, installation, commissioning	1	LS.	$ 40,000	$ 40,000	
	Integration of new PLC with Village SCADA system	1	LS.	$ 28,000	$ 28,000	
	Raise critical electrical equipment (switchgear etc) inside existing building	1	LS.	$ 8,000	$ 8,000	
	PVC electrical conduit -electrical kiosk	50	LM	$ 80	$ 4,000	
	PVC electrical conduit - generator relocate	50	LM	$ 120	$ 6,000	
	Electrical Wiring	50	LM	$ 150	$ 8,000	
	Electrical Wiring	50	LM	$ 120	$ 6,000	
	Outdoor electrical kiosk	1	LS.	$ 58,000	$ 58,000	
	Supply and install surge protection devices	1	LS.	$ 13,000	$ 13,000	
	Installation of voltage monitoring relays and control system integration for equipment protection	1	LS.	$ 10,000	$ 10,000	
	Technician to resolve vault alarms/electrical issues	24	HRS	$ 190	$ 5,000	
	Decommissioning/removal of existing VFDs/PLC	1	LS.	$ 5,000	$ 5,000	
6	***Equipment Deliveries***				***$ 37,000***	
	Sum of all non-civil cost items / equipment cost items x 10%	10%	unit	$ 363,000	$ 37,000	
SUMMARY						
SubTotal (1) "Front End"					*$ 71,000*	
SubTotal (2 - 6)					*$ 557,000*	
SubTotal					***$ 628,000***	

Contingency		*40%*			*$*	*251,200*	
WORKPACKAGE #1 Capital Costs					***$***	***879,200***	
Engineering 15%		*15%*			*$*	*131,880*	
WORKPACKAGE #1 Construction Costs- Present Day Cost					***$***	***1,012,000***	

Subheading	Description	No. units	Unit	Unit cost	Cost (Excl GST)	Comments
WORKPACKAGE #2 Option A Phase 1						
SCOPE	*Construct a new building, building extension or lean-to, to house additional membrane trains, the break tank and distribution pumps (as applicable). Include site civil to decommission water main under the existing building. Tear down existing masonry/storage building behind existing WTP. OPTION A REFERS TO TANK HOUSED INSIDE NEW BUILDING.					
1	***Front End***				***$ 183,000***	
	Insurance/Bonding	1.5%	%	$ 1,052,000	$ 16,000	
	Mobilization and Demobilization	3.0%	%	$ 1,052,000	$ 32,000	
	General Requirements	5.0%	%	$ 1,052,000	$ 53,000	
	Start-up and Commissioning	3.0%	%	$ 1,052,000	$ 32,000	
	Environmental protection	1	LS.	$ 50,000	$ 50,000	
2	***Civil Site Works***				***$ 189,000***	
	Excavation	320	CUM	$ 25	$ 8,000	
	Subgrade/Foundation Preparation	80	CUM	$ 50	$ 4,000	
	Backfill, Trenching	100	M	$ 370	$ 37,000	
	Plant/Yard Piping, Valves	1	LS.	$ 50,000	$ 50,000	
	Access / driveway	1	LS.	$ 30,000	$ 30,000	
	Fencing	40	M	$ 200	$ 8,000	
	Landscaping	80	SQM	$ 20	$ 2,000	
	Civil works to decommission piping under existing WTP building	1	LS.	$ 50,000	$ 50,000	
3	***Process Mechanical***				***$ -***	
	N/A					
4	***Structural***				***$ 850,000***	
	Building extension / new building	100	SQM	$ 8,000	$ 800,000	
	Demolition of existing masonry storage building	1	LS.	$ 50,000	$ 50,000	Assuming contains no hazardous materials.
5	***Electrical and Controls Upgrades***				***$ 13,000***	
	PVC electrical conduit - new building	50	LM	$ 80	$ 4,000	
	Electrical Wiring - new building	100	SQM	$ 90	$ 9,000	
6	***Equipment Deliveries***				***$ -***	
	Sum of all non-civil cost items / equipment cost items x 15%	15%	unit	$ -	$ -	
SUMMARY						
SubTotal (1) "Front End"					*$ 183,000*	
SubTotal (2 - 6)					*$ 1,052,000*	
SubTotal					***$ 1,235,000***	
Contingency		*40%*			*$ 494,000*	
WORKPACKAGE #2 Option A Phase 1 Capital Costs					***$ 1,729,000***	
Engineering 15%		*15%*			*$ 259,350*	
WORKPACKAGE #2 Option A Phase 1 Construction Costs- Present Day Cost					***$ 1,989,000***	

Subheading	Description	No. units	Unit	Unit cost	Cost (Excl GST)	Comments
WORKPACKAGE #2 Option A Phase 2						
SCOPE	*Relocate the distribution pumps to connect with a relocated break tank. Allocate space for 4th pump. Simultaneously address concern with pump discharge piping.					
	*Install new break tank in a relocated location. OPTION A REFERS TO TANK HOUSED INSIDE NEW BUILDING.					
1	***Front End***				***$ 79,000***	
	Insurance/Bonding	1.5%	%	$ 214,000	$ 4,000	
	Mobilization and Demobilization	3.0%	%	$ 214,000	$ 7,000	
	General Requirements	5.0%	%	$ 214,000	$ 11,000	
	Start-up and Commissioning	3.0%	%	$ 214,000	$ 7,000	
	Environmental protection	1	LS.	$ 50,000	$ 50,000	
2	***Civil Site Works***				***$ -***	
	N/A					
3	***Process Mechanical***				***$ 154,000***	
	Relocate 3 x distribution pumps into building extension	3	LS.	$ 3,000	$ 9,000	
	2 x 45 m3 indoor polyethylene tanks	2	LS.	$ 40,000	$ 80,000	
	Above-ground piping allowances	1	LS.	$ 15,000	$ 15,000	
	Supply 4th distribution pump to meet peak-hourly flow during reservoir bypass	1	LS.	$ 50,000	$ 50,000	Incl. pump, motor, pump valves and VFD
4	***Structural***				***$ -***	
	N/A					
5	***Electrical and Controls Upgrades***				***$ 40,000***	
	Relocate electrical and instrumentation for break tank and distribution pumps to new building	1	LS.	$ 20,000	$ 20,000	
	Commissioning allowance	1	LS.	$ 20,000	$ 20,000	
6	***Equipment Deliveries***				***$ 20,000***	
	Sum of all non-civil cost items / equipment cost items x 15%	15%	unit	$ 130,000	$ 20,000	
SUMMARY						
SubTotal (1) "Front End"					*$ 79,000*	
SubTotal (2 - 6)					*$ 214,000*	
SubTotal					***$ 293,000***	
Contingency		*40%*			*$ 117,200*	
WORKPACKAGE #2 Option A Phase 2 Capital Costs					***$ 410,200***	
Engineering 15%		*15%*			*$ 61,530*	
WORKPACKAGE #2 Option A Phase 2 Construction Costs- Present Day Cost					***$ 472,000***	

Subheading	Description	No. units	Unit	Unit cost	Cost (Excl GST)	Comments
WORKPACKAGE #2 Option B Phase 1						
SCOPE	*Construct a new building, building extension or lean-to, to house additional membrane trains, the break tank and distribution pumps (as applicable). Include site civil to decommission water main under the existing building. Tear down existing masonry/storage building behind existing WTP. OPTION A REFERS TO TANK HOUSED OUTSIDE NEW BUILDING.					
1	*Front End*				*$ 149,000*	
	Insurance/Bonding	1.5%	%	$ 770,000	$ 12,000	
	Mobilization and Demobilization	3.0%	%	$ 770,000	$ 24,000	
	General Requirements	5.0%	%	$ 770,000	$ 39,000	
	Start-up and Commissioning	3.0%	%	$ 770,000	$ 24,000	
	Environmental protection	1	LS.	$ 50,000	$ 50,000	
2	*Civil Site Works*				*$ 227,000*	
	Excavation	320	CUM	$ 25	$ 8,000	
	Subgrade/Foundation Preparation	80	CUM	$ 50	$ 4,000	
	Backfill, Trenching	100	M	$ 250	$ 25,000	
	Plant/Yard Piping, Valves	1	LS.	$ 50,000	$ 50,000	
	Access / driveway	1	LS.	$ 30,000	$ 30,000	
	Fencing	40	M	$ 200	$ 8,000	
	Landscaping	80	SQM	$ 20	$ 2,000	
	Underground piping to the steel bolted tank	1	LS.	$ 50,000	$ 50,000	
	Civil works to decommission piping under existing WTP building	1	LS.	$ 50,000	$ 50,000	
3	*Process Mechanical*				*$ -*	
	N/A					
4	*Structural*				*$ 530,000*	
	Building extension / new building	60	SQM	$ 8,000	$ 480,000	
	Demolition of existing masonry storage building	1	LS.	$ 50,000	$ 50,000	Assuming contains no hazardous materials.
5	*Electrical and Controls Upgrades*				*$ 13,000*	
	PVC electrical conduit - new building	50	LM	$ 80	$ 4,000	
	Electrical Wiring - new building	100	SQM	$ 90	$ 9,000	
6	*Equipment Deliveries*				*$ -*	
	Sum of all non-civil cost items / equipment cost items x 15%	15%	unit	$ -	$ -	
SUMMARY						
SubTotal (1) "Front End"					*$ 149,000*	
SubTotal (2 - 6)					*$ 770,000*	
SubTotal					***$ 919,000***	
Contingency		*40%*			*$ 367,600*	
WORKPACKAGE #2 Option B Phase 1 Capital Costs					***$ 1,286,600***	
Engineering 15%		*15%*			*$ 192,990*	
WORKPACKAGE #2 Option B Phase 1 Construction Costs- Present Day Cost					***$ 1,480,000***	

Subheading	Description	No. units	Unit	Unit cost	Cost (Excl GST)	Comments
WORKPACKAGE #2 Option B Phase 2						
SCOPE	*Relocate the distribution pumps to connect with a relocated break tank. Allocate space for 4th pump. Simultaneously address concern with pump discharge piping.					
	*Install new break tank in a relocated location. OPTION B REFERS TO TANK HOUSED OUTSIDE NEW BUILDING.					
1	***Front End***				***$ 117,000***	
	Insurance/Bonding	1.5%	%	$ 528,000	$ 8,000	
	Mobilization and Demobilization	3.0%	%	$ 528,000	$ 16,000	
	General Requirements	5.0%	%	$ 528,000	$ 27,000	
	Start-up and Commissioning	3.0%	%	$ 528,000	$ 16,000	
	Environmental protection	1	LS.	$ 50,000	$ 50,000	
2	***Civil Site Works***				***$ -***	
	N/A					
3	***Process Mechanical***				***$ 434,000***	
	Relocate 3 x distribution pumps into building extension	3	LS.	$ 3,000	$ 9,000	
	90 m3 outdoor epoxy steel bolted tank c/w insulation and foundation	1	LS.	$ 360,000	$ 360,000	Supply and install of 1 x 90 m3 useable capacity epoxy bolted steel tank c/w tank materials, ring beam foundation, R20 insulation, tank disinfection.
	Above-ground piping allowances	1	LS.	$ 15,000	$ 15,000	
	Supply 4th distribution pump to meet peak-hourly flow during reservoir bypass	1	LS.	$ 50,000	$ 50,000	Incl. pump, motor, pump valves and VFD
4	***Structural***				***$ -***	
	N/A					
5	***Electrical and Controls Upgrades***				***$ 32,000***	
	Relocate electrical and instrumentation for break tank and distribution pumps to new building	1	LS.	$ 12,000	$ 12,000	
	Commissioning allowance	1	LS.	$ 20,000	$ 20,000	
6	***Equipment Deliveries***				***$ 62,000***	
	Sum of all non-civil cost items / equipment cost items x 15%	15%	unit	$ 410,000	$ 62,000	
SUMMARY						
SubTotal (1) "Front End"					*$ 117,000*	
SubTotal (2 - 6)					*$ 528,000*	
SubTotal					***$ 645,000***	
Contingency		*40%*			*$ 258,000*	
WORKPACKAGE #2 Option B Phase 2 Capital Costs					***$ 903,000***	
Engineering 15%		*15%*			*$ 135,450*	
WORKPACKAGE #2 Option B Phase 2 Construction Costs- Present Day Cost					***$ 1,039,000***	

Subheading	Description	No. units	Unit	Unit cost	Cost (Excl GST)	Comments
WORKPACKAGE #3						
SCOPE	*Electrical surge protection					
	*Segregate electrical/controls equipment into small electrical room					
1	***Front End***				***$ 8,900***	
	Insurance/Bonding	1.5%	%	$ 37,000	$ 600	
	Mobilization and Demobilization	6.0%	%	$ 37,000	$ 2,300	
	General Requirements	10.0%	%	$ 37,000	$ 3,700	
	Start-up and Commissioning	6.0%	%	$ 37,000	$ 2,300	
2	***Civil Site Works***				***$ -***	
	N/A					
3	***Process Mechanical***				***$ -***	
	N/A					
4	***Structural***				***$ 10,000***	
	Construct new room (raised walls without ceiling c/w access door) for segregated electrical/controls in existing building	1	LS.	$ 10,000	$ 10,000	
5	***Electrical and Controls Upgrades***				***$ 27,000***	
	Supply and install surge protection devices	1	LS.	$ 13,000	$ 13,000	
	Relocate electrical equipment	1	LS.	$ 9,000	$ 9,000	
	Cable rerouting and termination	1	LS.	$ 5,000	$ 5,000	
6	***Equipment Deliveries***				***$ -***	
	Sum of all non-civil cost items / equipment cost items x 15%	15%	unit	$ -	$ -	
SUMMARY						
SubTotal (1) "Front End"					*$ 8,900*	
SubTotal (2 - 6)					*$ 37,000*	
SubTotal					***$ 45,900***	
Contingency		*40%*			*$ 18,360*	
WORKPACKAGE #3 Capital Costs					***$ 64,260***	
Engineering 20%		*20%*			*$ 12,852*	
WORKPACKAGE #3 Construction Costs- Present Day Cost					***$ 78,000***	

Subheading	Description	No. units	Unit	Unit cost	Cost (Excl GST)	Comments
WORKPACKAGE #4						
SCOPE	*Add third UF train in future to meet future demand. Includes CIP system and piping modifications.					
	*Upgrade the control system for the membrane trains and the WTP master control system					
1	***Front End***				***$ 96,000***	
	Insurance/Bonding	1.5%	%	$ 759,000	$ 12,000	
	Mobilization and Demobilization	3.0%	%	$ 759,000	$ 23,000	
	General Requirements	5.0%	%	$ 759,000	$ 38,000	
	Start-up and Commissioning	3.0%	%	$ 759,000	$ 23,000	
2	***Civil Site Works***				***$ -***	
	N/A - assuming building cost covered in WP2.					
3	***Process Mechanical***				***$ 542,000***	
	Above-ground piping allowances	1	LS.	$ 15,000	$ 15,000	
	Supply 3rd membrane train	1	LS.	$ 500,000	$ 500,000	includes the frame, UF membrane, and all valves associated with the membrane train.
	CIP system replacement	1	LS.	$ 15,000	$ 15,000	
	Air compressor system replacement	1	LS.	$ 10,000	$ 10,000	
	Desiccant air dryer for compressor	1	LS.	$ 2,000	$ 2,000	Desiccant air drying pkg incl. water removing filter, coalescing filter, desiccant dryer, filter/regulator and shut-off valve.
4	***Structural***				***$ -***	
	N/A - assuming building cost covered in WP2.					
5	***Electrical and Controls Upgrades***				***$ 217,000***	
	PLC programming, installation, commissioning	20%	%	$ 50,000	$ 10,000	
	PVC electrical conduit - new building	50	LM	$ 80	$ 4,000	
	Upgrade membrane train 1 & 2 with new controls	1	LS.	$ 70,000	$ 70,000	
	Upgrade WTP Master Controls	1	LS.	$ 70,000	$ 70,000	
	PLC programming, installation, commissioning	20%	%	$ 140,000	$ 28,000	
	Integration of new PLC with Village SCADA system	25%	%	$ 140,000	$ 35,000	
6	***Equipment Deliveries***				***$ -***	
	Sum of all non-civil cost items / equipment cost items x 15%	15%	unit	$ -	$ -	
SUMMARY						
SubTotal (1) "Front End"					*$ 96,000*	
SubTotal (2 - 6)					*$ 759,000*	
SubTotal					***$ 855,000***	
Contingency		*40%*			*$ 342,000*	
WORKPACKAGE #4 Capital Costs					***$ 1,197,000***	
Engineering 15%		*15%*			*$ 179,550*	
WORKPACKAGE #4 Construction Costs- Present Day Cost					***$ 1,377,000***	

Subheading	Description	No. units	Unit	Unit cost	Cost (Excl GST)	Comments
WORKPACKAGE #5						
SCOPE	*Install a pressure relief valve at the WTP inlet					
1	***Front End***				***$ 9,300***	
	Insurance/Bonding	1.5%	%	$ 39,000	$ 600	
	Mobilization and Demobilization	6.0%	%	$ 39,000	$ 2,400	
	General Requirements	10.0%	%	$ 39,000	$ 3,900	
	Start-up and Commissioning	6.0%	%	$ 39,000	$ 2,400	
2	***Civil Site Works***				***$ -***	
	N/A					
3	***Process Mechanical***				***$ 35,000***	
	Pressure relief valve	1	LS.	$ 19,200	$ 20,000	
	Isolation valve	1	LS.	$ 5,000	$ 5,000	
	Piping allowance	1	LS.	$ 10,000	$ 10,000	
4	***Structural***				***$ -***	
	N/A					
5	***Electrical and Controls Upgrades***				***$ -***	
	N/A					
6	***Equipment Deliveries***				***$ 4,000***	
	Sum of all non-civil cost items / equipment cost items x 15%	15%	unit	$ 25,000	$ 4,000	
SUMMARY						
SubTotal (1) "Front End"					*$ 9,300*	
SubTotal (2 - 6)					*$ 39,000*	
SubTotal					***$ 48,300***	
Contingency		*40%*			*$ 19,320*	
WORKPACKAGE #5 Capital Costs					***$ 67,620***	
Engineering 20%		*20%*			*$ 13,524*	
WORKPACKAGE #5 Construction Costs- Present Day Cost					***$ 82,000***	

Subheading	Description	No. units	Unit	Unit cost	Cost (Excl GST)	Comments
WORKPACKAGE #6						
SCOPE	*Complete Phase 3 rockfall hazard mitigation					
1	***Front End***				***$ 17,000***	
	Insurance/Bonding	1.5%	%	$ 129,000	$ 2,000	
	Mobilization and Demobilization	3.0%	%	$ 129,000	$ 4,000	
	General Requirements	5.0%	%	$ 129,000	$ 7,000	
	Start-up and Commissioning	3.0%	%	$ 129,000	$ 4,000	
2	***Civil Site Works***				***$ 129,000***	
	A. Mobilization of crew, Equipment & Supplies to site L/S	1	LS.	$ 17,000	$ 17,000	
	B. Place temporary tank protection L/S	1	LS.	$ 5,000	$ 5,000	
	C. Conduct a tree hazard assessment (As Per Work Safe Regulations)	1	LS.	$ 2,000	$ 2,000	
	D. Hazardous Tree Removal (Cost-Plus 15%) This task would be subcc	1	LS.	$ 10,000	$ 10,000	
	E. Area #01 as per outline	1	LS.	$ 32,000	$ 32,000	
	F. Area #02 as per outline	1	LS.	$ 23,000	$ 23,000	
	G. Area #03 as per outline	1	LS.	$ 25,000	$ 25,000	
	H. Clean-up & Demobilization L/S	1	LS.	$ 5,000	$ 5,000	
	Allowance for additional unit pricing	1	LS.	$ 10,000	$ 10,000	Allowance
3	***Process Mechanical***				***$ -***	
	N/A					
4	***Structural***				***$ -***	
	N/A					
5	***Electrical and Controls Upgrades***				***$ -***	
	N/A					
6	***Equipment Deliveries***				***$ -***	
	Sum of all non-civil cost items / equipment cost items x 15%	15%	unit	$ -	$ -	
SUMMARY						
SubTotal (1) "Front End"					*$ 17,000*	
SubTotal (2 - 6)					*$ 129,000*	
SubTotal					***$ 146,000***	
Contingency		*40%*			*$ 58,400*	
WORKPACKAGE #6 Capital Costs					***$ 204,400***	
Engineering 15%		*0%*			*$ -*	*Not applicable - complete package scoped.*
WORKPACKAGE #6 Construction Costs- Present Day Cost					***$ 205,000***	

Subheading	Description	No. units	Unit	Unit cost	Cost (Excl GST)	Comments
WORKPACKAGE #7						
SCOPE	*Train #2 membrane replacement					
1	***Front End***				***$ 28,800***	
	Insurance/Bonding	1.5%	%	$ 230,000	$ 3,500	
	Mobilization and Demobilization	3.0%	%	$ 230,000	$ 6,900	
	General Requirements	5.0%	%	$ 230,000	$ 11,500	
	Start-up and Commissioning	3.0%	%	$ 230,000	$ 6,900	
2	***Civil Site Works***				***$ -***	
	N/A					
3	***Process Mechanical***				***$ 200,000***	
	Procurement of membranes and installation	1	LS.	$ 200,000	$ 200,000	
4	***Structural***				***$ -***	
	N/A					
5	***Electrical and Controls Upgrades***				***$ -***	
	N/A					
6	***Equipment Deliveries***				***$ 30,000***	
	Sum of all non-civil cost items / equipment cost items x 15%	15%	unit	$ 200,000	$ 30,000	
SUMMARY						
SubTotal (1) "Front End"					*$ 28,800*	
SubTotal (2 - 6)					*$ 230,000*	
SubTotal					***$ 258,800***	
Contingency		*40%*			*$ 103,520*	
WORKPACKAGE #7 Capital Costs					***$ 362,320***	
Engineering 15%		*15%*			*$ 54,348*	
WORKPACKAGE #7 Construction Costs- Present Day Cost					***$ 417,000***	

Subheading	Description	No. units	Unit	Unit cost	Cost (Excl GST)	Comments
WORKPACKAGE #8						
SCOPE	*Conduct a detailed study on UF membrane performance					
	*Conduct lake pump testing to confirm max flows & assess impact to WQ					
1	***Front End***				***$ -***	
	Insurance/Bonding	0.0%	%	$ 70,000	$ -	Assuming desktop study with site visits.
	Mobilization and Demobilization	0.0%	%	$ 70,000	$ -	Assuming desktop study with site visits.
	General Requirements	0.0%	%	$ 70,000	$ -	Assuming desktop study with site visits.
	Start-up and Commissioning	0.0%	%	$ 70,000	$ -	Assuming desktop study with site visits.
2	***Civil Site Works***				***$ -***	
	N/A					
3	***Process Mechanical***				***$ 70,000***	
	Membrane performance desktop study	1	LS.	$ 35,000	$ 35,000	Detailed proposal required to provide firm costs.
	Lake pump testing desktop study w/ operational input from VoHHS	1	LS.	$ 35,000	$ 35,000	Detailed proposal required to provide firm costs.
4	***Structural***				***$ -***	
	N/A					
5	***Electrical and Controls Upgrades***				***$ -***	
	N/A					
6	***Equipment Deliveries***				***$ -***	
	Sum of all non-civil cost items / equipment cost items x 15%	15%	unit	$ -	$ -	
SUMMARY						
SubTotal (1) "Front End"					*$ -*	
SubTotal (2 - 6)					*$ 70,000*	
SubTotal					***$ 70,000***	
Contingency		*40%*			*$ 28,000*	
WORKPACKAGE #8 Capital Costs					***$ 98,000***	
Engineering 15%		*0%*			*$ -*	*Not applicable - engineering works scoped.*
WORKPACKAGE #8 Construction Costs- Present Day Cost					***$ 98,000***	

Subheading	Description	No. units	Unit	Unit cost	Cost (Excl GST)	Comments
WORKPACKAGE #9						
SCOPE	*Add improved secondary containment for hypochlorite drums and dosing system.					This option assumes a concrete curb is installed. Alternatively, a plastic basin could be procured.
1	***Front End***				***$ 500***	
	Insurance/Bonding	1.5%	%	$ 5,000	$ 100	
	Mobilization and Demobilization	3.0%	%	$ 5,000	$ 200	
	General Requirements	5.0%	%	$ 5,000	$ 300	
	Start-up and Commissioning	0.0%	%	$ 5,000	$ -	No commissioning required.
2	***Civil Site Works***				***$ 5,000***	
	Secondary containment - concrete curb	1	LS.	$ 5,000	$ 5,000	
3	***Process Mechanical***				***$ -***	
	N/A					
4	***Structural***				***$ -***	
	N/A					
5	***Electrical and Controls Upgrades***				***$ -***	
	N/A					
6	***Equipment Deliveries***				***$ -***	
	Sum of all non-civil cost items / equipment cost items x 15%	15%	unit	$ -	$ -	
SUMMARY						
SubTotal (1) "Front End"					*$ 500*	
SubTotal (2 - 6)					*$ 5,000*	
SubTotal					***$ 5,500***	
Contingency		*40%*			*$ 2,200*	
WORKPACKAGE #9 Capital Costs					***$ 7,700***	
Engineering 15%		*15%*			*$ 1,155*	
WORKPACKAGE #9 Construction Costs- Present Day Cost					***$ 9,000***	

Subheading	Description	No. units	Unit	Unit cost	Cost (Excl GST)	Comments
WORKPACKAGE 10						
SCOPE	*Conduct a lake intake extension and protection study					
1	***Front End***				*$ -*	
	Insurance/Bonding	0.0%	%	$ 20,000	$ -	Assuming desktop study only.
	Mobilization and Demobilization	0.0%	%	$ 20,000	$ -	Assuming desktop study only.
	General Requirements	0.0%	%	$ 20,000	$ -	Assuming desktop study only.
	Start-up and Commissioning	0.0%	%	$ 20,000	$ -	Assuming desktop study only.
2	***Civil Site Works***				*$ -*	
	N/A					
3	***Process Mechanical***				***$ 20,000***	
	Lake intake study	1	LS.	$ 20,000	$ 20,000	Budget pricing provided by GreatPacific Consulting Ltd. The primary focus would be on assessing the location, depth and distance from shore, and consider compliance factors (eg. Fish screening, water quality), system reliability, and hazards/risks.
4	***Structural***				*$ -*	
	N/A					
5	***Electrical and Controls Upgrades***				*$ -*	
	N/A					
6	***Equipment Deliveries***				*$ -*	
	Sum of all non-civil cost items / equipment cost items x 15%	15%	unit	$ -	$ -	
SUMMARY						
SubTotal (1) "Front End"					*$ -*	
SubTotal (2 - 6)					*$ 20,000*	
SubTotal					***$ 20,000***	
Contingency		*40%*			*$ 8,000*	
WORKPACKAGE 10 Capital Costs					***$ 28,000***	
Engineering 15%		*0%*			*$ -*	*Not applicable - engineering work scoped.*
WORKPACKAGE 10 Construction Costs- Present Day Cost					***$ 28,000***	

Subheading	Description	No. units	Unit	Unit cost	Cost (Excl GST)	Comments
WORKPACKAGE #11						
SCOPE	*New permanent generator (incl. capacity for future upgrades)					
1	***Front End***				***$ 15,000***	
	Insurance/Bonding	1.5%	%	$ 133,000	$ 2,000	
	Mobilization and Demobilization	3.0%	%	$ 133,000	$ 4,000	
	General Requirements	5.0%	%	$ 133,000	$ 7,000	
	Start-up and Commissioning	3.0%	%	$ 133,000	$ 4,000	
2	***Civil Site Works***				***$ 46,000***	
	Generator foundation (concrete pad)	1	LS.	$ 10,000	$ 10,000	
	Trenching for electrical conduits	50	LM	$ 715	$ 36,000	
3	***Process Mechanical***				***$ -***	
	N/A					
4	***Structural***				***$ -***	
	N/A					
5	***Electrical and Controls Upgrades***				***$ 87,000***	
	Generator and electrical integration	1	LS.	$ 75,000	$ 75,000	
	Generator Installation & Wiring	15%	%	$ 75,000	$ 12,000	
6	***Equipment Deliveries***				***$ -***	
	Sum of all non-civil cost items / equipment cost items x 15%	15%	unit	$ -	$ -	
SUMMARY						
SubTotal (1) "Front End"					*$ 15,000*	
SubTotal (2 - 6)					*$ 133,000*	
SubTotal					***$ 148,000***	
Contingency		*40%*			*$ 59,200*	
WORKPACKAGE #11 Capital Costs					***$ 207,200***	
Engineering 15%		*15%*			*$ 31,080*	
WORKPACKAGE #11 Construction Costs- Present Day Cost					***$ 239,000***	

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