

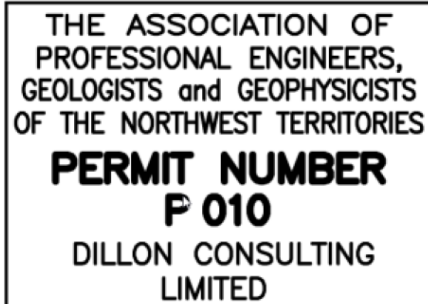


GOVERNMENT OF NUNAVUT

Water Treatment Plant Planning Study

Whale Cove, Nunavut

Final Report (Revision 1)



May 22, 2020



GOVERNMENT OF NUNAVUT
Department of Community and Government Services
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Attention: Aurangzeb Alamgir
Senior Municipal Planning Officer

***Water Treatment Plant Planning Study – Whale Cove, NU (Contract 2018-64)
Final Report (Rev.1)***

Dillon Consulting Limited is pleased to submit our revised final report summarizing the results of the planning study for the above noted project to date. This report provides a recommendation regarding the treatment process for a new water treatment facility for the community of Whale Cove, using Fish Lake as the source water. This version supercedes that previously issued, and includes a more indepth analysis into the use of membrane technology in the North, its practicality and potential risks for the Hamlet of Whale Cove.

This study also includes an evaluation of the Fish Lake water balance to evaluate the long-term sustainability of this water source and identify potential future risks for the community. The results of a bathymetric survey of Fish Lake related to the water balance and a geotechnical program (completed in summer 2019) were provided in a separate technical memo.

We appreciate the opportunity to work with you on this project, and look forward to continuing our relationship in the future. Should you have any questions, please contact the undersigned at your convenience.

Sincerely,

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Executive Summary

The Hamlet of Whale Cove (the Hamlet) has experienced potable water quality issues and boil water advisories that are problematic to the community residents. The Government of Nunavut (GN) is seeking to upgrade the potable water system, which includes a water treatment plant, and trucked delivery of water to the community. Dillon Consulting Limited (Dillon) was retained by the GN to study water treatment plant upgrades that will provide a more reliable and high quality water supply for the community and meets the criteria of the Guidelines for Canadian Drinking Water Quality (GCDWQ). Dillon was also asked to evaluate the long term sustainability of the existing Whale Cove raw water source.

The Hamlet currently uses Fish Lake as its source for drinking water. The lake is an 11 hectare fresh water body located approximately 3 km north of the community. Primary contributions to Fish Lake come from surface water runoff and ice/snow melt, with no major inlet rivers or streams. Raw water is pumped from the lake intake via a 110 m long, 100 mm $\varnothing$ HDPE pipe to an onshore chlorination system.

The community has been experiencing regular boil water advisories since 2015 due to repeated incidents of total coliforms in the potable water. Prior to summer 2018, the only treatment for the lake water was chlorine disinfection, with disinfection residence time provided in the trucks while en route to the Hamlet. In October 2017, a temporary mobile water treatment system manufactured by FilterBoxx was delivered to the community to provide enhanced treatment in order to resolve the boil water events. The FilterBoxx system was commissioned in August 2018 and includes media filtration, activated carbon contactors and cartridge filters. Ultraviolet (UV) light is included for primary disinfection, and chlorination for secondary disinfection. The system was designed to distribute water at 1,000 L/min and produce treated water at 110 L/min. The system was taken offline and winterized in October 2018 and was partially reinstated in the summer of 2019; the Hamlet subsequently resumes water treatment using the original chlorination system during the winter. Treated water from the FilterBoxx system was reported to meet water quality guidelines during its limited operation in 2018, indicating that the treatment process would be suitable for a future permanent treatment plant.

Evaluation of raw water quality data from 2015 – 2018 provided by the GN was completed, along with analytical results from water samples collected by Dillon during a site visit in February 2019. The results indicate that raw water can generally be characterized as a bicarbonate surface water with low hardness and moderate organic content. Based on the Langelier Index, the water is mildly aggressive, but within acceptable corrosion levels; scaling and precipitation associated with hardness is not expected to be a significant concern, and evidence of problems was not observed during the Dillon site visit. It was not possible to evaluate bacteriological parameters in the February samples, because the samples could not reach the laboratory within the specified hold time.

Treated water (prior to installation of the temporary FilterBoxx system) exceeded the Guidelines for Canadian Drinking Water Quality (GCDWQ) for turbidity, E. Coli., total coliforms and certain disinfection by products (DBPs). There was limited treated water quality data available, but it is understood that water quality changes somewhat seasonally, likely due to organics entering Fish Lake during the runoff season, and during winter ice cover. The available data indicates that a treatment process that includes filtration, dissolved organics removal and disinfection that meets contact holding time guidelines is required for the long term reliability of the community's drinking water supply.

The recommended treatment process for Whale Cove includes membrane ultrafiltration with a provision for dissolved organics removal via coagulant injection. The proposed disinfection process is UV for primary disinfection, followed by chlorination for viruses and secondary disinfection in order to maintain a residual concentration in the trucked water. The proposed treatment process would be fully automated, but still require periodic operator oversight and regular maintenance. Treated water would be delivered to a 180,000 litre capacity storage tank that includes one day maximum day storage (including fire flow); water trucks will fill from the storage tank, independent of the water treatment process production rate. The water treatment plant is sized to meet the peak daily design consumption within a 24 hour period, so that the water volume in the tank will decline during the day and refill prior to the following morning. A second tank is included to hold filter backwash waste, which would be periodically trucked to the Hamlet sewage lagoon. The tanks are proposed to be lined bolted steel construction with insulation located inside the treatment building.

It is normal practice to validate new potable water treatment processes by bench testing and/or pilot testing using the raw source water. The testing is normally conducted over an extended period that captures the worst case raw water quality. In the event that it is not practical to perform a pilot program at Whale Cove, there is a residual risk that the treated water quality will not meet all guidelines. However, Dillon has taken a conservative approach to the design basis for the facility as a risk mitigation approach. Due to the unknown peak concentration of dissolved organics in the raw water, and types of organic substances, there is a risk that the disinfection by-products that are currently found in the treated water may persist without proper organics removal such as coagulation or GAC.

A source water capacity analysis of Fish Lake was also completed as part of this study. Monthly and annual water balance models were developed using the projected 2041 design population of 657 residents to determine the sustainability of Fish Lake as a long-term water source for Whale Cove. The lake is under ice cover in the winter months, with no water inputs. As a result, the lake level drops during the winter, until subsequent recharge in the spring and summer as a result of snow melt and precipitation runoff. An analysis of historic conditions determined that the lake experienced 100-year low inflows during the 1995/1996 season, due to low precipitation (snow and rain). However, the lake still reached maximum level prior to winter ice cover, and was able to supply adequate water to the community during the ice cover season. Projected climate change impacts for the period 2021-2050 suggest that Whale Cove will be subject to a general warming trend, with higher average precipitation

compared to historic conditions. Therefore, there is a reduced risk that the area will experience precipitation lower than the 1995/1996 season over the 2021-2050 study period, and Fish Lake is expected to be capable of meeting the projected community water demand during the winter ice cover period between recharge seasons within the specified boundaries of the study.

1.0 Introduction

1.1 Introduction

Dillon Consulting Limited (Dillon) was contracted by the Government of Nunavut (GN) to complete a planning study for a new Water Treatment Plant (WTP) for the community of Whale Cove, NU. The primary goals of the project were to further develop studies related to the source water (Fish Lake), evaluate long term sustainability of the water source, confirm WTP site selection and establish a preferred treatment process for the new WTP.

The final report was originally issued in June of 2019 and recommended media filtration with GAC contactors, UV and chlorination. This recommendation was based on available source water quality data and the operational results of the temporary media filtration system, which identified the need for filtration based on GCDWQ guidelines, and organics removal to remove DBP precursor compounds. Subsequent to the original process recommendation, CGS expressed concerns regarding the management of a filtration system that requires coagulation to meet GCDWQ requirements for particulate removal. Following discussions with GN regarding recent operation of other media filtration plants and an operational experience transfer from the Northwest Territories Municipal and Community Affairs (MACA), Dillon's recommendation is now based on a membrane filtration approach, which will require a simplified coagulation process relative to media filtration for reduction of dissolved organics to meet DBP thresholds.

1.2 Background

The Hamlet of Whale Cove (Hamlet) is located approximately 70 km south of Rankin Inlet on the western shore of Hudson Bay. In the last census (2016), the community had a population of approximately 435 residents, the majority of which are Inuit. Access to the Hamlet is provided by boat (Hudson Bay) or via the Whale Cove Airport; there are no discernible roads to the community from other regions.

Currently drinking water is supplied from Fish Lake, an 11 hectare fresh water body approximately 3 kilometers from the town. Primary inflow to Fish Lake comes from surface runoff and ice/snow melt, and there are no major inlet rivers or streams. Raw water is currently pumped from the lake to a nearby truck fill station where it is chlorinated to provide disinfection. There is no permanent filtration or other physical treatment of the raw water. Chlorinated water from the fill station discharges to water trucks and after a twenty minute holding period for chlorine disinfection contact time the water is transported to the Hamlet and distributed to water cisterns in the community.

Since 2015, coliform bacteria has been detected in the unchlorinated raw water from Fish Lake during the summer and fall, leading to boil water advisories. Subsequent studies that utilized DNA sequencing

estimated that the source of coliforms was likely the result of surface runoff from vegetated and soil-covered areas rather than human or animal sources. However, this study was conducted over a very limited time period, when total and fecal coliforms were detected in other nearby lakes. There is a high probability that the same animal sources of fecal coliforms identified at nearby lakes would also impact Fish Lake at some time. Total coliforms are used as the indicator for potable water quality, and the total coliform results for Whale Cove exceeded the Guidelines for Canadian Drinking Water Quality, indicating that a filtration process is required. DNA sequencing is not an accepted determinant for drinking water quality, particularly for an unprotected watershed like Fish Lake.

In late summer 2018 a mobile water treatment system was installed as a temporary emergency measure at Whale Cove until a source water study was completed and appropriate treatment process selected. The temporary system, a FilterBoxx standard package, includes filtration, granular activated carbon (GAC) contactors, UV and chlorine disinfection. However, the FilterBoxx trailer is not winterized and is taken offline during the winter period. The FilterBoxx system is currently only scheduled to remain in Whale Cove until 2021.

1.3 Project Description

Dillon reviewed Federal and Territorial regulatory requirements related to water treatment, raw and treated water chemistry, 20-year population and flow data projections up to 2041, and estimated the long term sustainable yield of Fish Lake to 2050. Based on the available raw surface water quality, nature of the source water (surface lake) and taking into considering Canadian best practices, an appropriate water treatment process for Whale Cove was developed to provide a reliable potable water supply. Two new intakes are also proposed to increase system reliability. This information was used to develop a system description and an estimate of capital and operational costs. A decommissioning plan for the existing water treatment infrastructure was also prepared based on the final selected site and the amount of existing infrastructure to be reused. During detailed design, it may also be considered to use the existing intake as a standby for emergency water and fire service, with chlorination only.

A source water capacity assessment was completed to confirm the suitability of Fish Lake as a source of raw water. Three sites were evaluated for the future WTP on the shores of Fish Lake. Dillon attended a site visit to Whale Cove on February 20-21, 2019 to confirm the basis for the site assessment, and presented the results of the site evaluation and recommended location to the Hamlet Council. In March 2019, the GN and local government confirmed that the current site is the preferred option under Motion # 038/19.

A bathymetric survey of Fish Lake to support the source water capacity assessment and new intake, along with a geotechnical investigation at the proposed water treatment plant site is planned for the summer of 2019. A supplemental technical memo will follow these investigations that discusses any impacts to the recommendations of this report.

2.0 Document Review

2.1 Previous Studies

The following studies and reports were reviewed as part of this project:

- *Whale Cove Infrastructure Planning Study, 2002;*
- *Hamlet of Whale Cove Community Plan, FoTenn Consultants Inc., 2011;*
- *Watershed Mapping and Monitoring for Northern Community Impact Assessment – Whale, Cove, Nunavut, Natural Resources Canada, 2013;*
- *Whale Cove Water Supply Analysis and Recommendations, Amec Foster Wheeler, 2016; and*
- *FilterBoxx Technical Drawings and Operations and Maintenance Manual, 2017.*

2.2 Regulatory Requirements

The regulatory requirements involved with the approval process for design, construction and commissioning of a Water Treatment Plant in Nunavut are summarized herein.

2.2.1 Design Standards

There are several design standards published for drinking water systems, some of which are specific to northern Canada while others are more generic and applicable nationwide. The following were reviewed under the scope of this project.

- *Design Guidelines for First Nation Waterworks (2006), INAC;*
- *Protocol for Decentralized Water and Wastewater Systems in First Nation Communities (2010), INAC;*
- *Good Engineering Practices for Northern Water and Sewer Systems (2017), Government of Northwest Territories; and*
- *Protocol for Safe Drinking Water in First Nations Communities, (2006), ISC.*

Final design and construction of the new water treatment system and ancillary systems should adhere to these standards (and others that may govern) where applicable.

2.2.2 Regulatory Requirements

The minimum requirements for treated water quality are the Health Canada Guidelines for Canadian Drinking Water Quality (GCDWQ). This document is the minimum standard for potable water systems across Canada, and is reviewed on a regular basis to adjust Maximum Acceptable Concentrations (MAC) and aesthetic objectives (AO) for different parameters based on current research, science, and new contaminants of concern. Most provinces and territories adopt these guidelines as their regional requirements.

In addition to the GCDWQ, the Nunavut Public Health Act Public Water Supply Regulation states that a minimum free chlorine residual of 0.2 mg/L is required after 20 minutes of contact time, total coliforms are not to exceed 1 per 100 mL and the maximum acceptable turbidity is 5.0 NTU.

The existing license for the Whale Cove water system, license number 3BM-WHA1520, is a 5-year permit issued in 2015 that will expire on June 3, 2020. The existing 'Type B' license states that all fresh water processed by the system for all uses must not exceed 30,000 m³ per year or 299 m³ in any given day.

The Nunavut Water Board requires the Licensee to submit an abandonment and restoration plan at least six (6) months prior to abandoning any facilities or upon submission of final design drawings for the construction of new facilities to replace existing infrastructure. The plan should include the following information:

- Water intake facilities, the water treatment site and facilities, petroleum and chemical storage areas, any site affected by waste spills, an implementation schedule, maps delineating all disturbed areas and site facilities, consideration of altered drainage patterns, future area use, hazardous wastes, a proposal identifying measures by which restoration costs will be financed by the Licensee upon abandonment.

2.3 Population Projections

There were two independent projections for future Whale Cove population growth reviewed from the background information. **Table 2-1** contains data from the *Nunavut Population Projections by Region and Community 2014-2035*, published by the Nunavut Bureau of Statistics in 2014. **Table 2-2** contains data from the *Whale Cove Community Plan*, published by the Government of Nunavut and FoTenn Planning & Urban Design in 2011, which provided population projections from 2011 – 2031.

In each case, the average annual growth rate was calculated and used to extend the population to the 20 year (2041) assumed design life of a new water treatment plant using the following formula:

$$P_{\text{future}} = (P_{\text{current}})e^{rt}$$

Where:

P_{future} = projected population

P_{current} = current population

e = Euler's number, approximately 2.7183

t = number of time intervals (years)

r = annual growth rate

Table 2-1 – Nunavut Population Projections by Region and Community (2014 - 2035)

Parameter	Result
2014 population (actual)	456
2035 population (projected)	606
Average annual growth rate (calculated)	1.35%
2041 population (calculated – extension)	657
2050 population (calculated – extension)	742

Table 2-2 – Whale Cove Community Plan population Projection (2011-2031)

Parameter	Result
2011 population (actual)	408
2031 population (projected)	714
Average annual growth rate (calculated)	2.80%
2041 population (calculated – extension)	945
2050 population (calculated – extension)	1,215

The actual 2011 and 2014 population values, 408 and 456, respectively, result in a calculated population growth rate of 3.70%. However, this rate is considered generally high and unsustainable, particularly for a remote northern community. Based on discussions with the Department of Community and Government Services, the *Nunavut Population Projections by Region and Community* was selected for use in developing estimates for future water consumption. Therefore, the 2041 design population for the new water treatment plant is 657 residents.

2.4 Water Consumption

Water consumption in the Hamlet is tracked on a monthly basis and totalled annually. Data was provided by the CGS for 2016 and 2017, and is summarized in **Table 2-3**. The complete water consumption data is found in **Appendix A**.

Table 2-3 – Historical Water Consumption

Parameter	Value
Total Consumption – 2016	16,996 m ³
Total Consumption – 2017	18,685 m ³
Max Monthly Consumption – 2016	1,592 m ³
Max Monthly Consumption – 2017	1,853 m ³
Average Daily Consumption – 2016*	46.4 m ³
Average Daily Consumption – 2017 *	51.1 m ³
Per Capita Consumption – 2016/2017*	112 L/d/c

* denotes calculated or averaged value

Based on the population trends presented in Section 2.3, the projected 20-year design parameters are summarized in **Table 2-4**.

Table 2-4 – Projected Water Demands

Parameter	Value
2041 Average Day Consumption	74 m ³
2041 Average Daily Truck Count	5 – 6
Max Day Demand Factor (ISC Guideline)	2.5
2041 Max Day Consumption	185 m ³
2041 Max Daily Truck Count	14 – 15
Treatment System Design Flow	150 L/min
2041 Average Annual Consumption	27,010 m ³
2050 Average Annual Consumption	30,333 m ³

The treatment facility will be designed to meet the 185 m³ maximum day water demand for the design year 2041, with an average daily demand of 74 m³. The truck fill operation will be designed for a transfer rate of 1,250 L/min, to allow a truck fill time of less than 15 minutes. To meet fire demands, the GN requires that the system must be able to provide a minimum of 1,000 L/min at any moment in time (even if the treatment system or storage reservoir is down). There are several ways to meet this level of service; each option would need to be able to meet rapid supply of water in the event of a fire:

1. Size the entire treatment plant for a minimum rate of 1,250 L/min;
2. Provide two storage tanks each with 50% of the maximum day demand (including fire);
3. Investigate and maintain the existing intake pipe for deployment of a temporary truck fill rated pump during periods of maintenance when either the water treatment plant and/or treated water tank are off-line for maintenance. The high rate pump would be placed in storage at the water treatment plant. The risk of the water treatment facility being offline for unplanned maintenance is extremely low, which will permit operators to deploy the high rate pump as part of maintenance planning. Since maintenance typically occurs in the summer, it will be relatively easy to deploy the high rate pump from storage. This option will also allow the Hamlet to maintain water service through a bypass of the treatment tank and storage tank directly to truck fill, with chlorination. Although this situation would result in a boil water advisory since primary disinfection would not be achieved, it will allow the Hamlet to maintain uninterrupted water service, including fire protection, at the current level of service realized up until 2019.

Option 3 is the recommended option and would require the current intake be inspected and maintained as a backup, but would not provide immediate support in the event of a failure as the pump would need to be deployed into the intake pipe. This option would also require the existing plant to be maintained as an access point for the intake pump. The existing building could be replaced as strictly a structure to house the intake access, with piping connection to the new plant.

Option 1 is considered the least favorable at this stage, since it would require increasing the actual water treatment system design capacity by a factor of eight to nine times for an event that is considered very infrequent. The Hamlet has indicated that the community typically sees no more than one to two fire events per year, so the risk of a fire happening at the same time as scheduled downtown or primary system failure is considered very low.

Option 2 would have a larger capital and operational cost due to additional shipping and construction of a second tank, and heat required to prevent freezing.

It is recommended these options be reviewed with the GN during the next stage of design for the project to select the preferred alternative.

2.5 Water Storage

Water storage design is based on several factors, including minimum chlorine contact time for disinfection, storage to accommodate periods of peak water demand, and fire water storage.

Currently there is no treated water storage at the facility, and chlorine contact time is provided solely in the delivery trucks. This presents a risk as there is no way to guarantee contact times, and chlorine alone does not provide adequate disinfection for all surface water pathogens under current temperature and contact times. The CT value for giardia inactivation by chlorine at 5 degrees Celsius and pH 7.5 is 179 mg-min/L (GCDWQ, Table 8, Enteric Protozoa), which, assuming a target residual of 1.0 mg/L, would require approximately 30 hours of contact. The CT value for 4-log virus inactivation by chlorine at 5°C, pH of 6-9 is 8.0 mg-min/L; assuming a target residual of 1.0 mg/L, 8 minutes would be required for virus inactivation. ISC requires a minimum of 15 minutes contact time for trucked systems, which is inadequate for enteric protozoa inactivation but meets virus requirements. At colder temperatures approaching freezing the required contact time increases; however, virus inactivation would still be provided in the 15 minute truck hold time.

For the new treatment system the non-working volume of the tank, which includes fire and dead storage, must not be less than the equivalent retention time necessary to meet 12.0 mg-min/L under “poor” baffle conditions ($T_{10}/T = 0.1$) and near-freezing water (0.5 degrees C).). Based on a 0.1 baffling factor and a free chlorine residual of 1.0 mg/L, 120 minutes of storage volume is required for virus inactivation (approximately 15 m³ at the 2041 peak day rate). UV disinfection will be used for primary disinfection (giardia and cryptosporidium).

25,500 L of temporary tankage was provided with the temporary FilterBoxx system to provide onsite contact time for disinfection; however the tanks are not winterized. The tanks were placed in storage for the winter of 2019 to prevent damage and will be reinstated during the summer of 2019.

The new WTP will include a permanent year-round treated water storage volume for the year 2041 that will provide one day of peak storage capacity, emergency firefighting volume, and provide contact time required for virus disinfection.

The fire flow requirements for a trucked system from *Good Engineering Practice for Northern Water and Sewer Systems* recommend a minimum truckfill rate of 1,000 L/min. Where this flow is not provided, a minimum storage capacity of 60,000 L (1,000 L/min for 60 minutes) is recommended; this requirement was confirmed with GN staff during the project as the standard for remote communities on trucked systems. This exceeds the volume required for 4 log inactivation of virus by chlorination under winter conditions. The total recommended storage is the projected max day demand (less instantaneous treatment capacity over the day) plus fire storage.

As part of the knowledge sharing discussions with MACA, it was revealed that NWT water treatment plants do not provide fire water storage in their treated water tankage; instead, the plants are bypassed, and the raw water pumps are sized to fill the water trucks during fire fighting events. Chlorine is added to the bypassed flow, but since the WTP is bypassed, the water trucks must be disinfected prior to their return to use for routine potable water delivery. This option will reduce the size of storage tanks, and also the associated heating costs. Optimization of water tank sizing for Whale Cove should be discussed prior to project tender.

3.0 Water Chemistry Review and Process Evaluation

3.1 Historical Water Quality

The summarized raw and treated water analytical data are provided in **Appendix B**, and includes a comparison with the Guidelines for Canadian Drinking Water Quality (GCDWQ). The water quality samples were taken between 2015 and 2018, and the e-coli and total coliforms samples are from 2016 and 2018. All of the general chemistry samples taken during this period were in the summer months, which present a risk since water chemistry is expected to change seasonally and can impact treatment. It is recommended that a sampling program be started immediately to support the WTP design basis, with a minimum frequency of monthly sampling for full water chemistry analysis.

In general, based on available data, the raw water from Fish Lake can be characterized as a bicarbonate surface water with low hardness and moderate organic carbon. Based on Langelier Index values, the water is mildly aggressive, but within acceptable corrosion levels. The negative Langelier indices suggest that scaling and precipitation associated with hardness are not a concern.

Two additional sets of samples were collected by Dillon during the site visit in February 2019 and April 2019 to compare winter water quality against the historical data, which were taken predominantly during the warmer months. Bacteriological scans were not possible due to exceeding maximum sample hold times based on flight schedules; however, general raw water analyses suggested that the seasonally water quality may not vary significantly as originally thought. The February water analyses indicates that the turbidity and organics treatment will be required year-round. The April water analyses showed increased levels of ammonia, alkalinity and bicarbonate; however they are within GCDWQ aesthetic guidelines and are not considered to be a health risk. Organic carbon levels remained high compared to earlier sampling, indicating that year-round treatment is required to manage the risk of disinfection by products.

Several of the treated water historic samples exceeded GCDWQ guidelines for the following parameters: **turbidity, E.coli, total coliforms, bromodichloromethane, total trihalomethanes, and total haloacetic acids**. Elevated levels of turbidity, E.coli, and total coliforms in treated drinking water are indications of ineffective filtration, which normally remove the particulates typically associated with these parameters. However, in the case of Whale Cove where there is no filtration, E.Coli in the raw water will pass directly to the water trucks. Therefore, a filtration process as a barrier to particulates is required.

E. Coli is a form of bacteria that is normally present in the digestive tract and faeces of animals and humans, and is used as an indicator of the microbiological safety of drinking water; when present, it is a sign that other enteric pathogens that can make people sick may also be present. E.coli can contaminate

a water supply through many pathways, including surface runoff water that contacts animal and human faeces, septic system runoff, and animals that have direct contact with the water.

Bromodichloromethane, total trihalomethanes (THM), and total haloacetic acids (HAA) are all byproducts related to the disinfection of drinking water by chlorination. Certain dissolved organic compounds that are naturally occurring in surface waters react with chlorine to form disinfection by-products (DBPs) that increase the risk of adverse health effects at levels above the GCDWQ limits. Bromodichloromethane is one of the DBP compounds that are included under the THM classification. Control methods for THMs and HAAs are based on reduction of the organic compounds that are precursors to the DBPs prior to chlorination. For a community population like Whale Cove, this could be accomplished through contacting the water through activated carbon prior to chlorination, and/or enhancing the filtration process with the use of a coagulant chemical.

Media filtration technologies applicable to potable water require additional measures, including the injection of a coagulant upstream of the filters or granular activated carbon contactors, in order to meet the GCDWQ requirements for the treatment of surface water. This will require a chemical storage and injection system. Management of this system is more complex compared to other chemical systems like chlorine, since the operator must monitor coagulation performance using bench scale jar tests. The jar testing results must be performed to determine necessary dose adjustments to maintain treatment performance. Operators normally require more advanced training for coagulation chemistry. Estimated annual cost details are provided in the cost estimate section.

3.2 Northern Experience Feedback

Feedback from municipal staff in Nunavut and Northwest Territories provided a valuable understanding of challenges, and design approaches for WTPs in remote northern communities. As well as working with the GN, the department of Municipal and Community Affairs (MACA) was consulted to understand the challenges and successes they have had with the implementation of WTP in some of their NWT communities. Currently in the NWT, seven membrane filtration systems are in use, with two more scheduled for commissioning by the end of 2020. The membrane WTPs are only used in the NWT where offline source water reservoirs are used, and are not used where a community obtains their raw water directly from a river source.

MACA's current standard is to design all water treatment plants with upstream coagulation and flocculation. This typically includes a coagulant injection port, a flocculation tank, and coagulant injection pumps. While MACA's current preference is to utilize coagulant for dissolved organics removal, GAC contractors downstream of membrane filters are also being piloted at two locations.

Water storage tanks are not sized for fire water storage, and 20,000 L storage tanks are used to manage demand. Fire protection is provided by sizing the WTP intake pump to ramp up to 1,000 L/min with a bypass of the WTP. This allows the fire trucks to be filled with untreated (non-potable) water, following

which the trucks must be cleaned and disinfected before returning to delivery of potable water. All new NWT membrane plants utilize a single raw water intake due to historic issues maintaining and operating a backup intake line.

MACA reinforced the need for training, such as on and offsite operator training, a circuit rider program, and operational support after WTPs are constructed. Membrane cleaning was discussed as an area where support is typically needed, and it was discussed that vendors can be engaged after startup to provide multi-year support service. This along with an online SCADA system for turbidity and plant status gives support to local operators on cleaning and when maintenance is required.

3.3 Treatment Requirements

Fish Lake falls under the category of surface water, and requires, at a minimum, reduction of pathogens and organic content. The disinfection requirements for a source water of this type is presented in **Table 3-1:**

Table 3-1 – Disinfection Requirements

Pathogen	Removal/Inactivation Requirement
Cryptosporidium	3 log (99.9%) ¹
Giardia	3 log (99.9%) ¹
Viruses	4 log (99.99%)

Source: *Guidelines for Canadian Drinking Water Quality: Guideline Technical Document - Enteric Protozoa: Giardia and Cryptosporidium.*

1: Based on typical source water contamination containing 34 cysts/100 L. Detailed risk assessments are required if protozoa contamination exceeds typical levels.

Log reduction can be achieved through a combination of water treatment processes, including physical removal (e.g., filtration), and inactivation (e.g., disinfection); each process of the treatment system is considered to be a 'barrier' and is assigned a log reduction credit. Log removal credits are cumulative based on the included processes in a water treatment system. A multi-barrier approach to log-reduction is always recommended to reduce the risk of treated water contamination and failure of individual treatment processes. All other water quality parameters must meet the GCDWQ for MACs, and it is recommended that new systems are designed to also meet the AOs.

The necessary reduction of pathogens can be accomplished through the use of properly-sized filters, UV reactors and chlorine disinfection.

3.4 Process Evaluation

The proposed water treatment plant will be a significant capital investment and needs to consider current and future risks, variability and potential future changes in raw (source) water quality and quantity, treated water regulatory requirements, community needs (reliability/taste/appearance/health risk) and potential climate change impacts over the 20+ year design life of a new treatment plant. A

multi-barrier approach should be implemented for the new treatment plant to reduce the risk of water-borne contaminants from impacting the community. The four main components of the multi-barrier approach are:

- Source water protection (watershed security);
- Effective treatment of raw water for both aesthetic parameters and health protection;
- Operation and maintenance of the distribution or delivery system; and
- Comprehensive monitoring of water quality.

ISC, Health Canada, the United States Environmental Protection Agency, and best practices throughout southern-Canadian provinces recommend or require the use of engineered filtration for treatment systems relying on surface water as their source. Filtration is an effective technology for the removal of suspended particles contained in raw water, including bacteria and protozoa, which have previously been identified in the raw water of Fish Lake. Algae is also a potential concern for health risks and general taste and odour impacts in the treated water. Blue-green algae blooms can affect water systems by releasing toxins (microcystins) into the raw water, which can be passed to the treated water. Filtration has been shown to provide partial removal of microcystins, but removal of algae upstream of chlorination, which ruptures the algae cells and releases the microcystins, is generally a best practice. It is unknown if Fish Lake has experienced algae blooms in the past; however, climate change impacts may increase the risk of future algal growth in Fish Lake, which should be considered in the source water protection plan. Filtration also reduces taste/odour (aesthetic) issues and can also reduce the formation of disinfection by products by removing organic compounds prior to chlorination.

Coagulation is practiced at all media filtration plants treating surface water based on GCDWQ requirements, with a secondary benefit of removing a portion of dissolved organics, depending on coagulant dose and flocculation time. However, membrane filtration does not require coagulation as long as the membranes have been validated for log removal of *Giardia* and *Cryptosporidium* based on USEPA guidelines. Where dissolved organics removal is required, the membranes must be supplemented with an organics removal process. Normally this would include a coagulation step upstream of the membranes, similar to conventional and direct filtration. Coagulant is injected into the raw water to precipitate dissolved organics, allowing them to be removed by the downstream filter. A sedimentation process may be required to upstream of the membrane filters depending on turbidity and organics loading. This typically requires testing at startup to confirm an optimal dose; the dose may need to be adjusted periodically based on seasonal source water loading, or if lake chemistry changes (e.g.: pH), but generally the constant dose may be adequate without operator intervention.

Activated carbon is another alternative that can be used for removal of dissolved organics, for membrane filtration plants where coagulation is not practiced. Carbon contactors are vessels that contain granular activated carbon (GAC), which is effective in the removal of dissolved organic compounds from the raw water, which can control the formation potential of DBPs from downstream chlorination. The GAC must be periodically replaced when it becomes exhausted and dissolved organics

and/or DBP levels increase. Vessels are normally connected in series, so that organics removal of the upstream vessel is monitored for exhaustion, after which the media is changed, and the vessel order is reversed. The frequency of GAC replacement is determined through piloting, but for a community of this size and the expected levels of DOC, media changes once or twice a year is expected. This can be confirmed by monitoring the GAC over the summer with the temporary FilterBoxx system. It is recommended that GAC treatment occur year-round, based on the available raw water quality data.

Treated water leaving the new system must meet the GCDWQ, published by the Federal-Provincial-Territorial Committee on Drinking Water. In addition, sufficient disinfection log removal credits must be achieved through the treatment system based on the type of source water. Each treatment step, including disinfection, is considered a barrier to pathogenic organisms, and is assigned a disinfection log removal credit. A multi-barrier approach means that treatment must include log removal credits from two or more types of treatment.

Two filtration processes common for surface water treatment in North America were reviewed for Fish Lake:

- Membrane Filtration (Microfiltration/Ultrafiltration); and
- Media Filtration.

Final treatment design must consider the area's remoteness, and wherever possible equipment should be mounted on a portable skid or marine container for ease of transport to site.

Table 3-2 was used to compare these two filtration technologies for the new water treatment system in Whale Cove, relative to the existing system:

Table 3-2 – Comparison of Membrane Filtration and Media Filtration

Parameter	Membrane Filtration (MF/UF)	Media Filtration	Rationale
Capital Costs	Medium-High	Medium	Process equipment for membrane filtration is more expensive to purchase compared to conventional media filtration. Membrane filters have additional/more complex ancillary equipment including chemical cleaning systems, which also increases the relative equipment cost generally by 150 to 200% compared to a same capacity media filtration system.
Operational Costs	Medium	Low-Medium	Membrane filters require chemical cleaners to maintain and restore treatment performance, however, the total cost of this was not seen as an significant obstacle by the NWT
Operational Complexity	Medium-High	Medium	While both plants would be fully automated, membrane systems have additional equipment and are less resilient to operator error. Both

Parameter	Membrane Filtration (MF/UF)	Media Filtration	Rationale
			technologies require additional measures to reduce dissolved organics, such as GAC or coagulation. Coagulation for media filtration requires more operator attention, and requires more advanced training relative to membrane filtration. Log reduction credits for membranes are not reliant on precise coagulant dose control. UF membranes must be properly maintained or will fail prematurely and require replacement. With the implementation of a circuit rider program and established adjustment to dosing, the complexity to the local operator can be reduced.
Maintenance Requirements	Medium	Low-Medium	Membrane plants require chemical cleaners and integrity monitoring, this can be done through a circuit rider program a few times per year and otherwise automated operation. Media filtration typically only requires routine backwashes and annual media inspections.
Required Footprint	Medium	Medium	For a plant of this size, both options are expected to have a comparable footprint. Space is required for UF clean-in-place equipment, which is mobile.
Backwash/waste	Medium	Medium	UF membrane systems and media filtration typically generate similar backwash volumes (<5% of production volume). UF will have spent cleaning solution for disposal several times per year, which can be neutralized or buffered by the backwash waste tank.
Local serviceability	Medium	Medium	While both systems will require an operator responsible for the plant, many components of a media filtration system can be maintained by someone with basic mechanical skills, and the GN has local resources skilled in media filter operation available for support. However additional support will be required for the operation of a coagulant system. Membrane systems typically require a higher level of training specific to the membrane package, however, this can be mitigated through a training and circuit rider program
Treated Water Quality	High	Medium	As they have smaller pore sizes, membrane filters can remove smaller particles generally resulting in a higher degree of treated water quality compared to media filtration. Media filters have a higher risk of water quality upset related to proper coagulation control. However, both systems, when designed and operated properly, will satisfy filtration requirements to meet Health Guidelines.

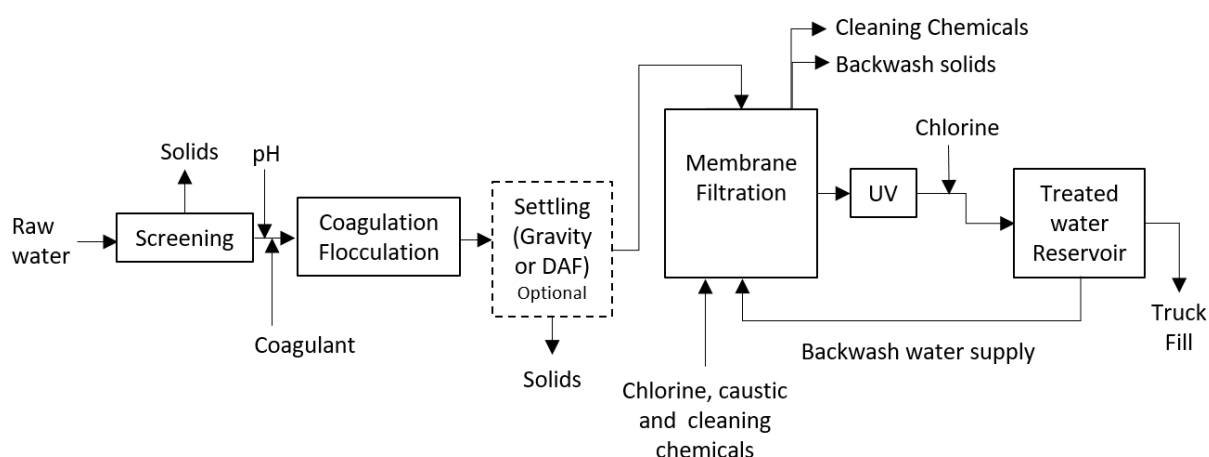
Parameter	Membrane Filtration (MF/UF)	Media Filtration	Rationale
Robustness/Resiliency	High	Medium	Both systems are considered to be comparable in terms of resilience towards raw water quality shifts. Membranes can take a higher load of turbidity relative to media filters without impacting production. Where upstream sedimentation is provided, both membranes and media filtration have similar robustness. Membranes are not as resilient/recoverable if not properly operated and maintained, and would require pre-mature replacement of membrane vessels if damaged. Membranes must be replaced eventually, so goal is to extend membrane life expectancy for as long as possible.
Familiarity within the North	Medium	Medium	The use of membrane plants is limited in Nunavut, specifically as it relates to remote municipal systems. However, the NWT has been implementing mostly membrane filtration plants with success (limited to communities that use offline seasonal fill storage reservoirs), using strong operational support. In contrast, media filters are common throughout the north, however are mainly seen in older plants. Nunavut has expressed a concern that the coagulant control required for media plants has been an historic issue.
Familiarity within Canada	High	High	Both technologies are widely used across Canada.

A standard approach to reduce DBP formation is reducing DOC in the treated water, which are the precursor compounds for DBPs. Conventional filtration and ultrafiltration membrane technologies cannot remove DOC without the use of upstream coagulation or downstream GAC. Therefore, the installation of a coagulation injection point or an activated carbon process is recommended to supplement either filtration process. GAC treatment consists of vessels containing a fixed bed of activated carbon media, which is charcoal that has been treated with oxygen to significantly increase its porosity and surface area. This creates a high number of active surface sites that adsorb impurities as the water passes through the media bed. Once the majority of these capture sites have been consumed, the carbon media requires disposal and replacement with new media.

Organic carbon exceedances are sometimes a seasonal issue with surface water sources, such as spring runoff or during an algae event. However, due to the limited water quality data available from the winter months for Fish Lake, this cannot be verified. However, for membrane filtration it may be possible to operate at a fixed dose year-round, since the goal is simply to reduce dissolved organics below a threshold where DBPs are not an issue. In contrast, coagulation for media filtration must be continuously monitored, since both turbidity and dissolved organics removal performance is dictated by

effective coagulation, which can be affected by multiple source water physical and chemical factors. Therefore, it is expected that coagulant dose monitoring can be significantly reduced or eliminated for membranes. Initial year operation of a membrane plant, in the absence of pilot testing prior to operation, will require more intensive monitoring of treated water DBPs to determine an effective coagulant dose, and if seasonal adjustments to coagulant dose are necessary.

Dillon is recommending a ultrafiltration membrane process for the new Whale Cove WTP, which includes screening, coagulation and a flocculation tank for dissolved organics removal, combined with UV and chlorine disinfection. Based on experience in the NWT where membranes have been successfully used in communities similar to Whale Cove where source water is obtained from a lake or reservoir, Whale Cove is a good candidate for evaluation of membrane treatment in Nunavut. However, Dillon bases this recommendation on the inclusion of a sedimentation vessel upstream of the membranes as a measure to reduce organic loading, and fouling risk, to the membranes. Although it may be possible to operate the membranes in a direct mode (no sedimentation), in the absence of pilot testing and comprehensive source water quality data, this is recommended for risk mitigation. A bypass should be provided on the sedimentation vessel, which could be bypassed if initial operation 1-2 years after startup indicates that the risk to membranes is low. A better operator understanding of water chemistry and water treatment processes will be required relative to the current system, regardless of the filtration technology selected. A circuit rider and training program is also recommended to assist local operators with ongoing operator support, plant monitoring, membrane chemical cleaning, and monitoring of coagulation (particularly in the initial year of operation). A typical membrane filtration flow schematic is shown below:



3.5 Fluoridation

The addition of fluoride is a standard practice in larger communities throughout Canada as a public health initiative. It results in a tangible improvement in the dental health of residents, but does present significant challenges that need to be considered. It is normally injected as liquid fluorosilicic acid, which is a difficult chemical for handling and storage, and health and safety. It is an acid that has extremely aggressive properties that will attack most metals, and requires specialized operator skills, storage, containment, and dosing systems to avoid leaks. Leaks or spills can cause significant damage to plant infrastructure and risk of injury for personnel.

Small scale systems can use solid sodium fluoride salt, which requires a dissolution/saturation tank and dosing system very similar to a calcium hypochlorite disinfectant system. The saturated sodium fluoride solution strength is approximately 10% of the strength of fluorosilicic acid, but is a less severe solution for handling. Sodium fluoride is shipped as a solid, which is beneficial relative to the shipping and handling of solutions to remote communities. Sodium fluoride is not as aggressive compared to fluorosilicic acid; however, there are significant health and safety issues related to occupational exposure by inhalation of dusts, ingestion, and contact with skin. Safety shower and eye wash stations must be included wherever sodium fluoride is used. Separation must be made between other chemicals with acidic or oxidizing properties to avoid the generation of hydrogen fluoride gas. For this reason, a separate room within the WTP to house the fluoride storage and feed equipment would be required.

For these reasons, including the need to ship an annual supply of chemical to the site, and given the size and remoteness of the community, fluoridation is an option but not considered necessary at this time for Whale Cove. It could be added to the treatment plant in the future by the addition of a small room or structure for the required chemical storage and dosing equipment.

3.6 Disinfection Credits

Disinfection credits are applied to each qualifying process within the treatment system, and cumulatively must meet or exceed the log removal requirements for surface water. A summary of the log removal credits and comparison against regulatory requirements is presented in **Table 3-3**.

Table 3-3 – Disinfection Log Removal Credits

Process	Cryptosporidium Credit	Giardia Credit	Virus Credit	Comment/Assumptions
Membrane Filtration	Removal efficiency demonstrated through challenge testing and verified by direct integrity testing.	Removal efficiency demonstrated through challenge testing and verified by direct integrity	Removal efficiency demonstrated through challenge testing. UF is the only membrane	Dillon has assumed a conservative 3.0 log reduction credit for Giardia and Cryptosporidium; higher log reduction may be possible depending on challenge and integrity testing. No membrane virus reduction

Process	Cryptosporidium Credit	Giardia Credit	Virus Credit	Comment/Assumptions
	Minimum of 3.0 assumed.	testing. Minimum of 3.0 assumed.	that will reject virus. 0.0 log removal assumed.	credit is considered, because if MF is provided, no virus removal is possible.
Chlorination	0	0	4.0	Assumes a CT value of at least 12 mg-min/L, pH of 6-9 and 0.5 deg. C.
UV Disinfection	3.0	3.0	0.0	40 mJ/cm ² @ 0.5 deg. C
TOTAL	6.0	6.0	4.0	Acceptable
REQUIRED	3.0	3.0	4.0	Source: GCDWQ

Disinfection is required to provide at least 0.5 log inactivation of Giardia. Note that the log removal credits for chlorination in **Table 3-3** are based on CT for primary disinfection of virus only, since UV disinfection is used for primary disinfection of cryptosporidium and Giardia. The chlorine dose is also controlled to meet secondary disinfection requirements. Specific log removal credits for membrane filtration is based on challenge testing, and manufacturers can verify specified performance requirements by providing challenge test reports for their membranes. Microfiltration membranes, due to their larger pore sizes, will not remove virus. For this reason, it is recommended that the Whale Cove WTP use ultrafiltration membranes, as an added barrier to virus. All membrane systems should be provided with direct and indirect integrity test methods that satisfy USEPA requirements.

4.0 Site Selection

4.1 Site Background

The existing WTP is located in a low lying area at the west end of Fish Lake at the end of a community access road. The water intake runs directly from the existing WTP 20-30 metres into the lake. It is understood from the community and GN that there are no concerns with the current WTP location. Based on the requirements of this study, three (3) potential WTP sites were evaluated through desktop analysis to determine if there are advantages to a new location. The three sites evaluated are shown on **Figure 4-1**, and are as follows:

- Site 1: Existing WTP location on Fish Lake;
- Site 2: Fish Lake south of Existing WTP; and
- Site 3: Fish Lake north of Existing WTP.

Figure 4-1 – Three Potential Sites for WTP



4.2 Alternatives Investigated

Each potential site for the new WTP was evaluated under the following criteria:

- Proximity to the community;
- Adjacent shoreline condition and characteristics;
- Reuse of current intake;
- Road access;
- Proximity to existing power supply;
- Surrounding terrain and site conditions;
- Community planning;
- Visual soil conditions;
- Anecdotal evidence; and
- Community and council feedback.

A comparison of the 3 sites is detailed in **Table 4-1**. The potential sites were evaluated through desktop analysis to compare advantages and disadvantages of each location.

Table 4-1 – Site Selection Matrix

Site	Advantages	Disadvantages
1 – Current Location	• Deep water, no issues with clogging of intake. • Gently sloping meadows to shoreline, with absence of bedrock cliffs • Not on traditional lands • Existing intake can be reused • Existing power supply	• Maintaining continuous operation of existing WTP during construction period
2 – South of Existing WTP	• No visible bedrock cliffs, rolling meadows to shoreline • Located near access road	• Unknown if muskeg present • Shallow lake depth in this area • Two new intakes required • Requires access road extension and power lines
3 – North of Existing WTPS	• Deep water close to shoreline for new intake	• Unknown if muskeg present • Requires new access road and power extension • Two new intakes required

In March 2019, the GN and local government selected site #1 (the current WTP site) as the preferred option, based on the evaluation results and a meeting with the community. The proposed position of the new WTP infrastructure in relation to the existing WTP on site #1 is shown on the schematic drawings in **Appendix D**.

4.3 Lake Intake

To install a new water treatment plant, the building will need to align directly with the intake pipe to permit installation and removal of pumps in the winter. All site options will require new intakes, and at the request of the GN a secondary redundant intake is required. The existing intake could be maintained as an emergency backup with a shelf spare pump. To prevent interruption to water service, the existing intake system will remain in operation during construction. It is understood from the community and GN that the current intake is in a preferred location, and extension of the new intake to a deeper position will be considered during the design phase.

4.4 Decommissioning Plan and Hazmat Assessment

There was no obvious hazardous material identified during the site visit to Whale Cove, however, snow drifts on the perimeter of the WTP building prevented a complete assessment. A subsequent site trip by Dillon was cancelled, and Dillon recommends collecting hazardous material samples including lead paint, asbestos and toxic leaching materials before detailed design. These materials should be analyzed at an accredited laboratory, and the results discussed in connection to the decommissioning philosophy and revised capital cost estimate during design.

The community and GN indicated a preference for the existing building to be decommissioned and removed from the site. The building will be stripped of parts/items and either sent to the landfill or repurposed for community use. Where feasible, existing equipment in good condition should be salvaged and stored for use as emergency backups or spares.

5.0 Source Water Capacity Analysis

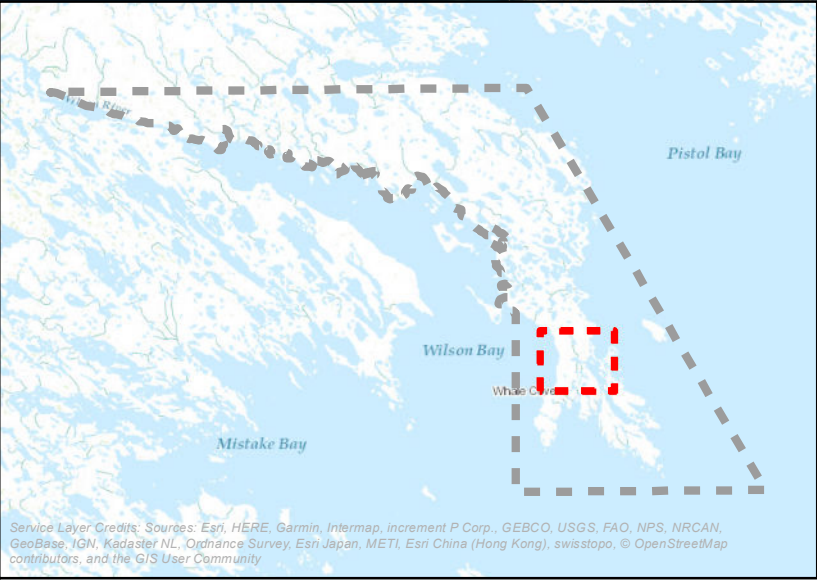
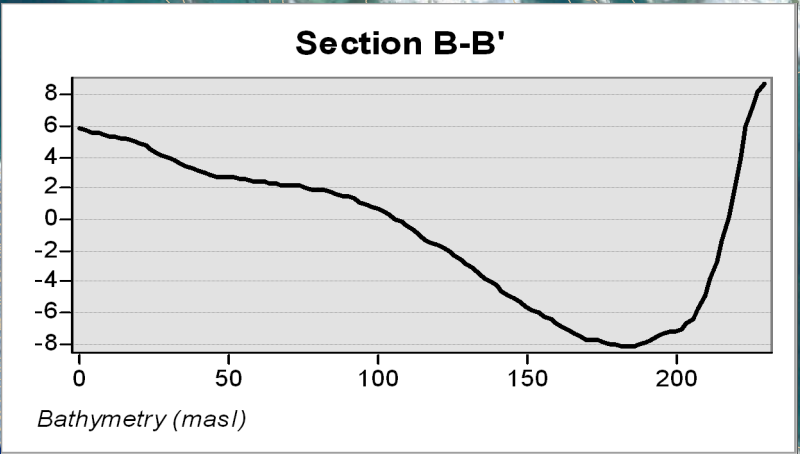
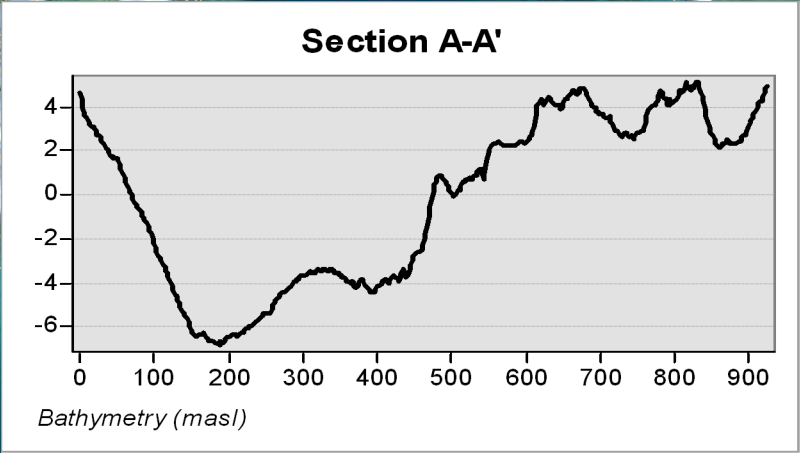
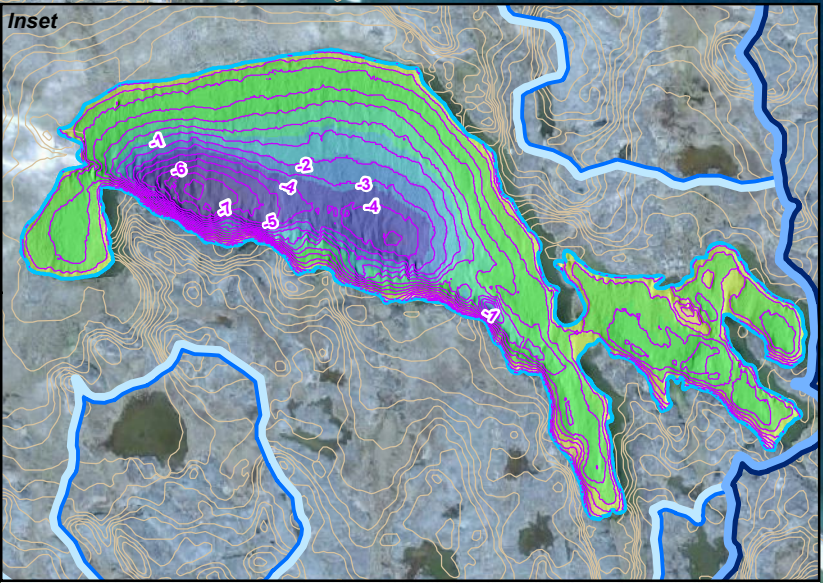
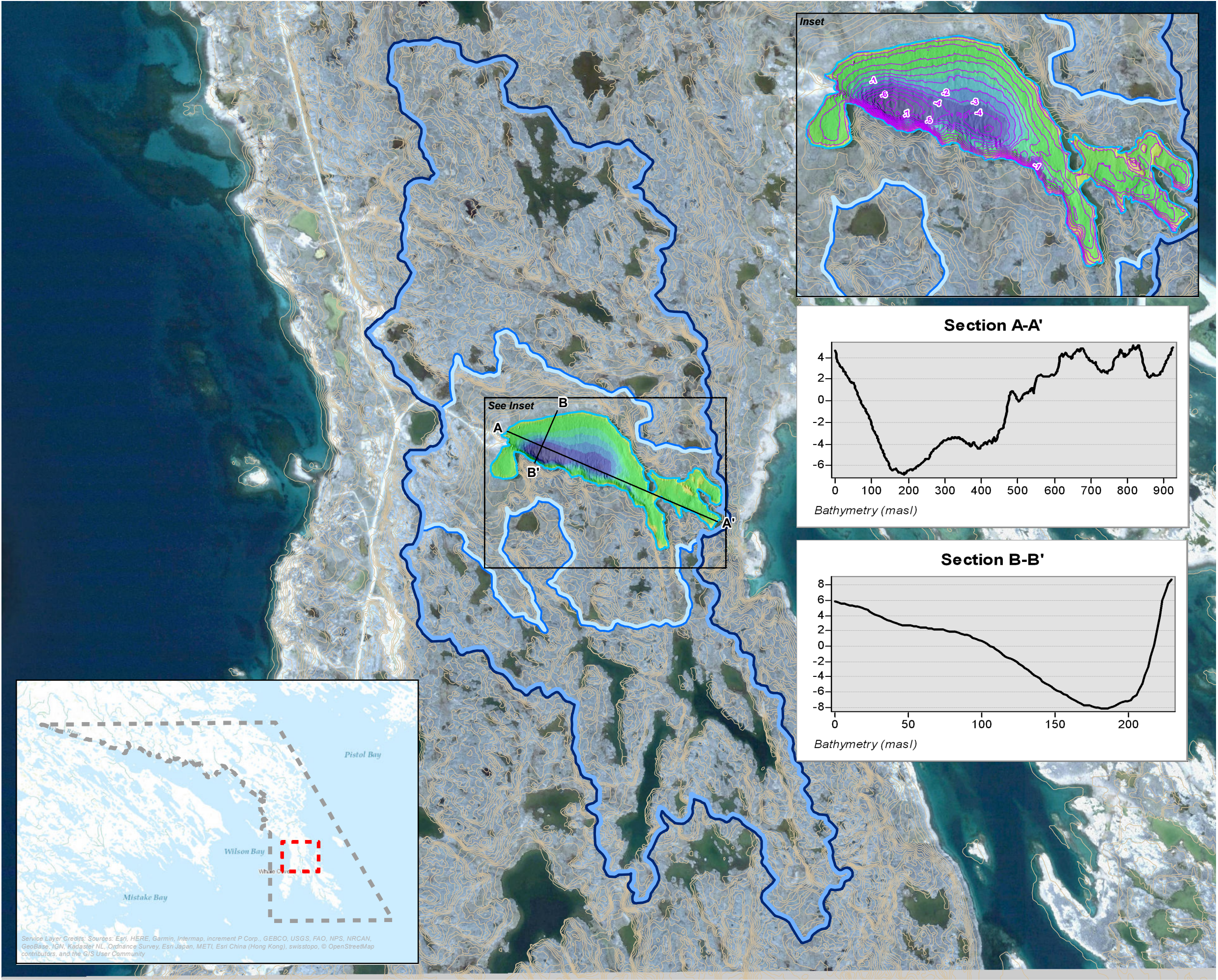
Fish Lake has served as Whale Cove's potable water source since 1982 (Ferguson Simek Clark Engineers & Architects, 2002) and is located approximately 3 km north of the community. The source water capacity assessment is intended to ascertain Fish Lake's suitability as a long-term supply of potable water to the Hamlet. **Tables 2-3** and **2-4** provide an overview of the community's historical and projected water demands up to 2050. This analysis will focus both on Fish Lake's historical and projected future lake levels.

5.1 Study Location & Physiography

The Fish Lake watershed has an approximate area of 324 ha with numerous additional lakes present within this area, which is shown in **Figure 5-1**. The surficial geology is dominated by bedrock (gneiss, basalt, and pillow lavas), with small areas of shallow surficial deposits, comprised mainly of sandy-silty poorly sorted soils (Climate Change Adaptation Action Plan for Whale Cove, 2010). Whale Cove is located in a region of continuous permafrost, which fundamentally affects the hydrologic response of the watershed. The presence of permafrost and bedrock will result in a more immediate or flashy runoff response within the Fish Lake watershed. There are no major watercourses into the lake; therefore, the only means of replenishment is due to overland runoff from the steeply graded watershed during the spring freshet or precipitation events. The lake intake structure is situated approximately 4.75 m above the lowest elevation of the lake bottom, resulting in a storage volume unavailable for withdrawal of approximately 21,478 m³.

Similar to the flow regime in a wetland dominated catchment, the depression storage areas within the watershed fill and then spill downstream during large rainfall and melt events, which is evidenced by defined flow paths in the bedrock. This results in a variable contributing watershed area, which is seasonally dependent. It is expected that the full 324 ha watershed (less the amount of storage in smaller lakes and ponding) contributes runoff during the spring freshet which tends to occur in late May or early June; however, it is likely that during the remainder of the year, only a portion of the overall watershed contributes to the Lake's replenishment. The delineated subwatershed is additionally provided in **Figure 5-1**.

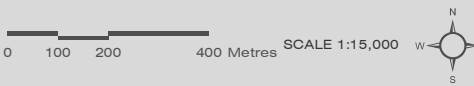
Lake levels are ultimately controlled by naturally occurring rock weirs on the eastern side of the lake that direct overflow to Hudson Bay and are identified in **Figure 5-2**. The central rock weir is also hydrologically significant, and plays an important role in regulating water levels in Fish Lake. Overflows from the central weir pool in a ponding area to the east of the main lake and are unavailable for withdrawal after overflow events occur.



GOVERNMENT OF NUNAVUT
WHALE COVE WASTEWATER
TREATMENT PLANT PLANNING STUDY

PROJECT STUDY AREA
FIGURE 5-1

- Depth Contour (1m)
 - Contour (1m)
 - Fish Lake Watershed
 - Fish Lake Sub-watershed
 - Municipal Boundary
- Bathymetry (masl)
- 8.8 - -6.4
 - 6.3 - -4.8
 - 4.7 - -3.3
 - 3.2 - -1.9
 - 1.8 - -0.51
 - 0.5 - 0.95
 - 0.96 - 2.2
 - 2.3 - 3.1
 - 3.2 - 4
 - 4.1 - 5
 - 5.1 - 6.4
 - 6.5 - 11



MAP DRAWING INFORMATION:
GOVERNMENT OF NUNAVUT; NATURAL RESOURCES CANADA;
ARCTICDEM, GOOGLE EARTH

MAP CREATED BY: JAB
MAP CHECKED BY: NO
MAP PROJECTION: NAD 1983 UTM Zone 15N

FILE LOCATION: X:\PROJECTS\DRIFT\JM Modelling\Whale Cove\GIS\18-8932_FigX_Project_Study_Area_20190401.mxd



PROJECT: 18-8932
STATUS: DRAFT
DATE: 2019-04-09

Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

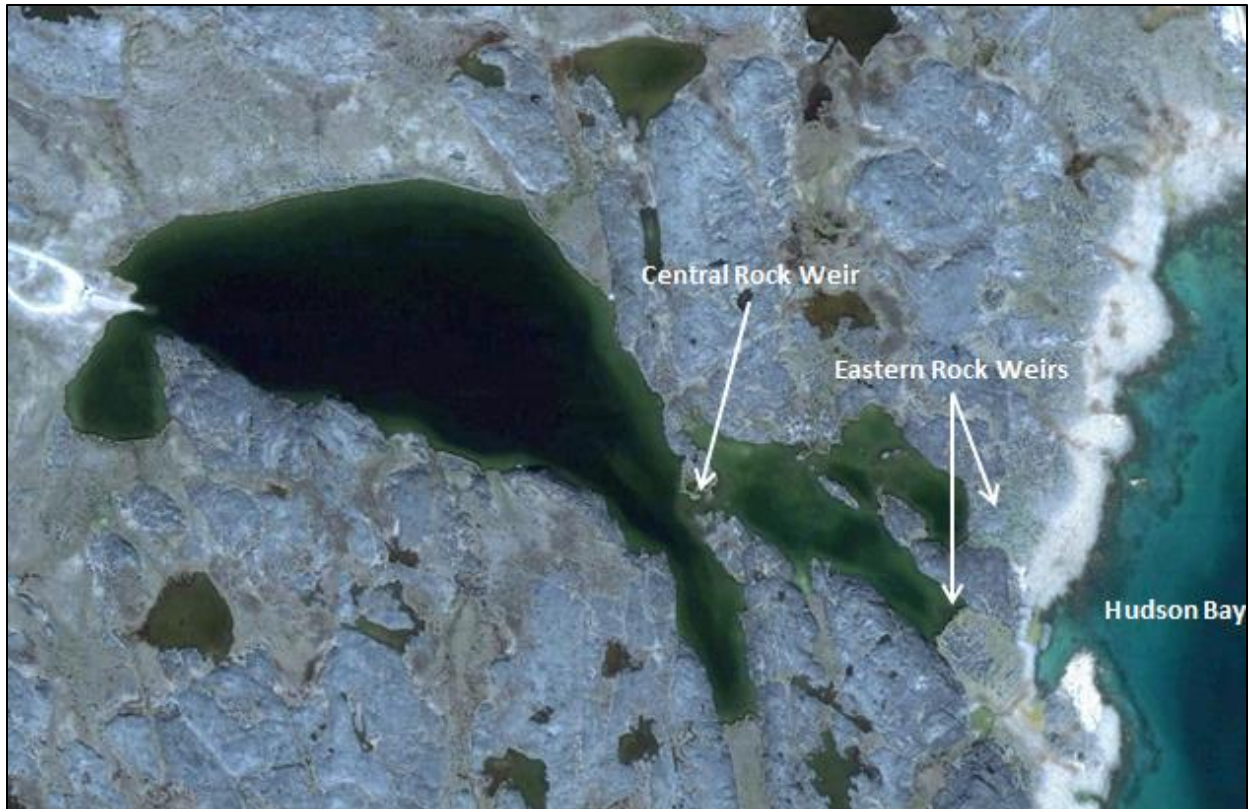


Figure 5-2 – Aerial Image of the Fish Lake Rock Weirs

5.2 Objectives and Scope

The primary objective of this analysis is to determine if Fish Lake has adequate water to meet the long-term potable water demands of the community. The reliability of the Fish Lake water supply will also be investigated to determine the lake's ability to withstand an assumed drought condition. Projected lake conditions spanning from 2021-2050 are assessed to determine the future sustainability of the lake for municipal use. This analysis is undertaken through the completion of several tasks including:

- Data Compilation, review, and analysis;
- Spreadsheet based Fish Lake water balance;
- Assessment of historical future (climate change projected) climate;
- Uncertainty and risk analyses; and
- Conclusions.

5.3 Data Compilation, Review, and Analysis

Meteorological and climatological data for Whale Cove are critical for the assessment of a hydrologic budget and to evaluate the lake's water level fluctuations on a monthly and annual basis.

Daily precipitation and temperature data for Whale Cove were retrieved from the Government of Canada's online historical weather and climate database from 1984 to 2013. Due to the lack of

precipitation data from 2013 to the present and missing data during the period of record, a composite record was created by supplementing data from Rankin Inlet, located approximately 70 km north of Whale Cove. The climate stations used for this analysis are summarized in **Table 5-1**.

Table 5-1 – EC Meteorological Stations in the Vicinity of the Study Area

ID	Station Name	Interval	Start	End	Elev.,m	Latitude	Longitude
2303986	Whale Cove A	Daily	1984	2013	12.2	62°14'24"	92°35'53"
2303401	Rankin Inlet A	Daily	1981	2013	32.3	62°49'00"	92°07'00"
2303405	Rankin Inlet A	Daily	2013	Present	32.3	62°48'38"	92°06'53"

To determine the suitability of a precipitation data transfer between Whale Cove and Rankin Inlet, a trend analysis was completed to compare cumulative average monthly rainfall depths for the common period of record between 1985 and 2007. Generally, the records during this period were relatively complete, resulting in a robust comparison. The trend analysis for stations 2303986 and 2303401 are provided in **Figure 5-3**.

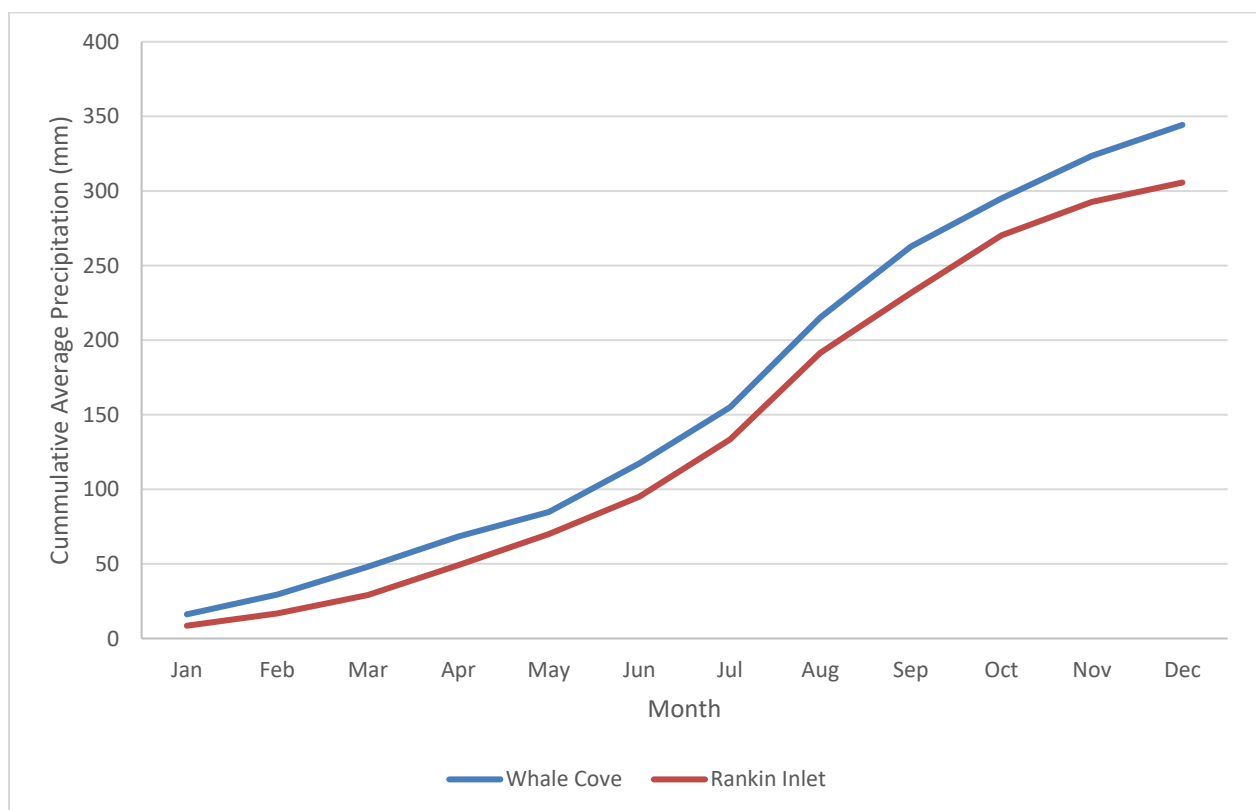


Figure 5-3 – Climate Station Trend Analysis for Period of Common Record (1985-2007)

Figure 5-3 indicates that the rainfall totals and timing at the two stations are quite similar, however, Whale Cove precipitation amounts trend higher. To account for this difference in meteorological regimes, the Rankin Inlet data was augmented on a monthly basis to account for the slight divergence. A

continuous record of precipitation was created with the Whale Cove and modified Rankin Inlet datasets, resulting in a period of record of 35 years (1984-2018).

Whale Cove falls in the Arctic climate zone which is characterized by long cold winters, and short cool summers. Maximum, minimum, and average monthly temperature data are provided in **Figure 5-4**. Temperatures are below zero from approximately October until May, with February being the coldest month of the year with a mean temperature of -29.2°C . Temperatures rise above zero in June, with average temperatures being highest in August at 9.8°C .

The annual precipitation, rain, and snow water equivalents, for the composite record are presented in **Figure 5-5**. Mean annual precipitation is approximately 350 mm; however, a visibly decreasing trend in mean annual precipitation is apparent in Figure 5-5. Therefore, annual precipitation totals have been lower in more recent years. More precipitation tends to fall as snow, although, summers in the area are known to be relatively wet.

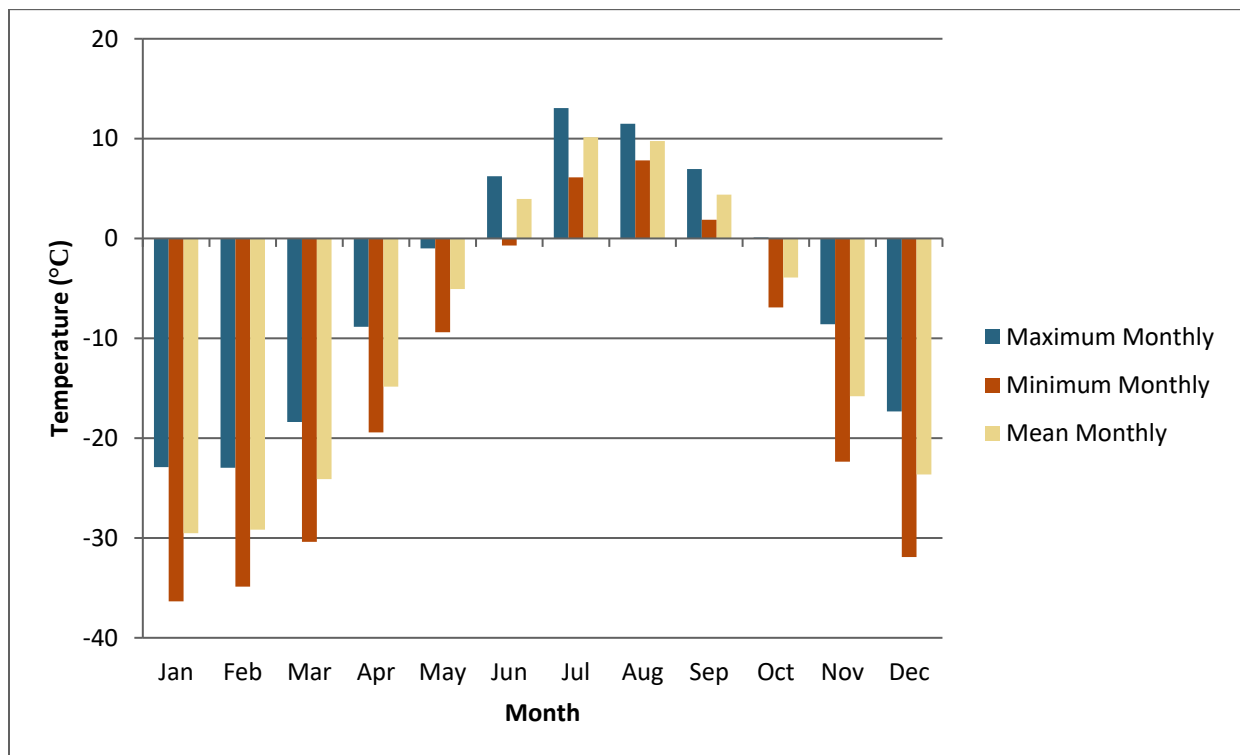


Figure 5-4 – Maximum, Minimum, and Mean Average Monthly Temperatures (1984-2018)

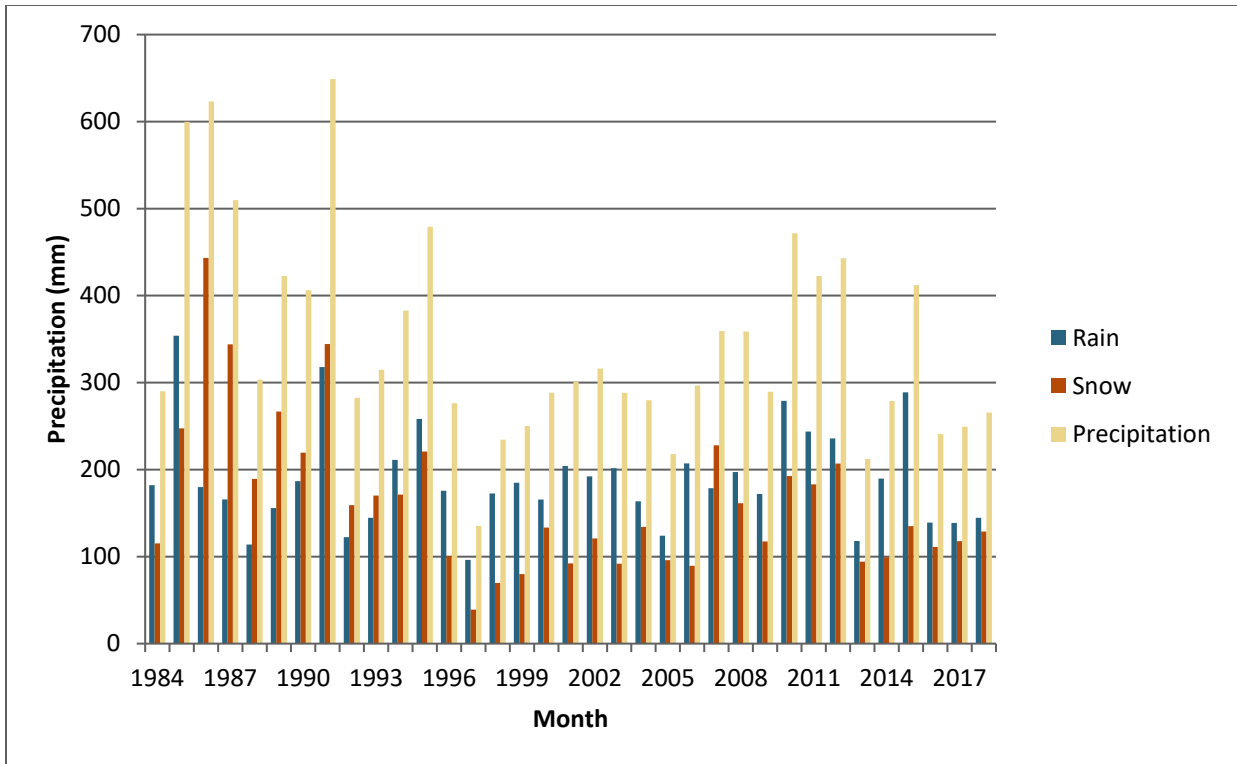


Figure 5-5 – Long-term Annual Precipitation from Composite Precipitation Record (1984-2018)

Figure 5-6 presents the long-term monthly average minimum, maximum and mean precipitation data.

The summer months (June to September) receive the highest precipitation amounts, with August receiving the most precipitation on average. This is also illustrated in **Figure 5-3**, where the slopes of the trend lines increase during the summer period. **Figure 5-6** further demonstrates the potential for excessively wet conditions in September.

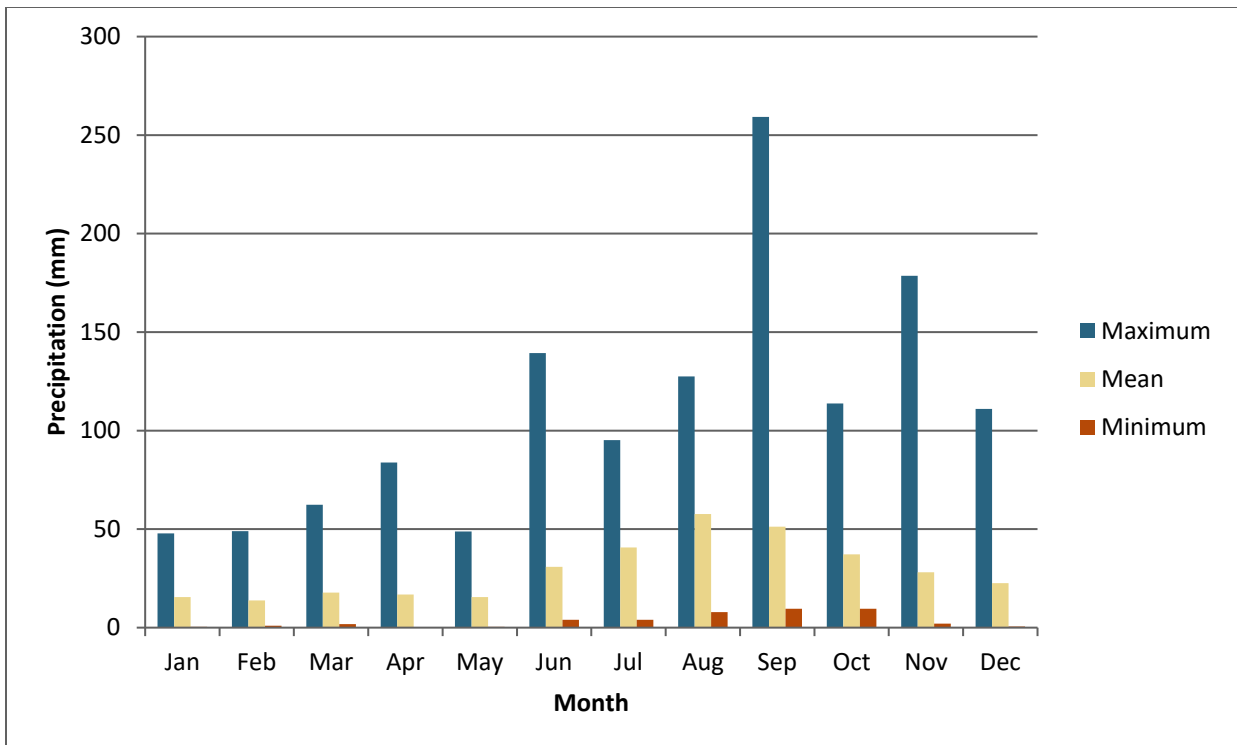


Figure 5-6 – Long-term Monthly Precipitation from Composite Precipitation Record (1984-2018)

The digital elevation model (DEM) used for this analysis was obtained from ArcticDEM, which provides 2m elevation data. The bathymetric data (1 m isobaths), acquired through the Watershed Mapping and Monitoring for Northern Community Impact Assessment – Whale Cove, Nunavut study (Budkewitsch et al., 2013) were obtained directly from Natural Resources Canada (NRCan). **Figure 5-1** indicates that Fish Lake is relatively deep with an approximate maximum depth of 12 m. The stage-storage and stage-area relationships for the lake are shown in **Figure 5-7**.

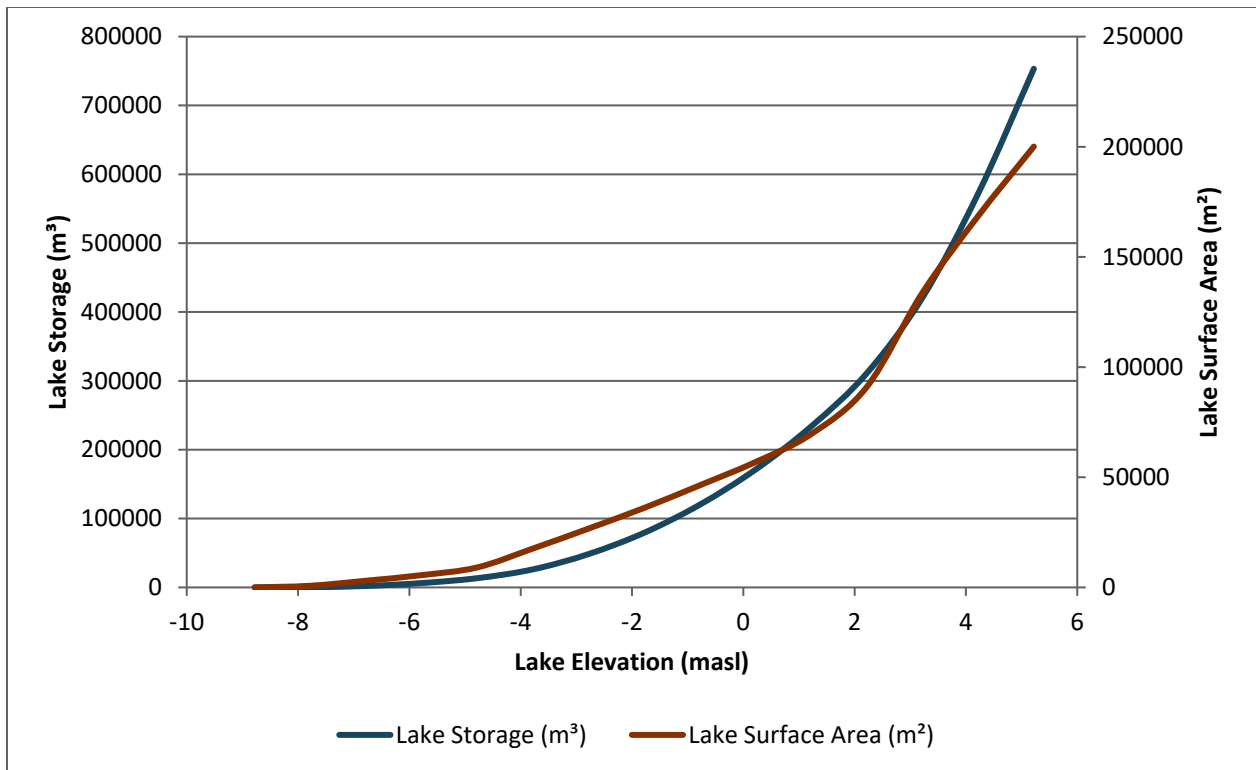


Figure 5-7 – Stage-Storage and Stage-Area Relationships for Fish Lake

5.4 Fish Lake Water Balance

A water balance model was developed for Fish Lake for the 1984 to 2018 period of record. The water balance simulation was based on results obtained from the USGS Thornthwaite monthly water balance model (https://www.brr.cr.usgs.gov/projects/SW_MoWS/Thornthwaite.html). The USGS model employs an accounting procedure to analyze and allocate water in different stages of the hydrologic cycle. Inputs into the model include a runoff factor, direct runoff factor, soil-moisture storage capacity, latitude of location, rain temperature threshold, and maximum snow-melt rate of the included snow storage. The benefits of the Thornthwaite model include the simulation of snowmelt at high latitudes and evapotranspiration calculations. Lake surface evaporation and watershed evapotranspiration were estimated separately in the water balance mode.

Several assumptions were made for this analysis, which included:

- Permafrost melt was not considered ;
- The only loss included in the model was evapotranspiration and lake surface evaporation;
- The net groundwater contribution was assumed to be zero due to the presence of continuous permafrost;
- Information regarding domestic water abstraction is available for 2016 and 2017 (**Table 2-3**) and a 2002 report by Ferguson Simek Clark Engineers & Architects states that the abstraction rate at the time was 9,000 m³. Abstraction rates preceding 2002 were conservatively assumed to be 9,000 m³

and abstraction rates falling between 2002 and 2016 were assumed to have linearly increased over time. Projected future abstraction rates were similarly estimated; and

- A 2 m lake winter ice cover thickness is suggested in the DFO Protocol for Winter Water Withdrawals from Ice-Covered water bodies in the Northwest Territories and Nunavut. This analysis applies a 25% factor of safety to this thickness, resulting in an ice thickness of 2.5 m.

A schematic of the water balance is presented in **Figure 5-8**. The surface water inflows, and land surface evapotranspiration were estimated from the USGS Thornthwaite model and monthly precipitation totals were calculated using the composite hydrometric dataset. Lake surface evaporation was estimated using the Hydrological Atlas of Canada (1978) to be approximately 200 mm annually.

The water balance equation used for model creation is as follows:

$$\Delta S = (P + R) - (E - O - A)$$

Where:

ΔS = Change in lake storage (m^3)

P = Precipitation (m^3)

R = Runoff from the Fish Lake watershed (m^3)

E = Evaporative losses from the lake surface (m^3)

O = Lake overflow (m^3)

A = Municipal Water Abstraction (m^3)

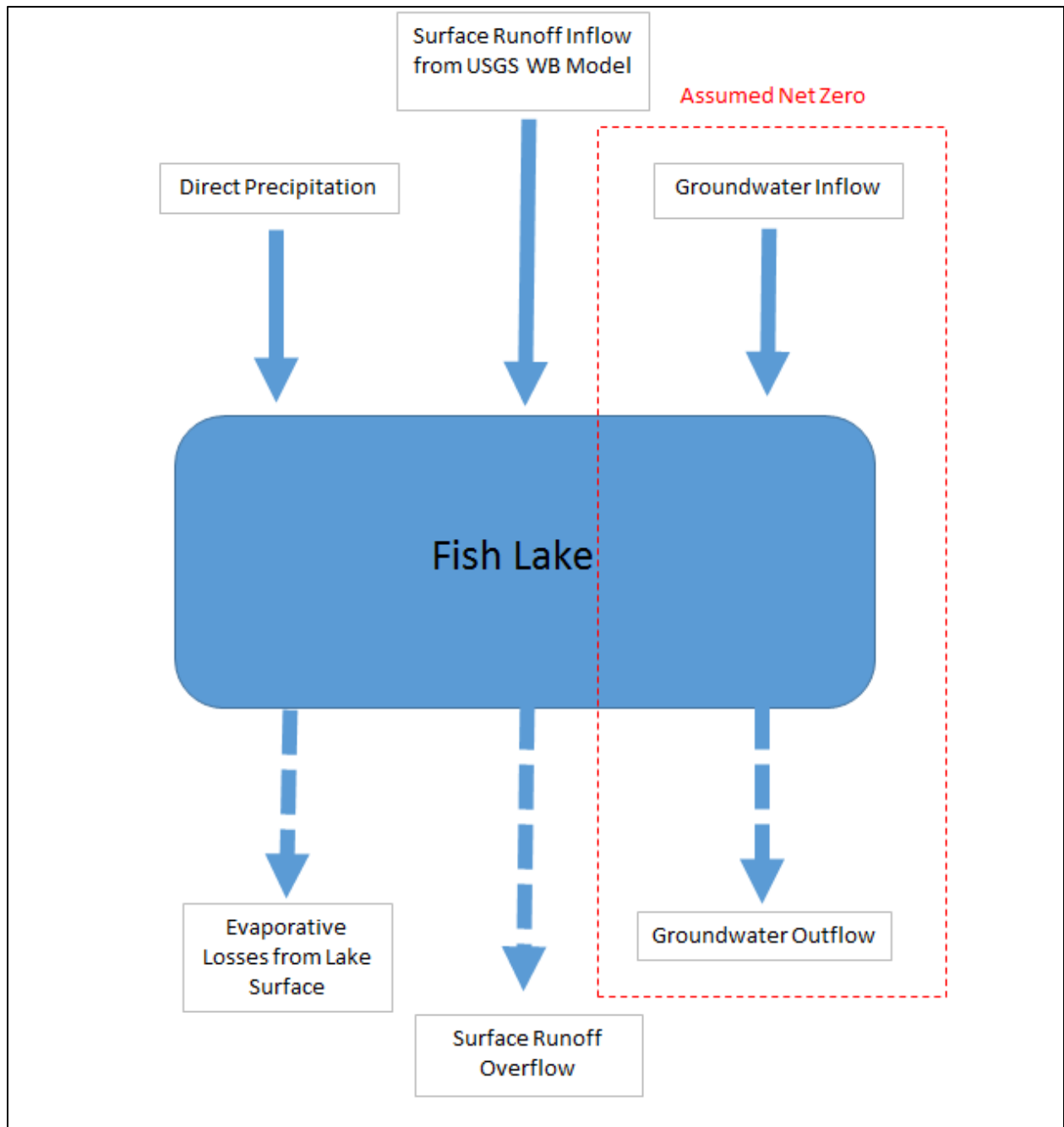


Figure 5-8 – Schematic of the Fish Lake Water Balance Model

5.5

Results and Discussion

Monthly and annual historical water balances were carried out for the composite period of record spanning 1984 to 2018. **Table 5-2** and **Figure 5-9** present the annual change in several lake characteristics including the direct lake precipitation, lake inflow (watershed runoff), lake surface evaporation, lake overflow, domestic water abstraction, remaining lake volume (after abstraction, ice cover considerations, and overflow), and lake level. The annual water balance is calculated based on the water year (October to September) to account for snow storage in the hydrologic cycle in the winter months.

Limited water balance model calibration data were available for this analysis; however, a relatively stable shoreline with high water marks indicating a lake level fluctuation less than 0.5 m is reported in The Sewage Lagoon and Solid Waste Sites Planning Study, completed in 2002 by Ferguson Simek Clark Engineers & Architects. This information was used to calibrate the spill elevation of the model, which was ultimately set to the elevation of the central rock weir. Spill elevations above this level resulted in less yearly lake fluctuations than reported in the solid waste planning study. The lower spill elevation also results in a conservative model output. Therefore, storage east of the central rock weir was not considered to be available for municipal use.

Table 5-2 indicates that the average annual change in storage of Fish Lake has historically been positive. Evaporative processes in a northern climate comprise a significant portion of the overall hydrologic budget; however, this is offset by the size of the contributing watershed. In each year of the precipitation record, there has been a net gain in lake volume, meaning that the evaporative losses are less than the volumetric runoff and direct precipitation into the lake. **Figure 5-9** shows that the historic and present domestic water abstraction amounts have been nominal in comparison to the lake volume after overflow events. Blue tones represent storage gains and red tones represent storage losses. **Figure 5-10** illustrates the monthly lake volumes over the period of record, in which it can be seen that the yearly minimum volumes rarely drop lower than the spill elevation volume (496,583 m³) and those periods of lower lake volumes are short-lived. Winter precipitation falls as snow and is unavailable for municipal abstraction, therefore, the lake level before freeze-up is the critical period of analysis, whereby the subsequent freshet and wetter summer months contribute to this lake level. The risk associated with this condition will be explored further in **Section 5.7**.

Table 5-2 – Historic Fish Lake Water Balance Summary (1984-2018)

Water Year (to-from)		Direct Precipitation (m ³)	Inflow Into Lake (m ³)	Lake Surface Evaporation (m ³)	Municipal Abstraction (m ³)	Overflow (m ³)	Net Gain* (m ³)
1984	1985	97380.66	218918.31	40293.47	9000.00	267005.50	276005.50
1985	1986	102799.68	397656.71	41493.70	9000.00	449962.70	458962.70
1986	1987	79644.97	448428.34	41648.01	9000.00	477425.30	486425.30
1987	1988	45710.26	92121.34	33383.57	9000.00	95448.03	104448.03
1988	1989	66331.15	245369.03	38407.39	9000.00	264292.80	273292.80
1989	1990	61463.62	153060.57	36847.09	9000.00	168677.09	177677.09
1990	1991	105533.13	275670.13	39298.99	9000.00	332904.27	341904.27
1991	1992	44307.64	135599.84	40533.51	9000.00	130373.97	139373.97
1992	1993	47620.23	88202.43	35303.94	9000.00	91518.72	100518.72
1993	1994	58777.01	125793.68	37637.18	9000.00	137933.51	146933.51
1994	1995	73415.50	132170.42	42865.39	9000.00	153720.53	162720.53
1995	1996	42751.46	107224.08	27365.27	9000.00	113610.28	122610.28
1996	1997	20618.81	61181.78	11299.32	9000.00	61501.27	70501.27**
1997	1998	35621.58	87817.46	16786.09	9000.00	97652.95	106652.95
1998	1999	38132.26	100264.95	18534.99	9000.00	110862.22	119862.22
1999	2000	43718.25	74883.55	26473.67	9000.00	83128.14	92128.14
2000	2001	45366.67	109619.02	22993.00	9000.00	122992.69	131992.69
2001	2002	48587.12	103219.14	28342.60	9000.00	114463.66	123463.66
2002	2003	43961.02	138613.64	21638.45	9571.14	151365.07	160936.21
2003	2004	43524.67	87638.98	27433.85	10142.29	93587.52	103729.81
2004	2005	33218.69	71504.00	24244.66	10713.43	69764.60	80478.03
2005	2006	45027.65	133370.04	21106.92	11284.57	146006.19	157290.77
2006	2007	50295.87	114169.45	32406.24	11855.71	120203.38	132059.09***
2007	2008	55776.47	117386.44	33400.71	12426.86	127335.34	139762.20
2008	2009	43126.30	79173.91	27073.78	12998.00	82228.43	95226.43
2009	2010	68040.42	135372.60	31771.83	13569.14	158072.05	171641.19
2010	2011	60450.09	149587.40	36984.26	14140.29	158912.94	173053.22
2011	2012	72597.02	263359.37	41099.34	14711.43	280145.62	294857.05
2012	2013	42324.07	67661.08	27759.63	15282.57	66942.94	82225.52
2013	2014	37134.88	87064.58	17763.42	15853.71	90582.33	106436.05
2014	2015	60571.92	154221.26	33606.47	16424.86	164761.86	181186.72
2015	2016	42904.10	81406.61	29971.48	16996.00	77343.23	94339.23
2016	2017	35679.89	62702.65	131.32	18685.00	79566.22	98251.22
2017	2018	49580.32	132587.60	29634.26	18685.00	133848.66	152533.66

*Net gain is equal to the direct precipitation plus the inflow into the lake minus the lake surface evaporation.

**Indicates the 100-year low net gain.

***Indicates the median net gain.

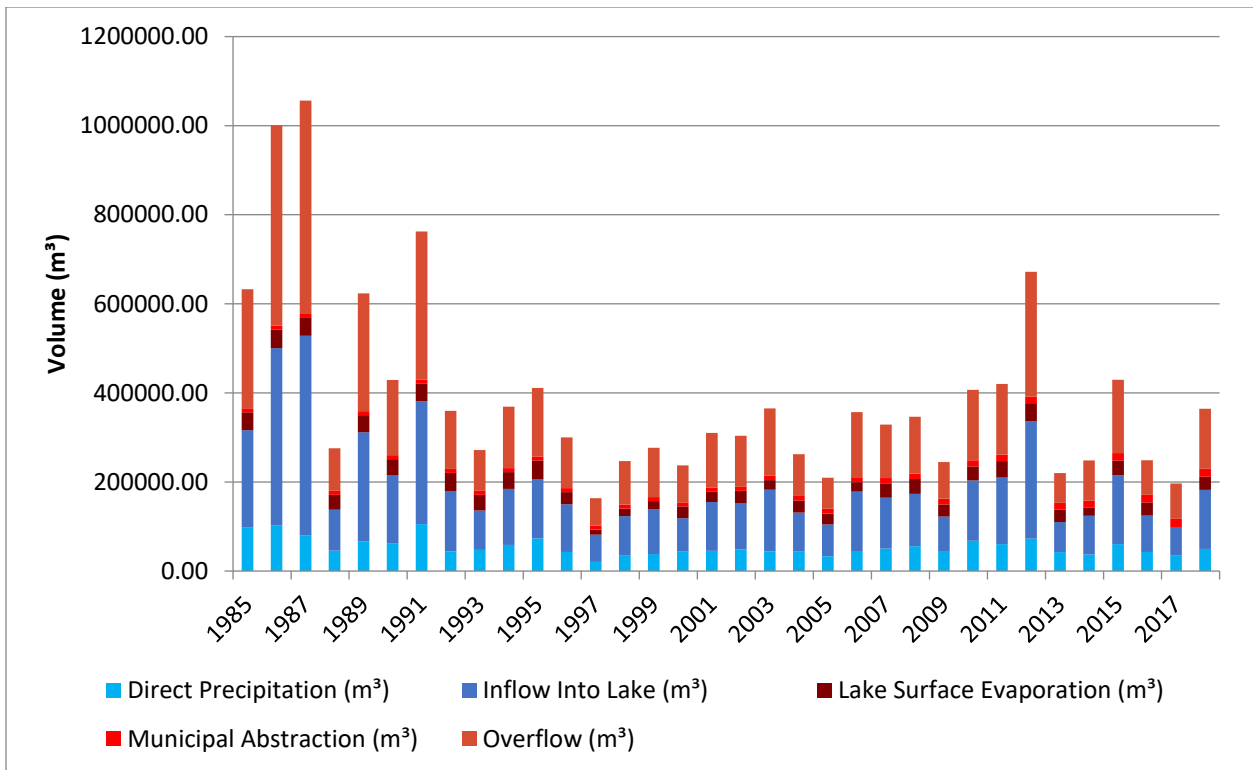


Figure 5-9 – Historical Fish Lake Water Balance Summary (1984-2018)

5.5.1 Projected Future Climate Impacts

The treatment plant life cycle is expected to be approximately 20-30 years; therefore, an analysis of projected lake level to 2050 was carried out. Statistically downscaled climate scenarios from the Canadian Center for Climate Services were obtained for the high emission scenario (RCP 8.5). An overview of the expected climate variations are presented in **Table 5-3**. The most recent 20 years of the period of record (2000-2019) were augmented using the data from **Table 5-3** for the period 2021-2040. The period from 2000 to 2009 were used to create the climate change projection from 2041-2050. These projected climate data were then input into the calibrated water balance model, the results of which are provided in **Table 5-4** and **Figure 5-11**. The historical and projected water balance model results arrive at a similar conclusion, being that the lake has been at capacity in the past and will be in the foreseeable future during open water conditions.

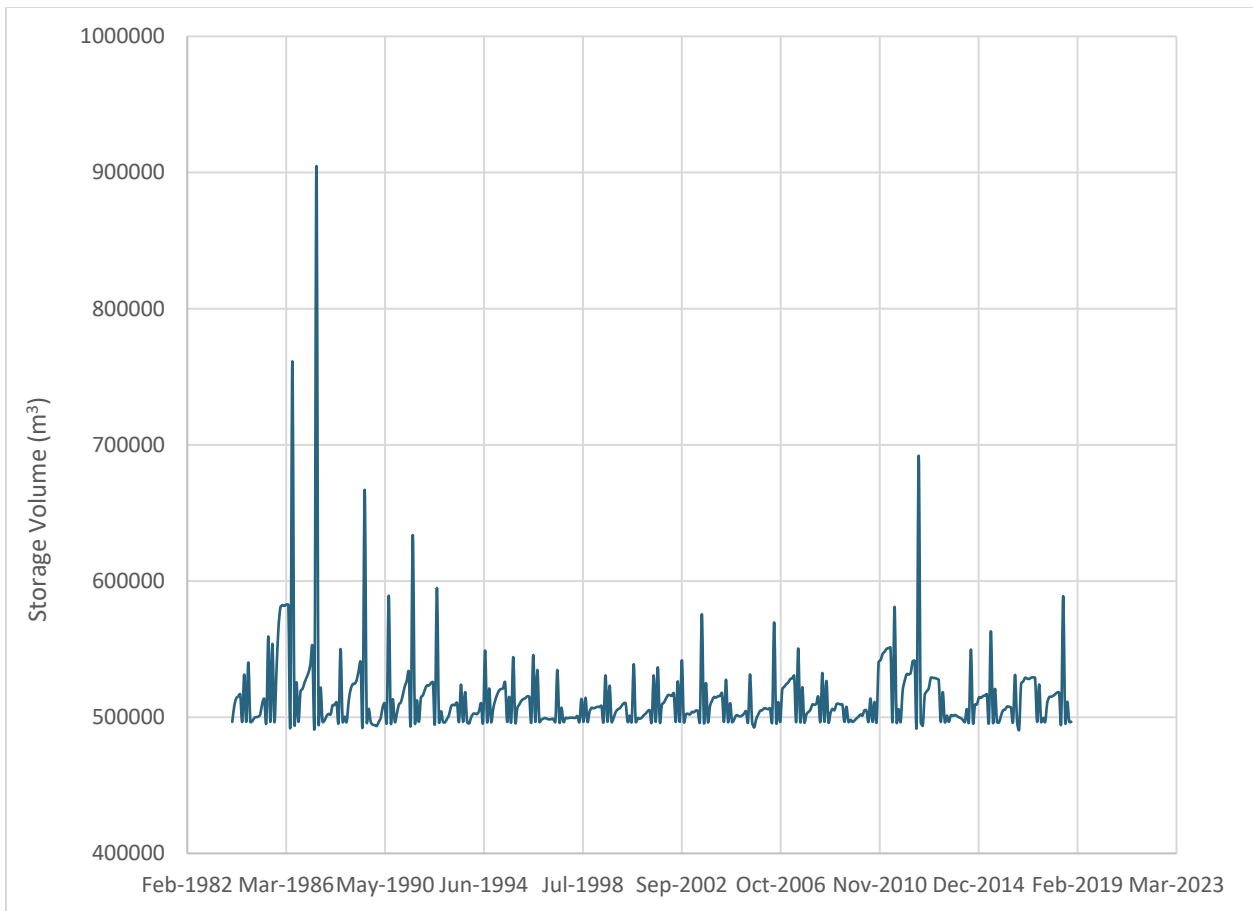


Figure 5-10 – Historical Monthly Fish Lake Storage Volume (1984-2018)

Table 5-3 – Statistically Downscaled Climate Scenarios (RCP 8.5)

Metric	Time Period	2021-2040	2041-2060
Average Changes in Mean Temperature (°C)	Winter (Dec-Feb)	2.8	5.6
	Spring (Mar-May)	1.7	2.7
	Summer (Jun-Aug)	1.7	2.4
	Autumn (Sep-Nov)	2.1	3.8
Average Changes in Daily Minimum Temperature (°C)	Winter (Dec-Feb)	2.9	5.9
	Spring (Mar-May)	1.8	3.1
	Summer (Jun-Aug)	1.6	2.4
	Autumn (Sep-Nov)	2.2	4
Average Changes in Daily Maximum Temperature (°C)	Winter (Dec-Feb)	2.8	5.4
	Spring (Mar-May)	1.5	2.5
	Summer (Jun-Aug)	1.7	2.5
	Autumn (Sep-Nov)	2.1	3.6
Average Changes in Total Precipitation (%)	Winter (Dec-Feb)	17.6	19.4
	Spring (Mar-May)	11.1	16.8
	Summer (Jun-Aug)	1	0.7
	Autumn (Sep-Nov)	9.7	16.3

Table 5-4 – Projected Fish Lake Water Balance Summary (2021-2050)

Water Year (to-from)		Direct Precipitation (m ³)	Inflow Into Lake (m ³)	Lake Surface Evaporation (m ³)	Municipal Abstraction (m ³)	Overflow (m ³)	Net Gain* (m ³)
2021	2022	46889.13	79594.43	27708.19	18658.00	80117.37	98775.37
2022	2023	48080.81	115756.30	27536.73	19097.58	117202.81	136300.39
2023	2024	51980.91	110353.43	27536.73	19537.16	115260.45	134797.61
2024	2025	46646.67	146730.63	26542.25	19976.74	146858.32	166835.06
2025	2026	46955.05	96603.00	23113.02	20416.32	100028.72	120445.04
2026	2027	35789.98	77498.64	32611.99	20855.89	59820.74	80676.63
2027	2028	47876.44	142560.20	21689.89	21295.47	147451.27	168746.75
2028	2029	54324.04	124177.31	25839.26	21735.05	130927.04	152662.09
2029	2030	59757.58	123012.77	35938.34	22174.63	124657.38	146832.01
2030	2031	46280.32	84028.59	32543.40	22614.21	75151.29	97765.50
2031	2032	73914.07	152429.35	33400.71	23053.79	169888.92	192942.71
2032	2033	66217.79	161173.17	32423.38	23493.37	171474.21	194967.58
2033	2034	78941.60	249259.34	40207.74	23932.95	264060.25	287993.20
2034	2035	46467.52	74293.06	41853.77	24372.53	54534.29	78906.81**
2035	2036	39200.44	92935.69	19958.13	24812.11	87365.90	112178.00
2036	2037	65151.16	161244.27	28565.50	25251.68	172578.25	197829.93
2037	2038	47250.05	86467.79	36727.07	25691.26	71299.51	96990.77
2038	2039	38525.20	71411.77	28479.77	26130.84	55326.36	81457.20
2039	2040	48431.79	113838.27	23884.60	26570.42	111815.05	138385.47
2040	2041	47481.06	96923.06	37704.40	27010.00	79689.72	106699.72
2041	2042	76208.37	110443.88	31206.00	27379.22	128067.02	155446.24
2042	2043	65500.43	84127.69	34412.34	27748.44	87467.33	115215.78
2043	2044	79460.07	119397.26	39950.54	28117.67	130789.11	158906.78
2044	2045	47607.11	113703.95	41853.77	28486.89	90970.41	119457.30
2045	2046	40033.57	152253.60	20249.61	28856.11	143181.44	172037.55
2046	2047	66412.57	100766.38	28634.08	29225.33	109319.54	138544.87
2047	2048	48927.88	81387.46	37927.30	29594.56	62793.49	92388.04
2048	2049	39495.47	149116.38	28085.40	29963.78	130562.67	160526.45
2049	2050	49599.35	127812.77	25153.41	30333.00	121925.70	152258.70

*Net gain is equal to the direct precipitation plus the inflow into the lake minus the lake surface evaporation.

*Approximate 22-year low net gain.

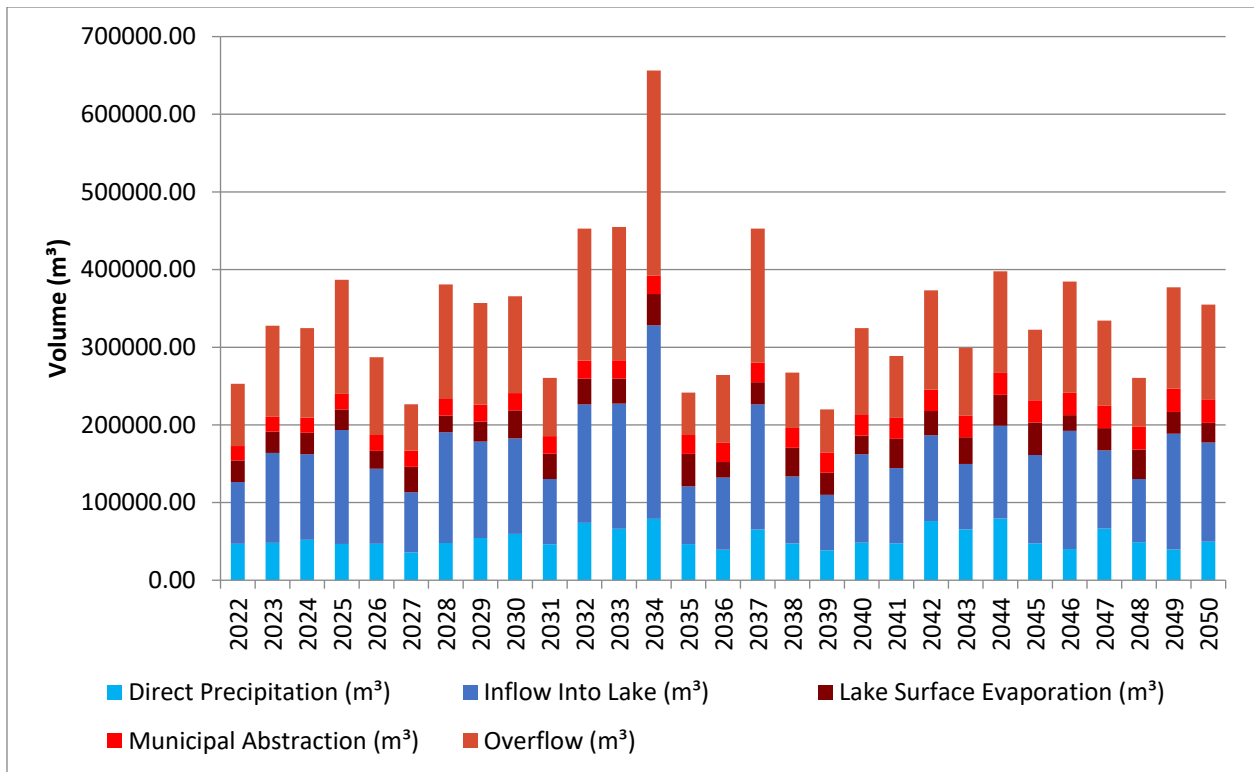


Figure 5-11 – Projected Fish Lake Water Balance Summary (2021-2050)

5.6 Uncertainty and Risk Analyses

Uncertainty regarding future water levels in Fish Lake is intrinsically linked to the overall net gain or loss in the lake's annual levels (or volume). An assessment of year over year net gain is advantageous, as it accounts for temperature and evaporative loss variability throughout the period of record. It was determined through the historic and projected water balance that annual net gains in lake levels have historically occurred and are projected to continue into the future. To this end, a frequency analysis of the net gain in lake volume was carried out, which is calculated by adding the direct precipitation on the lake and the runoff from the Fish Lake watershed then subtracting the lake surface evaporation. A summary of the historical Fish Lake net gains is presented in **Table 5-2**.

Five distributions were tested for goodness-of-fit to the historic net gain data using the Akaike Information Criterion (AIC) (Akaike, 1974). The AIC considers both model parsimony and goodness-of-fit and employs the negative log-likelihood that is provided with maximum likelihood parameter estimation. The included distributions included:

- Generalized extreme value (GEV);
- Gumbel;
- Lognormal;
- Pearson Type III; and
- Weibull.

The GEV distribution provided the lowest AIC and was therefore selected as the most suitable.

It can be seen in **Table 5-2** that there have been no years on record that have resulted in a net loss in Fish Lake's volume. With the available period of record, a 35-year return period low net gain was estimated. Extrapolating return periods past the period of record must be done cautiously due to the likelihood of not having experienced that magnitude of low-frequency event. For example, it is not likely to capture a 100-year low level in a 35-year time period. The median low net gain is approximately 134,224 m³ and occurred in the 2006/2007 water year. The 35 and 50-year low return period net gains were approximately 75,556 m³ and 73,203 m³, respectively. The lowest net gain on record occurred in the 1996/1997 water year and has an approximate return period of a 100-year low but nonetheless resulted in a net gain. The amount of available storage for the 1997/1998 winter months is governed by the net gain in the previous water year. After subtracting dead storage and ice volume storage, there is a remaining 219,315 m³ of available water for withdrawal over the winter months. Due to the low monthly abstraction rates at the time (~750 m³/month), there was nonetheless ample water reserves for winter use.

Moving forward into the projected time period, resultant net gains are anticipated through to 2050, which is outlined in **Table 5-4**. The lowest projected net gain is an approximate 22-year low in the 2034/2035 water year, which is less extreme than the historic low, however, abstraction rates at the time are likely to increase. Using the storage volume in October of the 2035/2036 water year (at freeze-up), there is an available 233,381 m³ of available water for municipal withdrawal over the winter months. Using an estimated 2104 m³/month of anticipated abstractions, the data suggests that there is still ample water available to service the community during this time.

5.7 Conclusions

This simulation suggests that Fish Lake has adequate water for municipal use based on both historical and projected future climate data. This finding is in agreement with the *Desktop Risk Assessment on the Sustainability of Nunavut's Primary Drinking Water Sources*, carried out by the Center for Water Resources at Dalhousie University (2016). An important limitation on this study was the lack of suitable calibration data available to support the assessment. In the absence of this data, historical aerial imagery available from Google Earth was helpful in determining past water levels. Field measured lake levels will be collected in the summer of 2019, and compared to model output to validate the water balance analysis. A supplemental memo that includes the updated results will be issued at that time.

Similar overall conclusions can be drawn through the water balance model and uncertainty analysis, being that the community is at very low risk of depleting Fish Lake's available water reserves for the projected future time period considered in this study.

6.0 Water Treatment System Design Basis

6.1 Basis of Design

It is recommended that the new water treatment system will be designed to meet the following criteria. Exact details and technical requirements should be re-evaluated and finalized during detailed design:

Table 6-1 – Preliminary Basis of Design

Preliminary Design Criteria	Value
2041 Population	657
Average per capita water consumption (L/p/d)	112
Peak: average demand factor (ISC)	2.5
Design Average day potable water production	74 m ³
Maximum day potable water production	185 m ³
UF maximum flux ¹	70 LMH suggested in the absence of pilot test data
Filter Backwash	5 % of daily production
Chlorine CT for Virus	12 mg-min/L
UV Dose	40 mJ/cm ²
Design truck fill rate	1,000 L/min
Raw water temperature	0.5-10 °C
Treated water storage tank active volume ²	180 m ³
Backwash storage tank volume	20 m ³ (approximately five days storage @ average production)
Ambient temperature range	-50 to +20 °C

1. Maximum flux is based on N operational trains, with an 'N+2' system. The maximum flux will be measured with one train offline, and one train in backwash.

2. To be confirmed based on fire protection approach.

6.2 Piloting

With any treatment system, bench scale piloting is recommended to reduce risk and confirm the concept treatment process. Typically pilot systems can be shipped to site in sea-containers pre-constructed, and a raw water feed being the only external connections required with power being provided by generators if site power is not readily available. The treatment system is typically operated for an extended period to capture seasonal water changes that include the worst case water quality, to identify the impacts to membrane operation, and to establish sustainable design parameters including but not limited to: membrane flux; membrane fouling rate; backwash frequency, duration and intensity; pre-treatment requirements; organics removal; projected cleaning frequency and chemicals. Alternatively, conservative design factors may be used, which would include a conservative flux rate with provision for pre-treatment (coagulation/sedimentation).

Based on the practicality of conducting pilot testing at Whale Cove in the available time frames, a conservative design approach is recommended. A comprehensive water quality monitoring program must be conducted in order to validate the proposed new WTP process during this period. Bench testing of coagulant chemicals is also recommended during this period. A conservative approach to membrane system design is strongly recommended without pilot testing, which would include pre-treatment and sedimentation upstream of ultrafiltration membranes, and a conservative maximum flux rate of 70 LMH.

7.0 Geotechnical Investigation

A geotechnical investigation will take place at the proposed WTP site in summer 2019 to determine permafrost and soil conditions and make recommendations for design and construction. An air track drill rig owned by Canadrill Ltd. in Iqaluit will conduct the drill program, consisting of four to five boreholes drilled at the proposed site. Boreholes will be advanced to depths of approximately ten to twelve metres, or 2 metres into competent bedrock, whichever is less. Any borehole number reduction or addition will be discussed with the GN prior to implementation of the drill program. All boreholes will be installed with PVC conduits to measure soil/permafrost temperature, and ground temperature data will be collected in each borehole approximately one day after completion of the drill program. Depending on diameter of boreholes and temperature of backfill materials, the ground temperature may not quickly stabilize after completion of the boreholes. As such, the ground temperature will be evaluated with considerations on measured data from previous projects.

Each borehole will be logged on a continuous basis. Where possible, representative samples will be retained and returned to Canadrill/Wood's laboratory to verify soil classification. Soil tests that may be conducted include: moisture content, grain size distribution, plasticity indices, and pore water salinity. On completion of the field work and laboratory testing, a geotechnical report will be prepared that will include the following:

- The results of the field and laboratory programs;
- Recommendations regarding the design and construction of a feasible foundation system;
- Recommendations for site grading and drainage; and
- Other observations related to geotechnical nature.

8.0 Recommendations

8.1 Design Life

This project was based on the assumption of a 20 year design life, with the new plant entering operation in early 2021. This results in an end-of-design life in the year 2041; however, the hydrologic assessment of Fish Lake was performed through 2050 as it was assumed that a replacement or upgraded water treatment system in 2041 would utilize the same source (Fish Lake) and re-use some of the existing infrastructure.

8.2 Water Treatment Plant System Sizing and Redundancy

The new water treatment system for Whale Cove is sized based on water consumption data from 2016 and 2017, and projected community population growth over a 20-year design life. The design basis for the new system will provide capacity to fill, on average, approximately 6 trucks per day with the ability to accommodate a non-frequent peak of up to 16 water trucks a day, all with a maximum filling time of 15 minutes. Dillon is recommending the new treatment process be sized to deliver a minimum of 150 L/min of treated water to a new storage tank of 180 m³ (active volume), which is sized to include capacity for emergency firefighting and virus inactivation CT. New truck filling pumps would provide a loading rate from the storage tank of 1,250 L/min.

Dillon evaluated options to provide N+1 redundancy in the treatment system including two (2) membrane trains at 100% capacity and three (3) membrane trains each at 50% capacity. Each configuration would allow for the plant to operate with one of the membrane trains out of service while presenting different advantages and disadvantages to short and long term operations. The design basis for WTP production includes consideration for water losses associated with off-line time for membrane train backwash, and also for consumption of treated water for backwash flows. A summary of the different advantages and disadvantages is presented in **Table 8-1**.

Table 8-1 – Redundancy Comparison

	Advantages	Disadvantages
2 Membrane Trains at 100% Capacity	• Reduced building space • Simple operation and instrumentation • 200% design capacity provides lowest operational flux/highest production during normal operation with all trains running	• Less flexibility with operations
3 Membrane Trains at 50% Capacity	• Provides greater flexibility in the event of maintenance or break-down • Smaller pumps and treatment trains	• 150% design capacity provides higher operational flux during normal operation with all trains running compared to 2@100% • More equipment to operate and maintain

	Advantages	Disadvantages
		• Higher level of operation and instrumentation required • Additional treatment train will require an increase in building footprint

From conversations with suppliers and reviewing previous installations, it was determined that both options are similar in price for the scale of the proposed system in Whale Cove. Based on this, Dillon recommends two membrane trains each at 100% capacity to save building space and to simplify operations. The reduced footprint required could either be used to reduce capital cost, or as available space for future expansions/modifications.

8.3 Intake System

Originally, GN discussed the need to replace the existing single intake with two new intakes in order to provide full redundancy. However, after discussions with the NWT, a single intake is recommended with shelf-spares equipment (e.g. pumps, wiring) due to operational issues in the idle intake including plugging with sediment. To prevent any interruption to water service, the existing intake and treatment system will remain in operation during construction, and a new intake constructed to replace the existing. The location of the existing and proposed intake pipes are shown in **Appendix D**. The new intake will consist of:

- 50 mm HDPE inner pipe within a 400 mm HDPE carrier pipe, c/w heat tracing and insulation;
- Approximately 140 m length, approximately 70% of which is in the lake while the remaining 30% is onshore (insulated and heat traced); and
- New intake screens;
- Redundant heat tracing installed to reduce the risk of freezing from heat trace failure

8.4 Treatment System

The proposed treatment includes the following processes:

- Pre-screening
- Coagulation
- Sedimentation
- Membrane ultrafiltration
- Ultraviolet light disinfection
- Chlorination (sodium hypochlorite)
- Storage tank, including CT volume for virus inactivation
- The controls and instrumentation will monitor treated water turbidity, process equipment, UV, chemical dosing, truck fill system, and treated water storage level.

The treatment system should be rated for a minimum of 150 L/min, which includes provision for membrane backwash. Average and peak daily design production of treated water is 74,000 and 185,000 L/day, respectively. All process systems will include 100% redundancy. The isometric view of the treatment train and process flow diagram are shown in **Appendix D**. As indicated previously in the report, these figures are based on a media filter system, rather than the revised membrane recommendation.

The process design is focused on meeting treated water turbidity requirements, reduction of dissolved organics to manage the risk of disinfection by-product formation, and achieving GCDWQ log removal credits for Giardia, Cryptosporidium, and virus.

8.5 Treatment Building

The building will contain all treatment systems including screening, coagulant dosing system, sedimentation vessel, ultrafiltration trains, UV disinfection, chlorination system, controls, chemical storage, CIP equipment, washroom, diesel furnace/generator room and combined laboratory/office area. The chlorine mixing and storage area, and coagulant dosing and storage will be located in a separate room within the treatment building. A treated water storage tank will be insulated and heat traced, and located inside the treatment building, along with a separate backwash waste holding tank.

It is recommended to construct a pre-fabricated treatment building in one or more components, and transport the components to site with the process equipment pre-installed and piped as much as possible. A preliminary building design has been developed to prepare costing at the planning stage and should be re-evaluated during the next phase of design. The following recommendations are made at this preliminary stage as minimum requirements:

- Dimensions: Length, width and height: 25 m (82 ft.), 3.7 m (13 ft.) and 4.0 m (13 ft.);
- Walls and roof: metal sheeting with spray foam insulation;
- Four rooms: main process area/lab, washroom, furnace/generator room, chemical room/storage space;
- Metal framed building with exterior metal cladding, insulated steel doors, one overhead door with manual operator;
- Fully insulated and winterized;
- Structural I-beam support skid with channel reinforcing for the floor; and
- Rock socketed pile foundation (pending geotechnical investigation).

8.6 Water Pumps

The water intake pumps should consist of two new raw water submersible pumps. One will be installed in the new intake conduit similar to the existing infrastructure, and one will be stored as a standby shelf spare. Two treated water truckfill pumps, two backwash pumps and interconnecting piping between external tanks and the treatment building are included. A membrane feed pump would also be required

if gravity sedimentation is used. The next design phase should evaluate whether there is an opportunity to reduce the number of pumps, by using a common standby pump for both truckfill and filter backwash. The preliminary pump design points are:

- Raw water intake pumps rated for 150 L/min at 42 m (60 psi), with the potential to ramp up to 1,250 L/min during a fire event (if this option of fire protection is selected);
- Treated water truckfill pumps rated for 1,250 L/min at 3.5 m (5 psi); and
- Two backwash pumps rated for 300 L/min at 21 m (30 psi), to be confirmed during detailed design.

8.7 Storage

Storage is recommended in any water system for several reasons:

- Optimize WTP design capacity to reduce capital costs;
- Provide sufficient volume to buffer against peak demand;
- Reduce stop/starts on equipment, which can impact equipment life;
- Provide contact time for virus disinfection;
- Support firefighting services; and
- Pressure management in distribution systems (not applicable to trucked systems such as Whale Cove).

Design guidelines generally recommend one – two days of storage at average demand; significantly more storage can lead to issues with water mixing and stagnation. For trucked water systems, guidelines recommend a minimum truck fill capacity of 1,000 L/min, however 1,250 L/min is used for this project based on GN discussions.

8.7.1 Treated Water

The fire flow requirements for a trucked system from *Good Engineering Practice for Northern Water and Sewer Systems* recommends a minimum truckfill rate of 1,000 L/min. Where this flow cannot be achieved, a minimum storage capacity of 60,000 L is suggested.

To provide fire flow capabilities, and manage the normal filling of tanker trucks, Dillon has designed based on a truckfill rate of 1,250 L/min and a water storage capacity of 180,000 L, which satisfies a one day maximum consumption of 185,000 L and fire flow storage of 60,000 L. In order to meet GN preferences for the ability to provide a minimum fire flow at all times (including during plant maintenance), maintaining the existing intake for deployment of a high rate pump is recommended. The treated water storage tanks must be protected against freezing, and a common method is to provide insulation and heat tracing. Alternatively, the raw water pumps could be sized with the ability to ramp up to 1,250 L/min and the treatment system bypassed, as is done in the NWT.

If the raw water pumps do not have the ability to increase flow to 1,250 L/min, there is a relatively small risk if consecutive days of maximum peak demand (e.g., 14-15 trucks per day) are experienced in addition to a fire scenario. This scenario would exceed the daily capacity of the treatment plant,

requiring a temporary halt in trucked water deliveries until a fire was extinguished and the storage tank had sufficient time to refill. However, this is unlikely as the Hamlet has reported that typically no more than one fire is experienced per year. The option of maintaining the existing intake for temporary deployment of a high rate pump that would produce chlorinated water but bypass the treatment system direct to truck fill would cover this unlikely scenario, although a temporary boil water advisory would be required. However, the risk of this scenario occurring is extremely low.

8.7.2 Backwash Waste

The backwash system should provide sufficient storage for 3-4 days of filter backwash waste, estimated at approximately 20,000 L. An insulated and heat traced steel bolted tank with cone bottom, located outside the treatment building is recommended to provide waste storage capacity for the year 2041. Once the waste tank is full, the contents will need to be hauled by the Hamlet to the community lagoon. An alternative to an external backwash tank is increasing the building footprint and incorporating the tank inside; this should be considered during the next stage of the project.

8.8 Procurement

There are three common procurement alternatives available to the Hamlet and GN for the new WTP:

- Design, Bid, Build;
- Design, Pre-purchase, Bid, Build; and
- Design, Build.

A summary of the different advantages and disadvantages is presented in **Table 8-2**, including risk mitigation measures for each of the procurement alternatives.

Table 8-2 – Procurement Method Comparison

	Advantages	Disadvantages	Risk Mitigation
Design, Bid, Build	• Owner has more control of design and specs during design phase • Opportunity for community input during design process • Simpler to define construction vs. design costs • Contractors can be local, design-build require skilled Contractors not usually available in Northern Canada • Impact of change orders reduced if made in design phase	• Owner responsible for changes not explicitly stated in tender • Costs may be higher compared to design-build by missed construction efficiencies • Typically longer project schedule since construction can't occur till after design and tender • Owner exposed to design phase change orders for scope changes	• Provide thorough review of tender documents (Owner and Consultant) • Onsite presence of Owner's representative during construction and commissioning

	Advantages	Disadvantages	Risk Mitigation
Design, Prepurchase, Bid, Build	- Process equipment purchased under separate contract by Owner - Accelerated schedule by purchasing equipment during design phase and reduced risk of delayed construction - Owner has more control over equipment and building quality compared to design-build - Increased chances of attracting local Contractor - Equipment inspections can occur in south, reducing travel and inspection costs - Owner/Community input throughout design process	- Engineering costs could be higher due to multiple contracts - Owner's team responsible for shipping logistics, insurance and other coordination - Owner may be responsible for delays or issues with equipment delivery - Clear definition of responsibility required between Contactor and equipment Contractor - For equipment warranties, Owner may have to coordinate with both manufacturer and Contractor to determine fault and liability	- Details and specs regarding limits of work need to be clearly communicated - Prioritization or pre-purchase contract critical to maintain schedule for sea lift - Insurance and risk associated with shipping, storage, loading, on-site transport to be clearly defined and understood by bidders - Review of draft tender documents by experienced construction inspector or Contractor.
Design, Build	- Schedule is expedited compared to design-bid-build, construction can start earlier - Owner has better control of construction costs - More risk placed on Contractor - Owner has one point of contact during design and construction - Owner transfers management of detailed design effort to Contractor	- Owner gives up degree of control - Owner's project manager needs specific knowledge and experience related to design-build projects - Requires experienced Contractor with high degree of skill delivering water treatment projects in Northern Canada - Contractors incentivized to find omissions in contract documents to leverage change orders - Owner needs to hire Owner's Engineer and onsite inspector	- Clearly specify and detail design build scope or work and performance requirements - Implement senior project lead on the Owner's side - Review draft tender documents by an experienced construction inspector or Contractor

Based on the advantages and disadvantages of each procurement alternative, it is recommended to implement a design-pre-purchase-bid-build approach for this project. This option provides less risk than the design-build approach by providing the Owner with greater control over the purchase of water treatment equipment and the design process.

8.9 Source Water Protection

A Water Source Protection Plan should be put in place to protect the Fish Lake water source including the following attributes:

- Boundaries of the supply area;
- Identification of potential threats to water supply; and
- Recommended methods to protect the water supply.

From Amec's 2016 report *Whale Cove Water Supply Analysis and Recommendations*, the boundaries of the water supply area is estimated to be 213 ha around Fish Lake. The lake is located less than 3 km north of the town site and approximately 4 km south of the airport. Water supply to the lake is replenished during spring melt and rain events that impact the immediate area of the water body, the outlet of Fish Lake is controlled by a naturally occurring rock weir. The existing WTP and access road is located on the west end of the lake. The land use north, south and east of the water supply is uninhabited and undeveloped.

The potential threats to the water supply include:

- Illegal dumping;
- Hazardous materials spill;
- Natural disasters (i.e., lightning, forest fires, flooding, extreme weather)
- Construction activities;
- Vandalism;
- Leakage/failure/spills from above ground storage tanks;
- Vehicle traffic on access road and ice; and
- Waste storage systems.

Recommended methods to protect the water supply include:

- Draft emergency response plans to enable Hamlet Staff to prepare for and react to foreseeable emergency incidents that may threaten the water supply. These plans should be available for viewing and updated on an annual basis;
- Provide education to residents to protect the water supply. This can be done by posting water supply boundary signs and/or fencing near Fish Lake, providing letters to residents in the Hamlet and posting notices at local businesses and town sites:
 - Signs can be placed near the water supply area at the intersection with transportation corridors. The signs indicate the boundary of the water supply area and provide emergency contact information should a person witness an incident that may threaten the water supply; and
 - Letters can be sent to residents with reminders that precautions should be taken to protect the water supply if within the Fish Lake boundary area.

8.10 Monitoring

Regular monitoring should occur to identify any potential contamination risks to the water supply, including the following:

- Update of the Source Water Protection Plan on an annual basis. The Plan should be reviewed by members of the Hamlet and GN Staff each year;
- Raw water samples should be taken at regular intervals each year to monitor general chemistry and bacteriological levels in Fish Lake, as well as pesticides;
- Treated water samples should be taken at the plant, in each truck and at various cisterns from the community on a regular basis to ensure drinking water meets regulatory requirements;
- Perform regular inspection and replacement of chemical and fuel storage tanks located in the source water supply area. These tanks should be monitored for spills or leaks that may potentially contaminate the water supply; and
- Monitor area near transportation corridor and WTP for illegal dumping.

8.11 Risk

There are three potential risks to the water source identified below:

- High dissolved organics leading to disinfection by-products;
- Detection of blue-green algae (cyanobacteria); and
- Detection of coliforms in raw water.

DBPs are caused by the presence of organic matter in the raw water, and are a particular concern for surface water sources. DBPs are divided into two groups of chlorinated compounds: trihalomethanes (THM) and haloacetic acids (HAA). The current health guidelines for Total THMs and HAAs is 0.1 mg/L and 0.080 mg/L, respectively. HAAs are not currently monitored at Whale Cove, but THMs are currently exceeded in the treated water and overnight water truck samples. A standard practice to reduce DBP formation is reducing DOC in the water upstream of chlorination. The use of membrane filtration and optimized coagulation will address DBP formation potential in most situations.

The detection of algae in Fish Lake, with the associated risk of blue-green algae (cyanobacteria) and toxic microcystins, is a risk that should also be addressed. Future levels of algae may increase with climate change, as is currently experienced in southern regions of Canada, partly due to suspected increased organics reaching surface water in runoff caused by higher intensity rainfall events. A properly designed multi-barrier water treatment process is an effective method for the control of algae, and to reduce the risk of microcystins entering the potable water supply.

Coliforms have been identified as a risk to the water source. While previous reports concluded that it was not likely a result of animal or human sources (which would indicate fecal contamination), they relied on a small snapshot of water quality data, that may not reflect the complete risk of faecal coliforms entering the water supply at different periods. Other local alternative water sources that were

evaluated showed presence of fecal coliforms, likely from runoff of wildlife feces, and it cannot be stated with certainty that Fish Lake is not exposed to similar risks over a longer period compared to the study timeline. Due to this undetermined risk, both present and future, Dillon proposes that all coliforms should be removed with a suitable treatment process to satisfy Canadian drinking water quality guidelines. A multi-barrier approach with filtration is recommended by Health Canada when coliforms are present, encompassing source water protection and adequate treatment. A combination of disinfection treatment through UV and chlorination will complement the filtration process to inactivate coliforms.

Appendix A

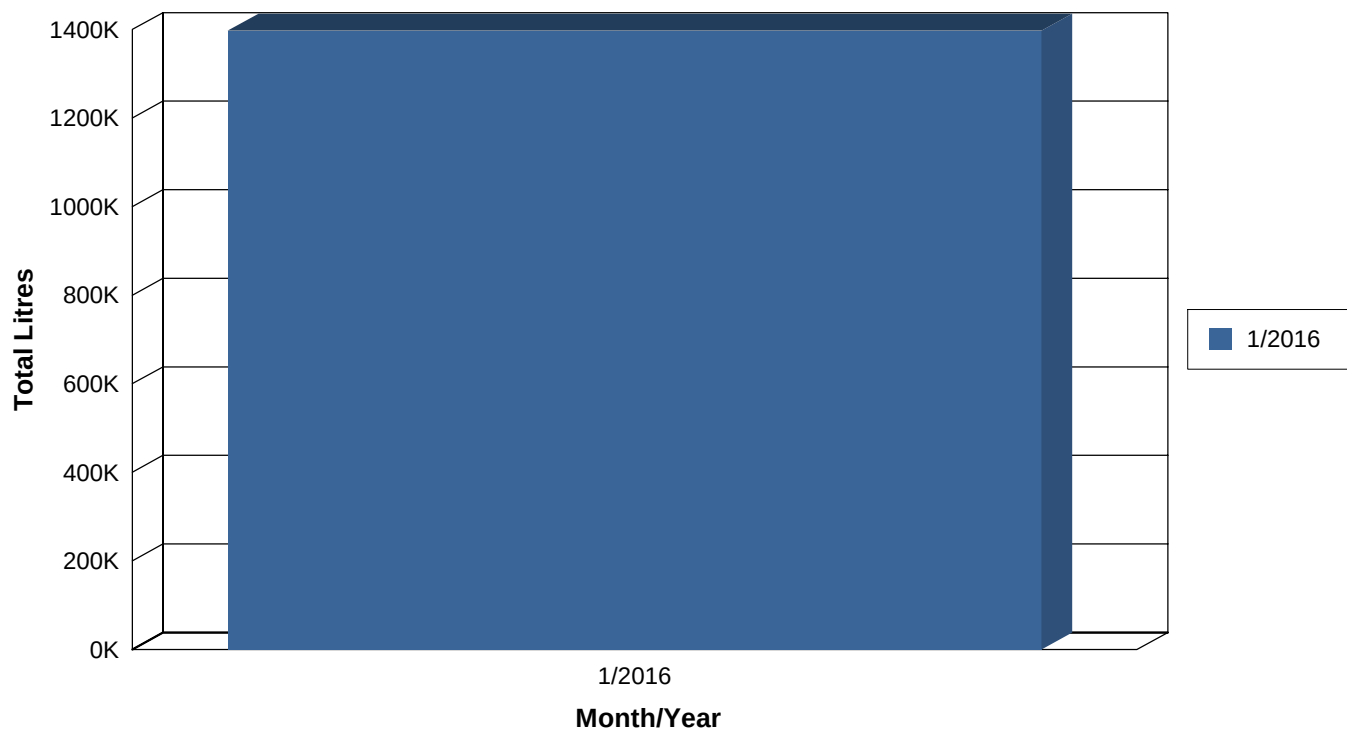
Historical Water Consumption Data

Delivery Summary By Month and Year

Printed on: Jan 31 2017 @ 10:59:31AM

Page: 1 of 1

Date Range From:Jan-01-2016 To: Jan-31-2016



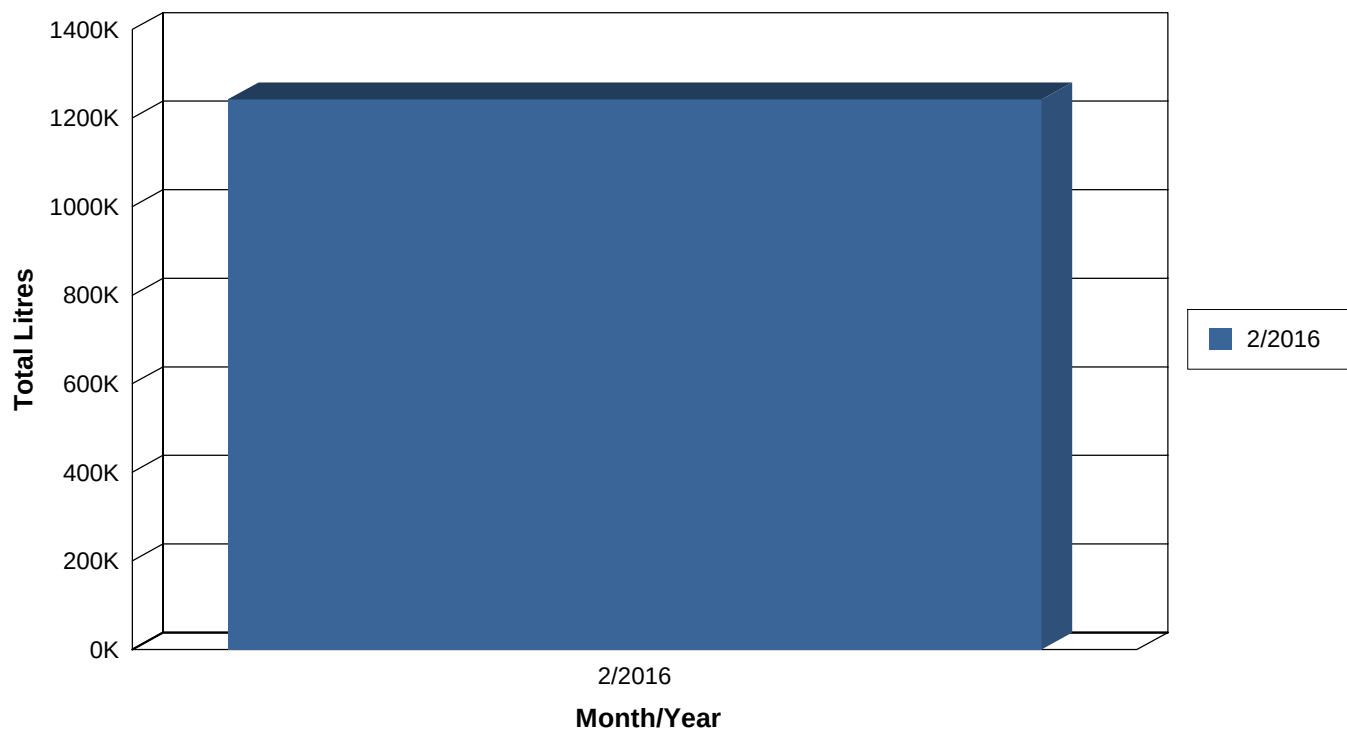
<u>Month / Year</u>	<u>Litres Delivered</u>
January 2016	1,397,510.00
Grand Total:	1,397,510.00

Delivery Summary By Month and Year

Printed on: Jan 31 2017 @ 11:00:35AM

Page: 1 of 1

Date Range From:Feb-01-2016 To: Feb-29-2016



Month / Year

Litres Delivered

February 2016

1,241,743.70

Grand Total:

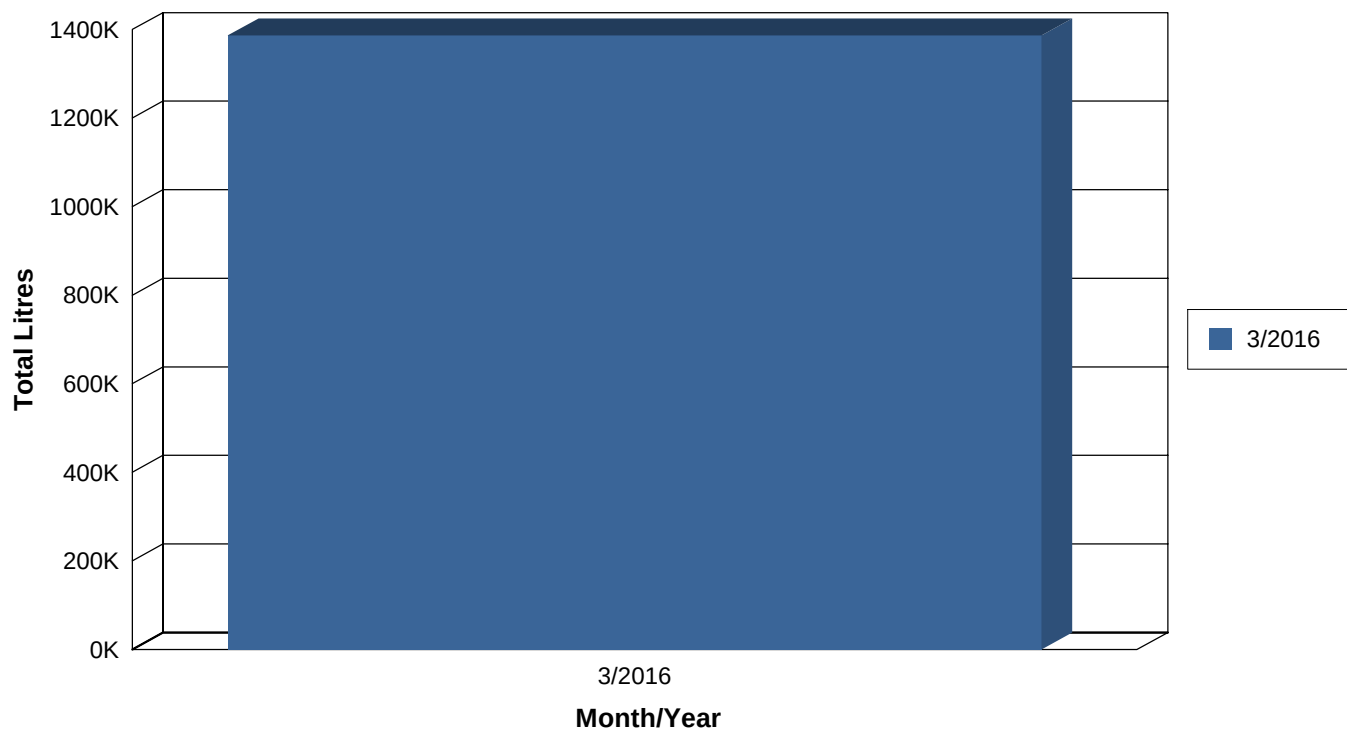
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Delivery Summary By Month and Year

Printed on: Jan 31 2017 @ 11:01:03AM

Page: 1 of 1

Date Range From:Mar-01-2016 To: Mar-31-2016



Month / Year

Litres Delivered

March 2016

1,386,385.80

Grand Total:

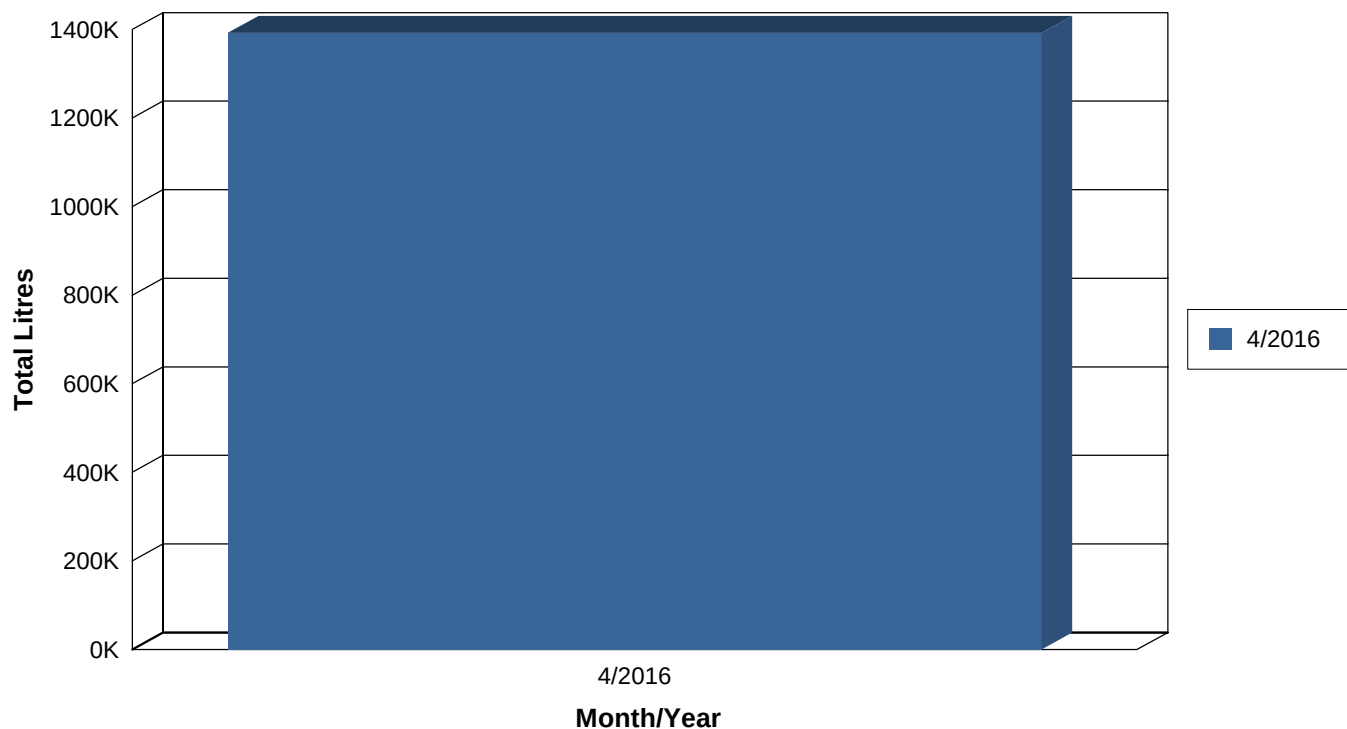
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Delivery Summary By Month and Year

Printed on: Jan 31 2017 @ 11:01:27AM

Page: 1 of 1

Date Range From:Apr-01-2016 To: Apr-30-2016



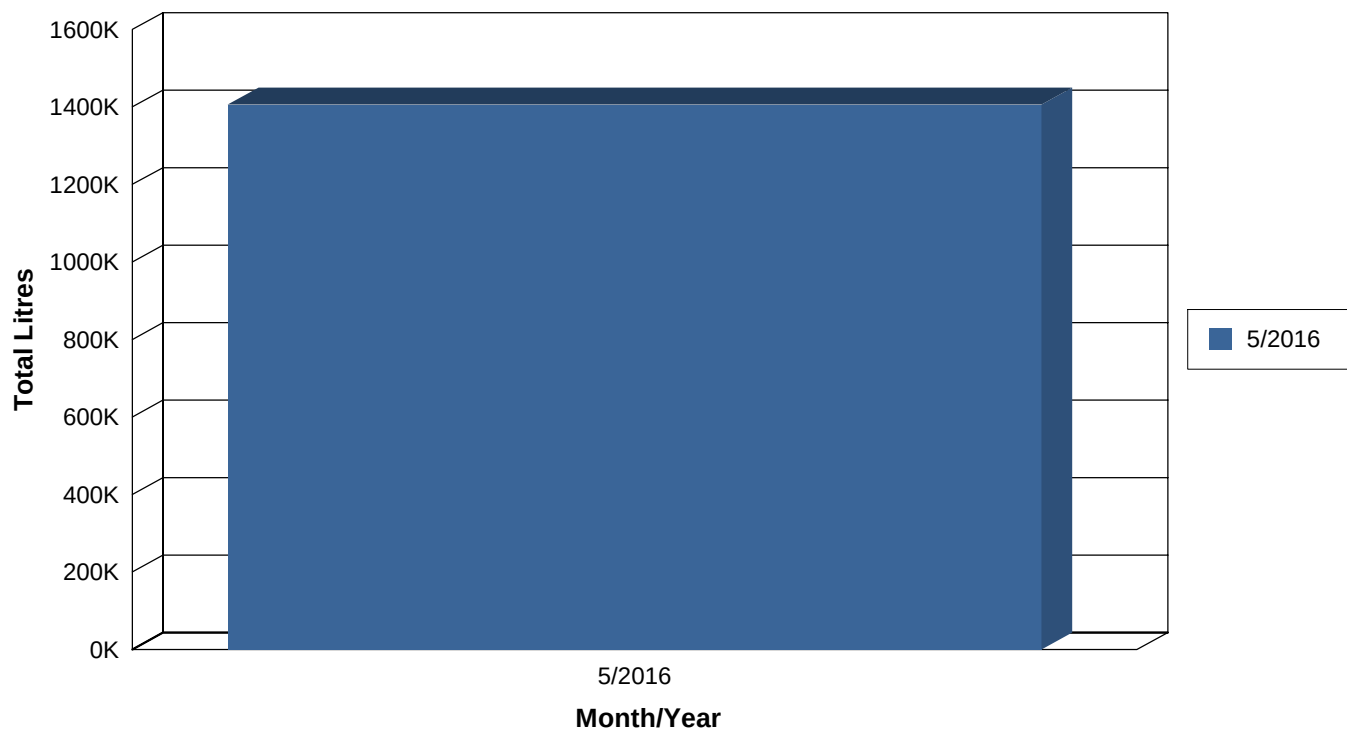
<u>Month / Year</u>	<u>Litres Delivered</u>
April 2016	1,392,461.20
Grand Total:	1,392,461.20

Delivery Summary By Month and Year

Printed on: Jan 31 2017 @ 11:01:58AM

Page: 1 of 1

Date Range From:May-01-2016 To: May-31-2016



Month / Year

Litres Delivered

May 2016

1,406,025.50

Grand Total:

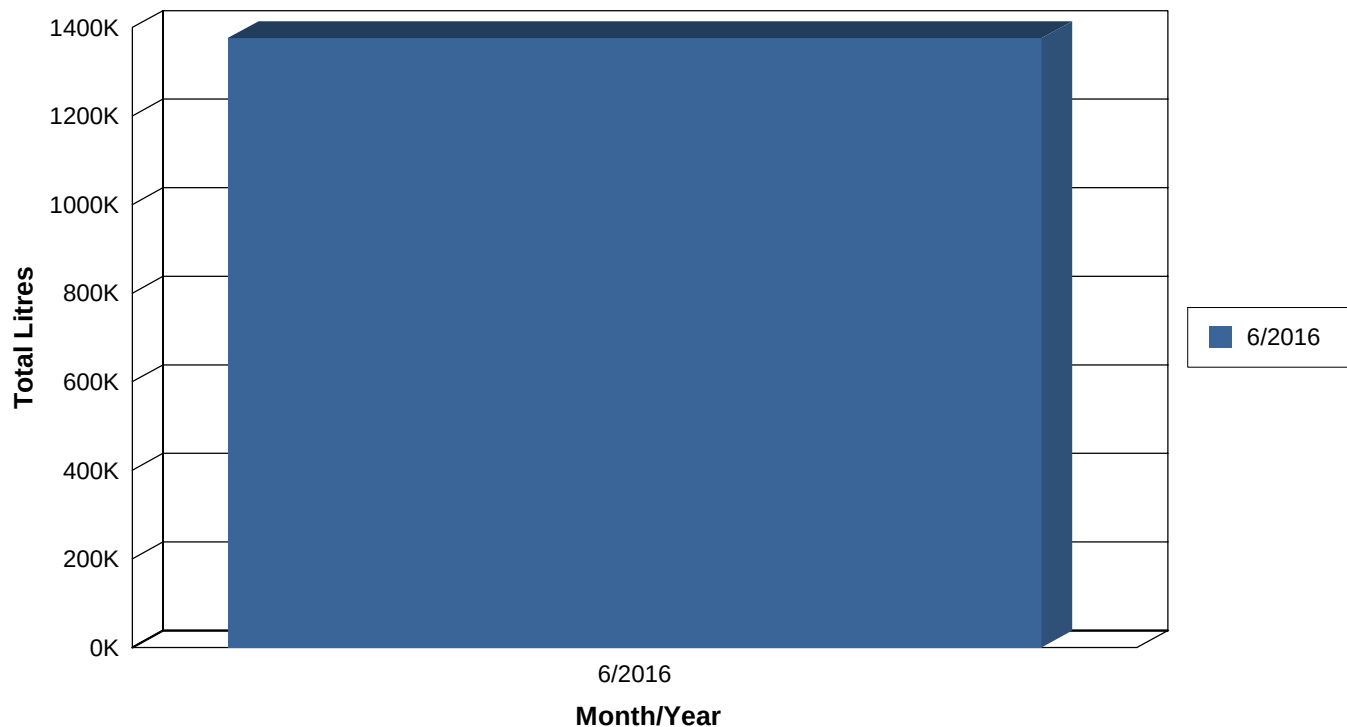
1,406,025.50

Delivery Summary By Month and Year

Printed on: Jan 31 2017 @ 11:02:23AM

Page: 1 of 1

Date Range From:Jun-01-2016 To: Jun-30-2016



Month / Year

Litres Delivered

June 2016

1,375,662.80

Grand Total:

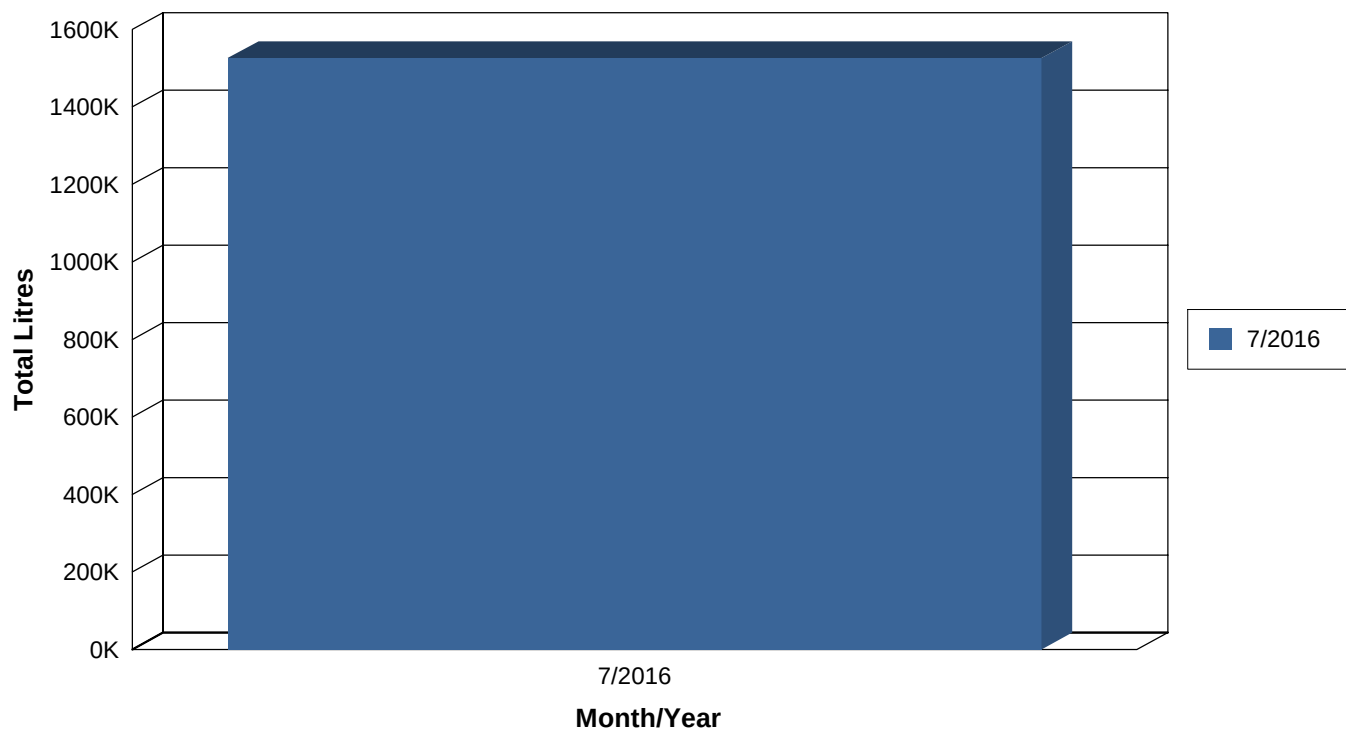
1,375,662.80

Delivery Summary By Month and Year

Printed on: Jan 31 2017 @ 11:02:47AM

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Date Range From:Jul-01-2016 To: Jul-31-2016



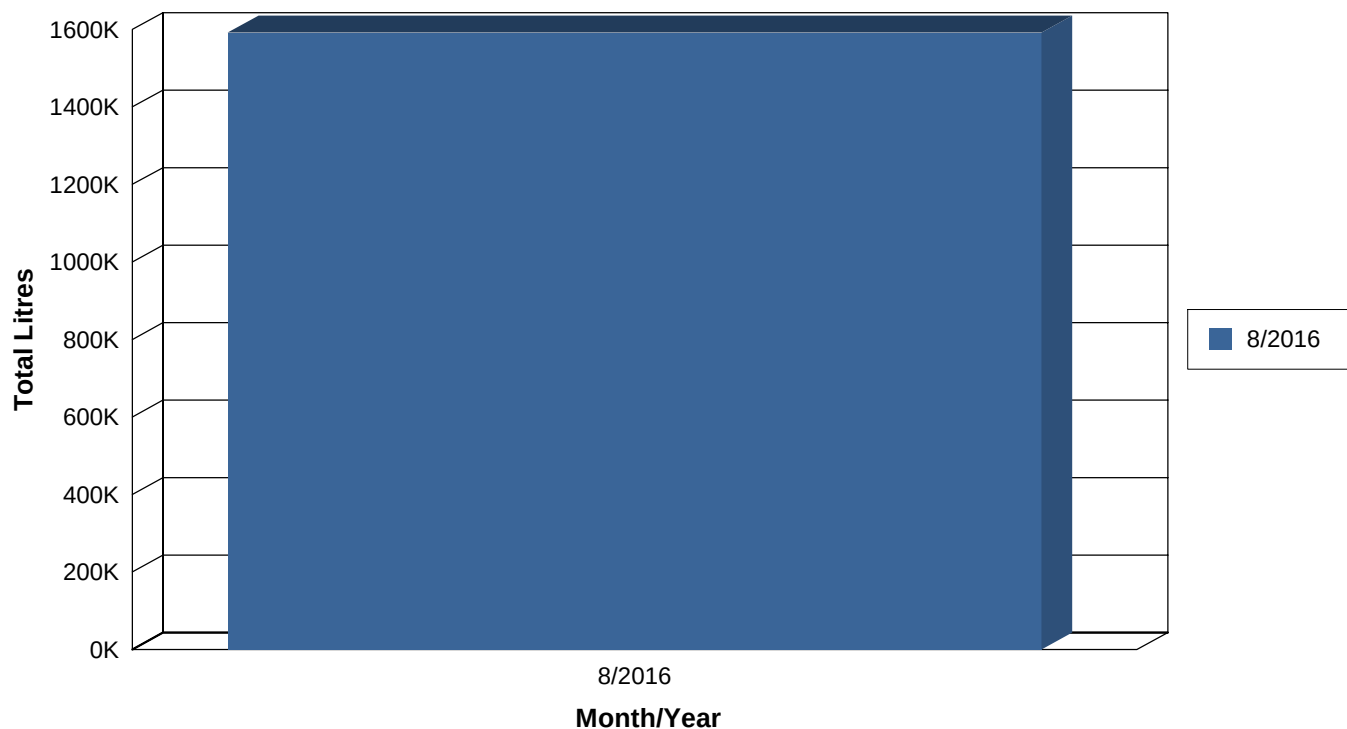
<u>Month / Year</u>	<u>Litres Delivered</u>
July 2016	1,525,870.80
Grand Total:	1,525,870.80

Delivery Summary By Month and Year

Printed on: Jan 31 2017 @ 11:03:10AM

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Date Range From:Aug-01-2016 To: Aug-31-2016



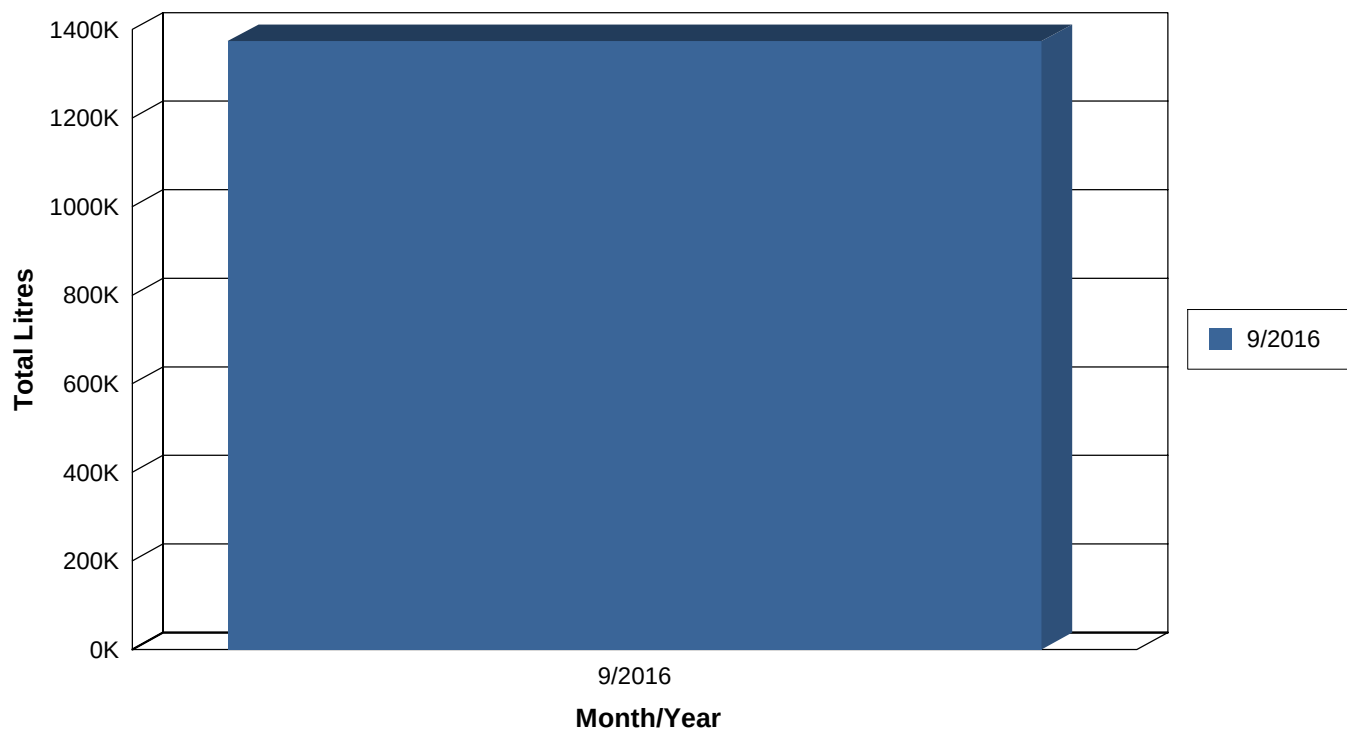
<u>Month / Year</u>	<u>Litres Delivered</u>
August 2016	1,592,404.50
Grand Total:	1,592,404.50

Delivery Summary By Month and Year

Printed on: Jan 31 2017 @ 11:03:36AM

Page: 1 of 1

Date Range From: Sep-01-2016 To: Sep-30-2016



Month / Year

Litres Delivered

September 2016

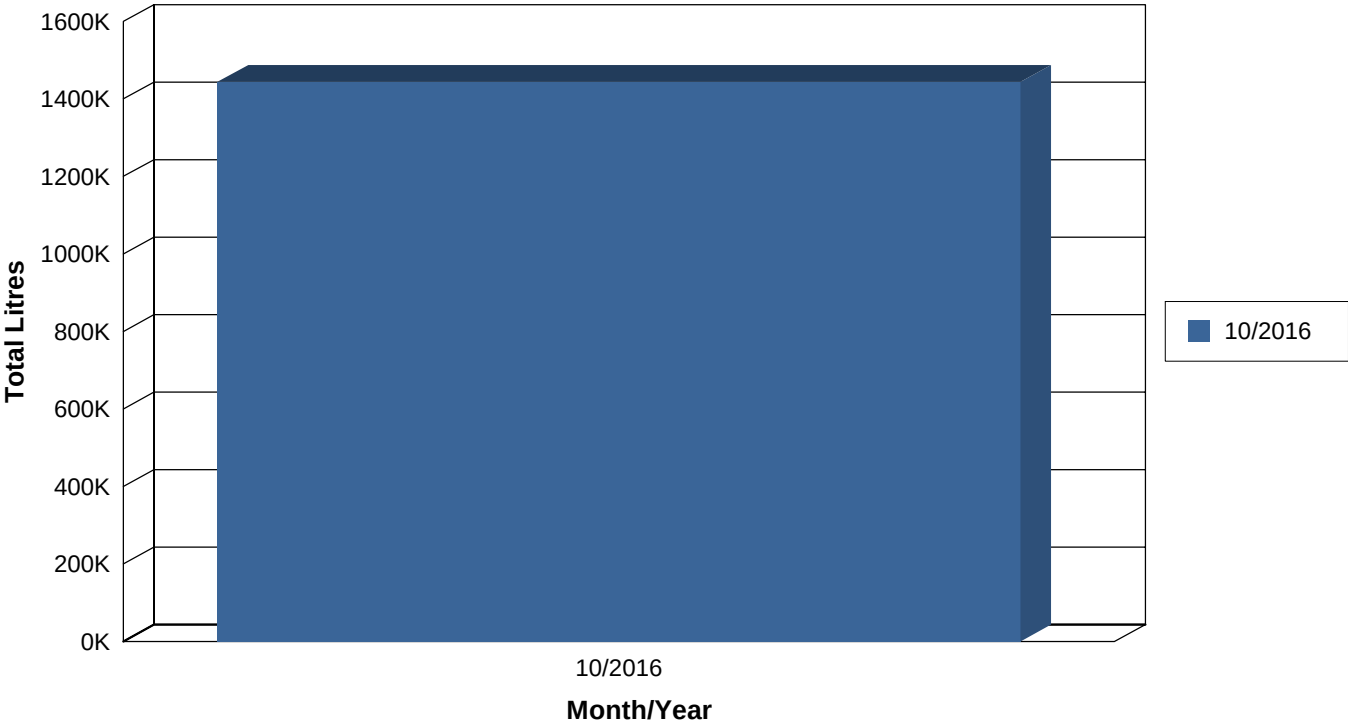
1,373,361.70

Grand Total:

1,373,361.70

Delivery Summary By Month and Year

Date Range From:Oct-01-2016 To: Oct-31-2016



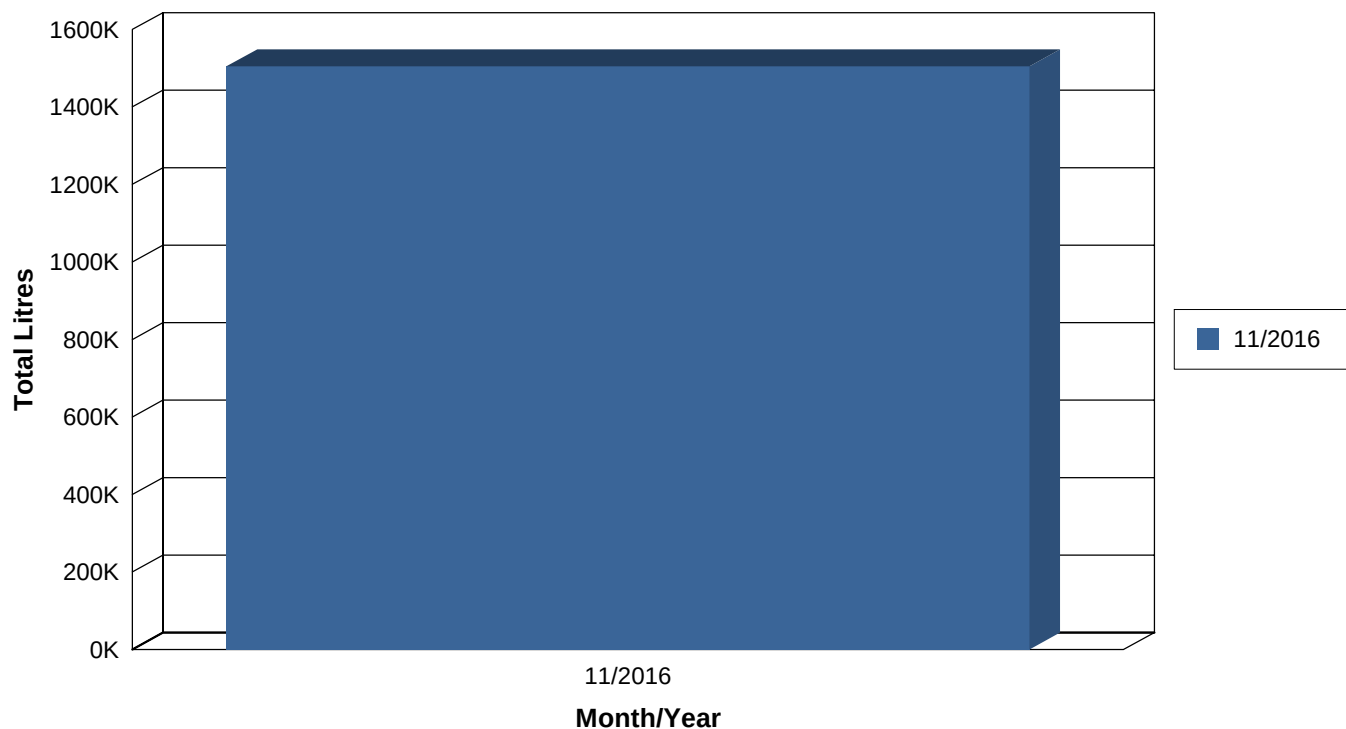
<u>Month / Year</u>	<u>Litres Delivered</u>
October 2016	1,443,940.30
Grand Total:	1,443,940.30

Delivery Summary By Month and Year

Printed on: Jan 31 2017 @ 11:04:24AM

Page: 1 of 1

Date Range From:Nov-01-2016 To: Nov-30-2016



Month / Year

Litres Delivered

November 2016

1,504,876.60

Grand Total:

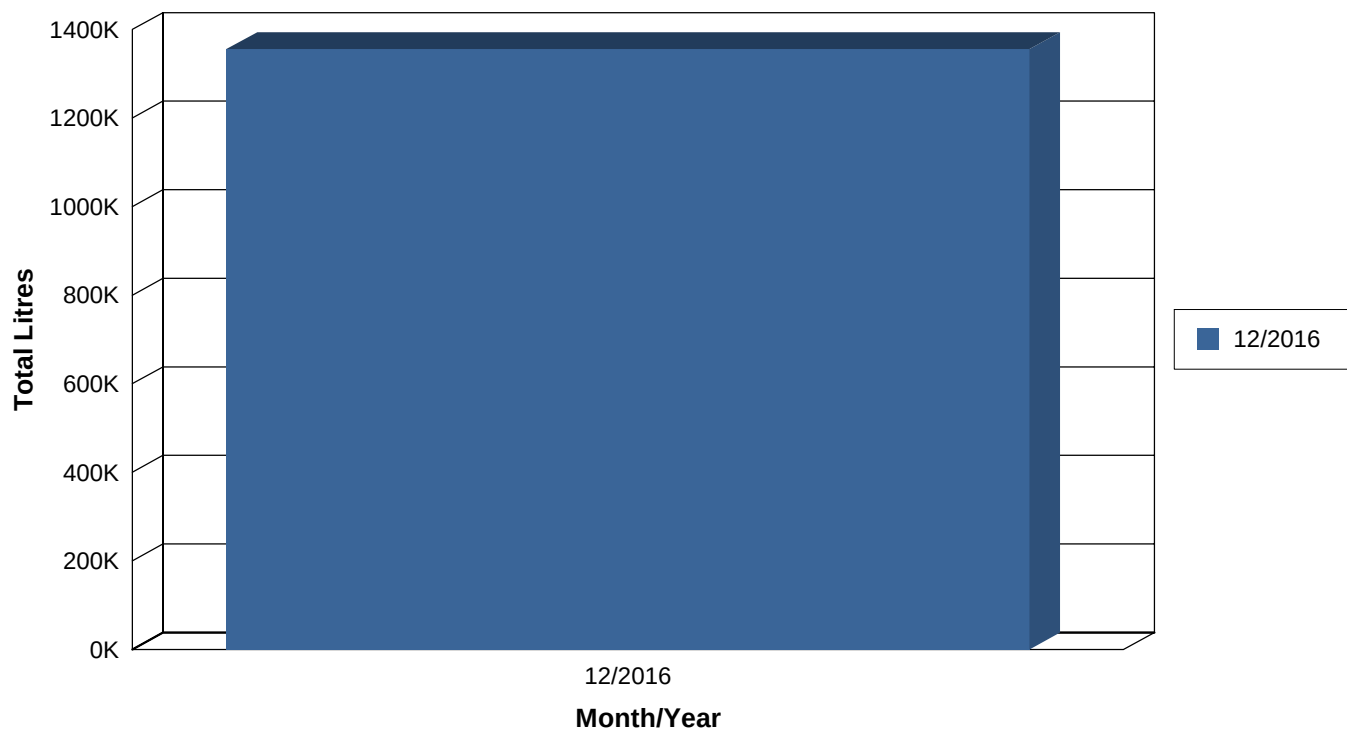
1,504,876.60

Delivery Summary By Month and Year

Printed on: Jan 31 2017 @ 11:04:48AM

Page: 1 of 1

Date Range From:Dec-01-2016 To: Dec-31-2016



<u>Month / Year</u>	<u>Litres Delivered</u>
December 2016	1,355,931.10
Grand Total:	1,355,931.10

ANNUAL REPORT FOR THE HAMLET OF WHALE COVE

YEAR BEING REPORTED: 2017

The following information is compiled pursuant to the requirements of Part B, Item 1 of Water License # 3BM-WHA1520 issued to the Hamlet of Whale Cove.

- i) - iii) tabular summaries of all data generated under the "Monitoring Program"; monthly and annual quantities in cubic metres of freshwater obtained from all sources; monthly and annual quantities in cubic metres of each and all wastes discharged;

Attached are quantities of water used as reported in our On Tap Water Delivery System and the estimated discharge of sewage waste based on quantities used.

Month Reported	Quantity of Water Obtained from all sources (litres)	Quantity of Sewage Waste Discharged (Estimated)
January	1,517,400	Same
February	1,424,200	Same
March	1,360,000	Same
April	1,717,500	Same
May	1,669,100	Same
June	1,778,700	Same
July	1,450,500	Same
August	1,389,200	Same
September	1,355,600	Same
October	1,740,400	Same
November	1,430,300	Same
December	1,852,500	Same
ANNUAL TOTAL	18,685,400	Same

Note: There is no meter existing at the Sewage discharge pipe. Therefore the monthly discharge volume is considered as equal to the monthly water consumption volume.

Appendix B

Historic Water Quality Data

TABLE B1: WATER CHEMISTRY DATA FROM 2015-2019

Parameter	Concentration				Unit	CDWQG Limits	
	Min	Max	Avg ¹	# of Samples		(MAC)	(AO)
Colour, True	<5.0	14.3	9.9	8	CU	-	≤15
Conductivity	246	500	357	8	umhos/cm	-	-
Hardness	66.4	120	93.0	8	mg/L	-	-
Langelier Index (4°C)	-1.08	-0.44	-0.73	8	Unitless	-	-
Langelier Index (60°C)	-0.093	0.33	0.084	7	Unitless	-	-
pH	7.32	8.2	7.72	8	pH units	-	7.0-10.5
TDS	120	269	205	8	mg/L	-	≤500
Transmittance, UV	74.1	80.7	78.0	7	%T	-	-
Turbidity	0.47	1.3	0.820	8	NTU	-	0.3¹
Alkalinity (CaCO ₃)	54.3	95	74.5	8	mg/L	-	-
Ammonia (N)	<0.01	0.067	0.019	7	mg/L	-	-
Bicarbonate (HCO ₃)	66.2	120	89.2	7	mg/L	-	-
Bromide (Br)	<0.1	0.235	0.164	7	mg/L	-	-
Carbonate (CO ₃)	<0.6		0	7	mg/L	-	-
Chloride (Cl)	38	88	60.3	8	mg/L	-	≤250
Fluoride (F)	0.031	0.15	0.057	8	mg/L	-	-
Hydroxide (OH)	<0.34		0	7	mg/L	-	-
Nitrate (N)	<0.005	0.056	0.012	8	mg/L	-	-
Nitrite (N)	<0.001	0.0011	0.000	7	mg/L	3	-
Sulfate (SO ₄)	8.47	17.6	12.79	8	mg/L	-	≤500
Dissolved Inorganic Carbon	10.5		10.5	1	mg/L	-	-
Dissolved Organic Carbon	3.4	5.54	4.36	8	mg/L	-	-
Total Carbon	13.9		13.9	1	mg/L	-	-
Total Inorganic Carbon	10.7		10.7	1	mg/L	-	-
Total Organic Carbon	3.3	5.26	4.54	7	mg/L	-	-
E. coli	9	7700	1403.82	83	MPN/100mL	0	-
Total Coliforms	0	10	0.19	83	MPN/100mL	0	-
Aluminum (Al)	<0.005	0.006	0.0022	8	mg/L	<0.1	-
Antimony (Sb)	<0.0001		0	8	mg/L	0.006	-
Arsenic (As)	0.0003	0.00059	0.0004	8	mg/L	0.01	-
Barium (Ba)	0.018	0.0173	0.0111	8	mg/L	1	-
Beryllium (Be)	<0.0002		0	8	mg/L	-	-
Bismuth (Bi)	<0.0002		0	8	mg/L	-	-
Boron (B)	0.029	0.058	0.037	8	mg/L	5	-
Cadmium (Cd)	<0.00001	1.61E-05	2.59E-06	8	mg/L	0.005	-
Calcium (Ca)	20.2	35.5	24.7556	8	mg/L	-	-
Cesium (Cs)	<0.0001	0.000016	2.29E-06	7	mg/L	10	-
Chromium (Cr)	<0.001		0	8	mg/L	0.05	-
Cobalt (Co)	<0.0001		0	8	mg/L	-	-
Copper (Cu)	0.00208	0.083	0.011	8	mg/L	-	≤1.0
Iron (Fe)	0.025	0.11	0.047	8	mg/L	-	≤0.3
Lead (Pb)	<0.00005	0.000164	2.67E-05	8	mg/L	0.01	-
Lithium (Li)	<0.002	0.003	0.0009	8	mg/L	-	-

Magnesium (Mg)	3.89	7.52	4.90	8	mg/L	-	-
Manganese (Mn)	0.00359	0.011	0.0056	8	mg/L	-	≤0.05
Molybdenum (Mo)	0.00139	0.00215	0.0016	8	mg/L	-	-
Nickel (Ni)	<0.002	0.001	0.00028	8	mg/L	-	-
Phosphorous (P)	<0.05		0	7	mg/L	-	-
Potassium (K)	1.5	3.1	1.9911	8	mg/L	-	-
Rubidium (Rb)	0.00154	0.00286	0.0019	8	mg/L	-	-
Selenium (Se)	<0.001	0.000062	1.37E-05	8	mg/L	-	0.05
Silicon (Si)	0.19	1	0.56	7	mg/L	-	-
Silver (Ag)	<0.0001		0	8	mg/L	-	-
Sodium (Na)	23.5	51	30.9	8	mg/L	-	≤200
Strontium (Sr)	0.113	0.2	0.1383	8	mg/L	5	-
Tellurium (Te)	<0.0002		0	8	mg/L	-	-
Thallium (Tl)	<0.0001		0	8	mg/L	-	-
Thorium (Th)	<0.0001		0	7	mg/L	-	-
Tin (Sn)	<0.0002		0	8	mg/L	-	-
Titanium (Ti)	<0.0005		0.000225	7	mg/L	-	-
Tungsten (W)	<0.0001		0	7	mg/L	-	-
Uranium (U)	0.000084	0.00013	4.48E-05	8	mg/L	0.02	-
Vanadium (V)	<0.0002		0.00013	8	mg/L	-	-
Zinc (Zn)	<0.002	0.0272	0.0072	8	mg/L	-	≤5.0
Zirconium (Zr)	<0.00006		0	7	mg/L	-	-
Total Dissolved Carbon	13.9		13.9	1	mg/L	-	-
TREATED WATER							
Bromodichloromethane	0.00901	0.0829	0.0296	7	mg/L	0.016	-
Bromoform	0.00071	0.0033	0.0014	8	mg/L	-	-
Dibromochloromethane	0.00687	0.029	0.0138	8	mg/L	-	-
Chloroform	0.0191	0.0686	0.0348	8	mg/L	-	-
4-Bromofluorobenzene (SS)	87.9	98	93.9	7	%	-	-
1,4-Difluorobenzene (SS)	96.4	102.1	99.0	7	%	-	-
Total THMs	0.0363	0.129	0.0807	7	mg/L	0.1	-
Bromochloroacetic Acid	0.0078	0.0215	0.0141	7	mg/L	-	-
Dibromoacetic Acid	0.0024	0.0065	0.0041	8	mg/L	-	-
Dichloroacetic Acid	0.0112	0.0491	0.0209	8	mg/L	-	-
Total Haloacetic Acid	0.0214	0.131	0.0498	7	mg/L	0.08	-
Monobromoacetic Acid	0.0014	0.0014	0.0002	8	mg/L	-	-
Monochloroacetic Acid	<0.005		0	8	mg/L	-	-
Trichloroacetic Acid	0.0077	0.0755	0.0217	8	mg/L	-	-
2,3-Dibromopropionic Acid (SS)	85	117.7	104.9	7	%	-	-

¹Based on conventional and direct filtration

²Note: Water quality results equal to or below detection limit are considered equal to zero for the calculation of the average



Nunavut - Community & Government
Services - Rankin Inlet
ATTN: PAUL VOISEY
Box 96
Whale Cove NU X0C 0J0

Date Received: 25-JUL-15
Report Date: 11-AUG-15 18:56 (MT)
Version: FINAL

Client Phone: 867-896-9305

Certificate of Analysis

Lab Work Order #: L1648153
Project P.O. #: NOT SUBMITTED
Job Reference: WHALE COVE, NU
C of C Numbers:
Legal Site Desc:

Craig Biddell, B.Sc.Ag
Account Manager

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ADDRESS: 1329 Niakwa Road East, Unit 12, Winnipeg, MB R2J 3T4 Canada | Phone: +1 204 255 9720 | Fax: +1 204 255 9721
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ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1648153-1 WHALE COVE PUMPHOUSE - TREATED								
Sampled By: PAUL VOISEY / MEGAN on 23-JUL-15 @ 11:45								
Matrix:								
Carbons								
Total Carbon								
Total Carbon		14.3		1.0	mg/L		10-AUG-15	R3244072
Total Inorganic Carbon								
Total Inorganic Carbon		10.9		1.0	mg/L		10-AUG-15	R3244072
Miscellaneous Parameters								
Carbon,Dissolved Inorganic								
Carbon,Dissolved Inorganic		10.6		1.0	mg/L		10-AUG-15	R3244072
Total Dissolved Carbon								
Total Dissolved Carbon		14.3		1.0	mg/L		10-AUG-15	R3244072
MB Chemistry for PWS								
% Transmittance by Spectrometry								
Transmittance, UV (254 nm)		84.5		1.0	% T		25-JUL-15	R3235322
Alkalinity, Bicarbonate								
Bicarbonate (HCO3)		66.6		1.2	mg/L		08-AUG-15	
Alkalinity, Carbonate								
Carbonate (CO3)		<0.60		0.60	mg/L		08-AUG-15	
Alkalinity, Hydroxide								
Hydroxide (OH)		<0.34		0.34	mg/L		08-AUG-15	
Ammonia by colour								
Ammonia, Total (as N)		<0.010		0.010	mg/L		27-JUL-15	R3233991
Bromide in Water by IC								
Bromide (Br)		<0.10		0.10	mg/L		25-JUL-15	R3233267
Chloride in Water by IC (Low Level)								
Chloride (Cl)		39.1		0.10	mg/L		25-JUL-15	R3233267
Colour, True								
Colour, True		6.0		5.0	CU		25-JUL-15	R3232968
Conductivity								
Conductivity		249		1.0	umhos/cm		06-AUG-15	R3242540
Fluoride in Water by IC								
Fluoride (F)		0.033		0.020	mg/L		25-JUL-15	R3233267
Hardness Calculated								
Hardness (as CaCO3)		68.1		0.30	mg/L		30-JUL-15	
Langelier Index 4C								
Langelier Index (4 C)		-0.56					08-AUG-15	
Langelier Index 60C								
Langelier Index (60 C)		0.21					08-AUG-15	
Nitrate in Water by IC (Low Level)								
Nitrate (as N)		<0.0050		0.0050	mg/L		25-JUL-15	R3233267
Nitrite in Water by IC (Low Level)								
Nitrite (as N)		<0.0010		0.0010	mg/L		25-JUL-15	R3233267
Sulfate in Water by IC								
Sulfate (SO4)		8.89		0.30	mg/L		25-JUL-15	R3233267
Total Alkalinity as CaCO3								
Alkalinity, Total (as CaCO3)		54.6		1.0	mg/L		06-AUG-15	R3242540
Total Dissolved Solids (TDS)								
Total Dissolved Solids		117		6.0	mg/L		30-JUL-15	R3240867
Total Metals by ICP-MS								
Aluminum (Al)-Total		0.0143		0.0050	mg/L	29-JUL-15	29-JUL-15	R3235173
Antimony (Sb)-Total		<0.00020		0.00020	mg/L	29-JUL-15	29-JUL-15	R3235173
Arsenic (As)-Total		0.00031		0.00020	mg/L	29-JUL-15	29-JUL-15	R3235173
Barium (Ba)-Total		0.00876		0.00020	mg/L	29-JUL-15	29-JUL-15	R3235173
Beryllium (Be)-Total		<0.00020		0.00020	mg/L	29-JUL-15	29-JUL-15	R3235173

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1648153-1 WHALE COVE PUMPHOUSE - TREATED							
Sampled By: PAUL VOISEY / MEGAN on 23-JUL-15 @ 11:45							
Matrix:							
Total Metals by ICP-MS							
Bismuth (Bi)-Total	<0.00020		0.00020	mg/L	29-JUL-15	29-JUL-15	R3235173
Boron (B)-Total	0.035		0.010	mg/L	29-JUL-15	29-JUL-15	R3235173
Cadmium (Cd)-Total	<0.000010		0.000010	mg/L	29-JUL-15	29-JUL-15	R3235173
Calcium (Ca)-Total	20.9		0.10	mg/L	29-JUL-15	29-JUL-15	R3235173
Cesium (Cs)-Total	<0.00010		0.00010	mg/L	29-JUL-15	29-JUL-15	R3235173
Chromium (Cr)-Total	<0.0010		0.0010	mg/L	29-JUL-15	29-JUL-15	R3235173
Cobalt (Co)-Total	<0.00020		0.00020	mg/L	29-JUL-15	29-JUL-15	R3235173
Copper (Cu)-Total	0.00480		0.00020	mg/L	29-JUL-15	29-JUL-15	R3235173
Iron (Fe)-Total	<0.10		0.10	mg/L	29-JUL-15	29-JUL-15	R3235173
Lead (Pb)-Total	0.000160		0.000090	mg/L	29-JUL-15	29-JUL-15	R3235173
Lithium (Li)-Total	<0.0020		0.0020	mg/L	29-JUL-15	29-JUL-15	R3235173
Magnesium (Mg)-Total	3.89		0.010	mg/L	29-JUL-15	29-JUL-15	R3235173
Manganese (Mn)-Total	0.00431		0.00030	mg/L	29-JUL-15	29-JUL-15	R3235173
Molybdenum (Mo)-Total	0.00151		0.00020	mg/L	29-JUL-15	29-JUL-15	R3235173
Nickel (Ni)-Total	<0.0020		0.0020	mg/L	29-JUL-15	29-JUL-15	R3235173
Phosphorus (P)-Total	<0.10		0.10	mg/L	29-JUL-15	29-JUL-15	R3235173
Potassium (K)-Total	1.50		0.020	mg/L	29-JUL-15	29-JUL-15	R3235173
Rubidium (Rb)-Total	0.00161		0.00020	mg/L	29-JUL-15	29-JUL-15	R3235173
Selenium (Se)-Total	<0.0010		0.0010	mg/L	29-JUL-15	29-JUL-15	R3235173
Silicon (Si)-Total	0.17		0.10	mg/L	29-JUL-15	29-JUL-15	R3235173
Silver (Ag)-Total	<0.00010		0.00010	mg/L	29-JUL-15	29-JUL-15	R3235173
Sodium (Na)-Total	24.3		0.030	mg/L	29-JUL-15	29-JUL-15	R3235173
Strontium (Sr)-Total	0.114		0.00010	mg/L	29-JUL-15	29-JUL-15	R3235173
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	29-JUL-15	29-JUL-15	R3235173
Thallium (Tl)-Total	<0.00010		0.00010	mg/L	29-JUL-15	29-JUL-15	R3235173
Thorium (Th)-Total	<0.00010		0.00010	mg/L	29-JUL-15	29-JUL-15	R3235173
Tin (Sn)-Total	<0.00020		0.00020	mg/L	29-JUL-15	29-JUL-15	R3235173
Titanium (Ti)-Total	<0.00050		0.00050	mg/L	29-JUL-15	29-JUL-15	R3235173
Tungsten (W)-Total	<0.00010		0.00010	mg/L	29-JUL-15	29-JUL-15	R3235173
Uranium (U)-Total	<0.00010		0.00010	mg/L	29-JUL-15	29-JUL-15	R3235173
Vanadium (V)-Total	<0.00020		0.00020	mg/L	29-JUL-15	29-JUL-15	R3235173
Zinc (Zn)-Total	0.0045		0.0020	mg/L	29-JUL-15	29-JUL-15	R3235173
Zirconium (Zr)-Total	<0.00040		0.00040	mg/L	29-JUL-15	29-JUL-15	R3235173
Turbidity							
Turbidity	0.69		0.10	NTU		25-JUL-15	R3234090
pH							
pH	7.99		0.10	pH units		06-AUG-15	R3242540
Miscellaneous Parameters							
Dissolved Organic Carbon	3.5		1.0	mg/L		09-AUG-15	R3243219
Total Haloacetic Acids 5	0.0214		0.0054	mg/L		06-AUG-15	
Total Organic Carbon	3.4		1.0	mg/L		09-AUG-15	R3243219
Total Coliform and E.coli							
Total Coliforms	4		0	MPN/100mL		25-JUL-15	R3233294
Escherichia Coli	0		0	MPN/100mL		25-JUL-15	R3233294
Haloacetic Acids							
Monobromoacetic Acid	<0.0010		0.0010	mg/L		31-JUL-15	R3235806
Monochloroacetic Acid	<0.0050		0.0050	mg/L		31-JUL-15	R3235806
Bromochloroacetic Acid	0.0078		0.0010	mg/L		31-JUL-15	R3235806
Dibromoacetic Acid	0.0024		0.0010	mg/L		31-JUL-15	R3235806
Dichloroacetic Acid	0.0112		0.0010	mg/L		31-JUL-15	R3235806
Trichloroacetic Acid	0.0077		0.0010	mg/L		31-JUL-15	R3235806

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1648153-1 WHALE COVE PUMPHOUSE - TREATED								
Sampled By: PAUL VOISEY / MEGAN on 23-JUL-15 @ 11:45								
Matrix:								
Haloacetic Acids								
Surrogate: 2,3-Dibromopropionic Acid (SS)		115.2		50-130	%		31-JUL-15	R3235806
THM by headspace								
Total Trihalomethanes (THMs)								
Total THMs		0.0410		0.0010	mg/L		31-JUL-15	
VOC plus F1 by GCMS								
Bromodichloromethane		0.0115		0.00050	mg/L		30-JUL-15	R3236221
Bromoform		<0.00050		0.00050	mg/L		30-JUL-15	R3236221
Chloroform		0.0227		0.00050	mg/L		30-JUL-15	R3236221
Dibromochloromethane		0.00687		0.00050	mg/L		30-JUL-15	R3236221
Surrogate: 4-Bromofluorobenzene (SS)		95.0		70-130	%		30-JUL-15	R3236221
Surrogate: 1,4-Difluorobenzene (SS)		99.4		70-130	%		30-JUL-15	R3236221
L1648153-2 WHALE COVE PUMPHOUSE - RAW								
Sampled By: PAUL VOISEY / MEGAN on 23-JUL-15 @ 11:45								
Matrix:								
Carbons								
Total Carbon								
Total Carbon		13.9		1.0	mg/L		10-AUG-15	R3244072
Total Inorganic Carbon								
Total Inorganic Carbon		10.7		1.0	mg/L		10-AUG-15	R3244072
Miscellaneous Parameters								
Carbon,Dissolved Inorganic								
Carbon,Dissolved Inorganic		10.5		1.0	mg/L		10-AUG-15	R3244072
Total Dissolved Carbon								
Total Dissolved Carbon		13.9		1.0	mg/L		10-AUG-15	R3244072
MB Chemistry for PWS								
% Transmittance by Spectrometry								
Transmittance, UV (254 nm)		80.7		1.0	% T		25-JUL-15	R3235322
Alkalinity, Bicarbonate								
Bicarbonate (HCO3)		66.2		1.2	mg/L		08-AUG-15	
Alkalinity, Carbonate								
Carbonate (CO3)		<0.60		0.60	mg/L		08-AUG-15	
Alkalinity, Hydroxide								
Hydroxide (OH)		<0.34		0.34	mg/L		08-AUG-15	
Ammonia by colour								
Ammonia, Total (as N)		<0.010		0.010	mg/L		27-JUL-15	R3233991
Bromide in Water by IC								
Bromide (Br)		<0.10		0.10	mg/L		25-JUL-15	R3233267
Chloride in Water by IC (Low Level)								
Chloride (Cl)		38.0		0.10	mg/L		25-JUL-15	R3233267
Colour, True								
Colour, True		10.5		5.0	CU		25-JUL-15	R3232968
Conductivity								
Conductivity		246		1.0	umhos/cm		06-AUG-15	R3242540
Fluoride in Water by IC								
Fluoride (F)		0.031		0.020	mg/L		25-JUL-15	R3233267
Hardness Calculated								
Hardness (as CaCO3)		66.4		0.30	mg/L		30-JUL-15	
Langelier Index 4C								
Langelier Index (4 C)		-0.56					08-AUG-15	
Langelier Index 60C								
Langelier Index (60 C)		0.21					08-AUG-15	
Nitrate in Water by IC (Low Level)								

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1648153-2 WHALE COVE PUMPHOUSE - RAW Sampled By: PAUL VOISEY / MEGAN on 23-JUL-15 @ 11:45 Matrix:							
Nitrate in Water by IC (Low Level) Nitrate (as N)	<0.0050		0.0050	mg/L		25-JUL-15	R3233267
Nitrite in Water by IC (Low Level) Nitrite (as N)	<0.0010		0.0010	mg/L		25-JUL-15	R3233267
Sulfate in Water by IC Sulfate (SO4)	8.85		0.30	mg/L		25-JUL-15	R3233267
Total Alkalinity as CaCO3 Alkalinity, Total (as CaCO3)	54.3		1.0	mg/L		06-AUG-15	R3242540
Total Dissolved Solids (TDS) Total Dissolved Solids	120		6.0	mg/L		30-JUL-15	R3240867
Total Metals by ICP-MS							
Aluminum (Al)-Total	<0.0050		0.0050	mg/L	29-JUL-15	29-JUL-15	R3235173
Antimony (Sb)-Total	<0.00020		0.00020	mg/L	29-JUL-15	29-JUL-15	R3235173
Arsenic (As)-Total	0.00030		0.00020	mg/L	29-JUL-15	29-JUL-15	R3235173
Barium (Ba)-Total	0.00842		0.00020	mg/L	29-JUL-15	29-JUL-15	R3235173
Beryllium (Be)-Total	<0.00020		0.00020	mg/L	29-JUL-15	29-JUL-15	R3235173
Bismuth (Bi)-Total	<0.00020		0.00020	mg/L	29-JUL-15	29-JUL-15	R3235173
Boron (B)-Total	0.029		0.010	mg/L	29-JUL-15	29-JUL-15	R3235173
Cadmium (Cd)-Total	<0.000010		0.000010	mg/L	29-JUL-15	29-JUL-15	R3235173
Calcium (Ca)-Total	20.2		0.10	mg/L	29-JUL-15	29-JUL-15	R3235173
Cesium (Cs)-Total	<0.00010		0.00010	mg/L	29-JUL-15	29-JUL-15	R3235173
Chromium (Cr)-Total	<0.0010		0.0010	mg/L	29-JUL-15	29-JUL-15	R3235173
Cobalt (Co)-Total	<0.00020		0.00020	mg/L	29-JUL-15	29-JUL-15	R3235173
Copper (Cu)-Total	0.00208		0.00020	mg/L	29-JUL-15	29-JUL-15	R3235173
Iron (Fe)-Total	<0.10		0.10	mg/L	29-JUL-15	29-JUL-15	R3235173
Lead (Pb)-Total	<0.000090		0.000090	mg/L	29-JUL-15	29-JUL-15	R3235173
Lithium (Li)-Total	<0.0020		0.0020	mg/L	29-JUL-15	29-JUL-15	R3235173
Magnesium (Mg)-Total	3.90		0.010	mg/L	29-JUL-15	29-JUL-15	R3235173
Manganese (Mn)-Total	0.00365		0.00030	mg/L	29-JUL-15	29-JUL-15	R3235173
Molybdenum (Mo)-Total	0.00149		0.00020	mg/L	29-JUL-15	29-JUL-15	R3235173
Nickel (Ni)-Total	<0.0020		0.0020	mg/L	29-JUL-15	29-JUL-15	R3235173
Phosphorus (P)-Total	<0.10		0.10	mg/L	29-JUL-15	29-JUL-15	R3235173
Potassium (K)-Total	1.50		0.020	mg/L	29-JUL-15	29-JUL-15	R3235173
Rubidium (Rb)-Total	0.00154		0.00020	mg/L	29-JUL-15	29-JUL-15	R3235173
Selenium (Se)-Total	<0.0010		0.0010	mg/L	29-JUL-15	29-JUL-15	R3235173
Silicon (Si)-Total	0.19		0.10	mg/L	29-JUL-15	29-JUL-15	R3235173
Silver (Ag)-Total	<0.00010		0.00010	mg/L	29-JUL-15	29-JUL-15	R3235173
Sodium (Na)-Total	24.7		0.030	mg/L	29-JUL-15	29-JUL-15	R3235173
Strontium (Sr)-Total	0.113		0.00010	mg/L	29-JUL-15	29-JUL-15	R3235173
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	29-JUL-15	29-JUL-15	R3235173
Thallium (Tl)-Total	<0.00010		0.00010	mg/L	29-JUL-15	29-JUL-15	R3235173
Thorium (Th)-Total	<0.00010		0.00010	mg/L	29-JUL-15	29-JUL-15	R3235173
Tin (Sn)-Total	<0.00020		0.00020	mg/L	29-JUL-15	29-JUL-15	R3235173
Titanium (Ti)-Total	<0.00050		0.00050	mg/L	29-JUL-15	29-JUL-15	R3235173
Tungsten (W)-Total	<0.00010		0.00010	mg/L	29-JUL-15	29-JUL-15	R3235173
Uranium (U)-Total	<0.00010		0.00010	mg/L	29-JUL-15	29-JUL-15	R3235173
Vanadium (V)-Total	<0.00020		0.00020	mg/L	29-JUL-15	29-JUL-15	R3235173
Zinc (Zn)-Total	<0.0020		0.0020	mg/L	29-JUL-15	29-JUL-15	R3235173
Zirconium (Zr)-Total	<0.00040		0.00040	mg/L	29-JUL-15	29-JUL-15	R3235173
Turbidity Turbidity	0.97		0.10	NTU		25-JUL-15	R3234090
pH pH	8.01		0.10	pH units		06-AUG-15	R3242540

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1648153-2	WHALE COVE PUMPHOUSE - RAW							
Sampled By: PAUL VOISEY / MEGAN on 23-JUL-15 @ 11:45								
Matrix:								
Miscellaneous Parameters								
Dissolved Organic Carbon		3.4		1.0	mg/L		09-AUG-15	R3243219
Total Organic Carbon		3.3		1.0	mg/L		09-AUG-15	R3243219
Total Coliform and E.coli								
Total Coliforms		>200		0	MPN/100mL		25-JUL-15	R3233294
Escherichia Coli		0		0	MPN/100mL		25-JUL-15	R3233294

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Qualifiers for Individual Samples Listed:

Sample Number	Client ID	Qualifier	Description
L1648153-1	WHALE COVE PUMPHOUSE	ISCR:ST ISCR:ST	C-DIS-ORG-ED - Improper Sample Container Received: Subsamples Taken C-TOT-ORG-ED - Improper Sample Container Received: Subsamples Taken
L1648153-2	WHALE COVE PUMPHOUSE	ISCR:ST ISCR:ST	C-TOT-ORG-ED - Improper Sample Container Received: Subsamples Taken C-DIS-ORG-ED - Improper Sample Container Received: Subsamples Taken

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-CO3CO3-CALC-WP	Water	Alkalinity, Carbonate	CALCULATION
The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by carbonate is calculated and reported as mg CO3 2-/L.			
ALK-HCO3HCO3-CALC-WP	Water	Alkalinity, Bicarbonate	CALCULATION
The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by bicarbonate is calculated and reported as mg HCO3-/L			
ALK-OHOH-CALC-WP	Water	Alkalinity, Hydroxide	CALCULATION
The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by hydroxide is calculated and reported as mg OH-/L.			
ALK-TITR-WP	Water	Total Alkalinity as CaCO3	APHA 2320B
The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. Total alkalinity is determined by titration with a strong standard mineral acid to the successive HCO3- and H2CO3 endpoints indicated electrometrically.			
BR-IC-N-WP	Water	Bromide in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
C-DIS-INORG-CL	Water	Carbon, Dissolved Inorganic	APHA 5310 B-Instrumental
C-DIS-ORG-ED	Water	Dissolved Organic Carbon	APHA 5310 B-Instrumental
This method is applicable to the analysis of ground water, wastewater, and surface water samples. The form detected depends upon sample pretreatment: Unfiltered sample = TC, 0.45um filtered = TDC. Samples are injected into a combustion tube containing an oxidation catalyst. The carrier gas containing the combustion product from the combustion tube flows through an inorganic carbon reactor vessel and is then sent through a halogen scrubber into a sample cell set in a non-dispersive infrared gas analyzer (NDIR) where carbon dioxide is detected. For total inorganic carbon and dissolved inorganic carbon, the sample is injected into an IC reactor vessel where only the IC component is decomposed to become carbon dioxide.			
The peak area generated by the NDIR indicates the TC/TDC or TIC/DIC as applicable. The total organic carbon content of the sample is calculated by subtracting the TIC from the TC. TOC = TC-TIC, DOC = TDC-DIC, Particulate = Total - Dissolved.			
C-TOT-CL	Water	Total Carbon	APHA 5310 B-Instrumental
C-TOT-DIS-CL	Water	Total Dissolved Carbon	APHA 5310 B-Instrumental
C-TOT-INORG-CL	Water	Total Inorganic Carbon	APHA 5310 B-Instrumental
C-TOT-ORG-ED	Water	Total Organic Carbon	APHA 5310 B-Instrumental
This method is applicable to the analysis of ground water, wastewater, and surface water samples. The form detected depends upon sample pretreatment: Unfiltered sample = TC, 0.45um filtered = TDC. Samples are injected into a combustion tube containing an oxidation catalyst. The carrier gas containing the combustion product from the combustion tube flows through an inorganic carbon reactor vessel and is then sent through a halogen scrubber into a sample cell set in a non-dispersive infrared gas analyzer (NDIR) where carbon dioxide is detected. For total inorganic carbon and dissolved inorganic carbon, the sample is injected into an IC reactor vessel where only the IC component is decomposed to become carbon dioxide.			
The peak area generated by the NDIR indicates the TC/TDC or TIC/DIC as applicable. The total organic carbon content of the sample is calculated by subtracting the TIC from the TC. TOC = TC-TIC, DOC = TDC-DIC, Particulate = Total - Dissolved.			
CL-L-IC-N-WP	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
COLOUR-TRUE-WP	Water	Colour, True	APHA 2120C
True Colour is measured spectrophotometrically by comparison to platinum-cobalt standards using the single wavelength method (450 - 465 nm) after			

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
filtration of sample through a 0.45 um filter. Colour measurements can be highly pH dependent, and apply to the pH of the sample as received (at time of testing), without pH adjustment. Concurrent measurement of sample pH is recommended.			
EC-WP	Water	Conductivity	APHA 2510B
Conductivity of an aqueous solution refers to its ability to carry an electric current. Conductance of a solution is measured between two spatially fixed and chemically inert electrodes.			
ETL-HARDNESS-TOT-WP	Water	Hardness Calculated	HARDNESS CALCULATED
ETL-LANGELIER-4-WP	Water	Langelier Index 4C	Calculated
ETL-LANGELIER-60-WP	Water	Langelier Index 60C	Calculated
F-IC-N-WP	Water	Fluoride in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HAA-WP	Water	Haloacetic Acids	EPA 552 (modified)
HAA concentration is determined using liquid-liquid extraction, capillary column, GC/electron capture techniques.			
HAA5-SUM-CALC-WP	Water	Total Haloacetic Acids 5 (HAA5)	CALCULATION
Total Haloacetic Acids 5 (HAA5) represents the sum of monobromoacetic acid, monochloroacetic acid, dibromoacetic acid, dichloroacetic acid and trichloroacetic acid. For the purpose of calculation, results less than the detection limit (DL) are treated as zero.			
IONBALANCE-CALC-WP	Water	Ion Balance Calculation	APHA 1030E
MET-T-L-MS-WP	Water	Total Metals by ICP-MS	APHA 3030E/EPA 6020A-TL
This analysis involves preliminary sample treatment by hotblock acid digestion (APHA 3030E). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).			
NH3-COL-WP	Water	Ammonia by colour	APHA 4500 NH3 F
Ammonia in water samples forms indophenol when reacted with hypochlorite and phenol. The intensity is amplified by the addition of sodium nitroprusside and measured colourmetrically.			
NO2-L-IC-N-WP	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
NO3-L-IC-N-WP	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
PH-WP	Water	pH	APHA 4500H
The pH of a sample is the determination of the activity of the hydrogen ions by potentiometric measurement using a standard hydrogen electrode and a reference electrode.			
SO4-IC-N-WP	Water	Sulfate in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
TC,EC-QT51-WP	Water	Total Coliform and E.coli	APHA 9223B QT51
This analysis is carried out using procedures adapted from APHA Method 9223B "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture of hydrolyzable substrates and then sealed in a 51-well packet. The packet is incubated at 35.0 – 0.5°C for 18 or 24 hours and then the number of wells exhibiting positive responses are counted. The final results are obtained by comparing the number of positive responses to a probability table.			
TDS-WP	Water	Total Dissolved Solids (TDS)	APHA 2540 SOLIDS C,E
A well-mixed sample is filtered through a glass fiber filter paper. The filtrate is then evaporated to dryness in a pre-weighed vial and dried at 180 – 2C. The increase in vial weight represents the total dissolved solids.			
THM-SUM-CALC-WP	Water	Total Trihalomethanes (THMs)	CALCULATION
Total Trihalomethanes (THMs) represents the sum of bromodichloromethane, bromoform, chlorodibromomethane and chloroform. For the purpose of calculation, results less than the detection limit (DL) are treated as zero.			
TURBIDITY-WP	Water	Turbidity	APHA 2130B (modified)
Turbidity in aqueous matrices is determined by the nephelometric method.			

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
UV-%TRANS-WP	Water	% Transmittance by Spectrometry	APHA 5910B
This method indicates the total concentration of UV-absorbing compounds found in water and wastewater. The analysis is carried out using procedures adapted from APHA 5910 B. The sample is filtered through a 0.45 um filter and measured for % transmittance in a quartz cell at 254 nm and reported as % Transmittance .The analysis is carried out without pH adjustment.			
VOC+F1-HSMS-WP	Water	VOC plus F1 by GCMS	EPA 8260C / EPA 5021A
In this method samples are analyzed using a headspace autosampler interfaced to a dual column gas chromatograph with MS and Flame Ionization detectors.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.

mg/kg - milligrams per kilogram based on dry weight of sample

mg/kg ww - milligrams per kilogram based on wet weight of sample

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight

mg/L - unit of concentration based on volume, parts per million.

< - Less than.

D.L. - The reporting limit.

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



Nunavut Community & Government
Services - Rankin Inlet
ATTN: PAUL VOISEY
Box 96
Whale Cove NU X0C 0J0

Date Received: 14-JUL-16
Report Date: 30-JUL-16 17:29 (MT)
Version: FINAL

Client Phone: 867-896-9305

Certificate of Analysis

Lab Work Order #: L1798782
Project P.O. #: NOT SUBMITTED
Job Reference: WHALE COVE
C of C Numbers:
Legal Site Desc:

Hua Wo
Chemistry Laboratory Manager

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Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1798782-1 RAW WATER							
Sampled By: Megan Lusty on 13-JUL-16 @ 10:45							
Matrix: Non-Treated-Municipal							
MB Chemistry for PWS							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	69.7		1.2	mg/L		22-JUL-16	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		22-JUL-16	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		22-JUL-16	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	57.1		1.0	mg/L		20-JUL-16	R3509699
Ammonia by colour							
Ammonia, Total (as N)	<0.010		0.010	mg/L		26-JUL-16	R3512863
Bromide in Water by IC (Low Level)							
Bromide (Br)	0.182		0.010	mg/L		16-JUL-16	R3506585
Chloride in Water by IC (Low Level)							
Chloride (Cl)	48.0		0.10	mg/L		16-JUL-16	R3506585
Colour, True							
Colour, True	<5.0		5.0	CU		17-JUL-16	R3507952
Conductivity							
Conductivity	291		1.0	umhos/cm		20-JUL-16	R3509699
Dissolved Organic Carbon by Combustion							
Dissolved Organic Carbon	3.80		0.50	mg/L		26-JUL-16	R3514036
Fluoride in Water by IC							
Fluoride (F)	0.039		0.020	mg/L		16-JUL-16	R3506585
Hardness Calculated							
Hardness (as CaCO3)	79.1		0.30	mg/L		27-JUL-16	
Langelier Index 4C							
Langelier Index (4 C)	-0.87					27-JUL-16	
Langelier Index 60C							
Langelier Index (60 C)	-0.093					27-JUL-16	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	<0.0050		0.0050	mg/L		16-JUL-16	R3506585
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		16-JUL-16	R3506585
Sulfate in Water by IC							
Sulfate (SO4)	9.48		0.30	mg/L		16-JUL-16	R3506585
Total Dissolved Solids (TDS)							
Total Dissolved Solids	177		20	mg/L		19-JUL-16	R3508715
Total Metals by ICP-MS							
Aluminum (Al)-Total	0.0051		0.0050	mg/L	26-JUL-16	26-JUL-16	R3512533
Antimony (Sb)-Total	<0.00020		0.00020	mg/L	26-JUL-16	26-JUL-16	R3512533
Arsenic (As)-Total	0.00030		0.00020	mg/L	26-JUL-16	26-JUL-16	R3512533
Barium (Ba)-Total	0.0102		0.00020	mg/L	26-JUL-16	26-JUL-16	R3512533
Beryllium (Be)-Total	<0.00020		0.00020	mg/L	26-JUL-16	26-JUL-16	R3512533
Bismuth (Bi)-Total	<0.00020		0.00020	mg/L	26-JUL-16	26-JUL-16	R3512533
Boron (B)-Total	0.037		0.010	mg/L	26-JUL-16	26-JUL-16	R3512533
Cadmium (Cd)-Total	<0.000010		0.000010	mg/L	26-JUL-16	26-JUL-16	R3512533
Calcium (Ca)-Total	24.2		0.10	mg/L	26-JUL-16	26-JUL-16	R3512533
Cesium (Cs)-Total	<0.00010		0.00010	mg/L	26-JUL-16	26-JUL-16	R3512533
Chromium (Cr)-Total	<0.0010		0.0010	mg/L	26-JUL-16	26-JUL-16	R3512533
Cobalt (Co)-Total	<0.00020		0.00020	mg/L	26-JUL-16	26-JUL-16	R3512533
Copper (Cu)-Total	0.00221		0.00020	mg/L	26-JUL-16	26-JUL-16	R3512533
Iron (Fe)-Total	0.063		0.010	mg/L	26-JUL-16	26-JUL-16	R3512533
Lead (Pb)-Total	0.000164		0.000090	mg/L	26-JUL-16	26-JUL-16	R3512533

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1798782-1	RAW WATER							
Sampled By: Megan Lusty on 13-JUL-16 @ 10:45								
Matrix: Non-Treated-Municipal								
Total Metals by ICP-MS								
Lithium (Li)-Total		<0.0020		0.0020	mg/L	26-JUL-16	26-JUL-16	R3512533
Magnesium (Mg)-Total		4.57		0.010	mg/L	26-JUL-16	26-JUL-16	R3512533
Manganese (Mn)-Total		0.00725		0.00030	mg/L	26-JUL-16	26-JUL-16	R3512533
Molybdenum (Mo)-Total		0.00139		0.00020	mg/L	26-JUL-16	26-JUL-16	R3512533
Nickel (Ni)-Total		<0.0020		0.0020	mg/L	26-JUL-16	26-JUL-16	R3512533
Phosphorus (P)-Total		<0.10		0.10	mg/L	26-JUL-16	26-JUL-16	R3512533
Potassium (K)-Total		1.90		0.020	mg/L	26-JUL-16	26-JUL-16	R3512533
Rubidium (Rb)-Total		0.00189		0.00020	mg/L	26-JUL-16	26-JUL-16	R3512533
Selenium (Se)-Total		<0.0010		0.0010	mg/L	26-JUL-16	26-JUL-16	R3512533
Silicon (Si)-Total		0.50		0.10	mg/L	26-JUL-16	26-JUL-16	R3512533
Silver (Ag)-Total		<0.00010		0.00010	mg/L	26-JUL-16	26-JUL-16	R3512533
Sodium (Na)-Total		27.6		0.030	mg/L	26-JUL-16	26-JUL-16	R3512533
Strontium (Sr)-Total		0.126		0.00010	mg/L	26-JUL-16	26-JUL-16	R3512533
Tellurium (Te)-Total		<0.00020		0.00020	mg/L	26-JUL-16	26-JUL-16	R3512533
Thallium (Tl)-Total		<0.00010		0.00010	mg/L	26-JUL-16	26-JUL-16	R3512533
Thorium (Th)-Total		<0.00010		0.00010	mg/L	26-JUL-16	26-JUL-16	R3512533
Tin (Sn)-Total		<0.00020		0.00020	mg/L	26-JUL-16	26-JUL-16	R3512533
Titanium (Ti)-Total		<0.00050		0.00050	mg/L	26-JUL-16	26-JUL-16	R3512533
Tungsten (W)-Total		<0.00010		0.00010	mg/L	26-JUL-16	26-JUL-16	R3512533
Uranium (U)-Total		<0.00010		0.00010	mg/L	26-JUL-16	26-JUL-16	R3512533
Vanadium (V)-Total		<0.00020		0.00020	mg/L	26-JUL-16	26-JUL-16	R3512533
Zinc (Zn)-Total		0.0272		0.0020	mg/L	26-JUL-16	26-JUL-16	R3512533
Zirconium (Zr)-Total		<0.00040		0.00040	mg/L	26-JUL-16	26-JUL-16	R3512533
Total Organic Carbon by Combustion								
Total Organic Carbon		4.50		0.50	mg/L		26-JUL-16	R3514026
Turbidity								
Turbidity		1.31		0.10	NTU		16-JUL-16	R3507710
UV Transmittance (Calculated)								
Transmittance, UV (254 nm)		80.7		1.0	%T/cm		15-JUL-16	R3507893
pH								
pH		7.61		0.10	pH units		20-JUL-16	R3509699
L1798782-2	TREATED WATER							
Sampled By: Megan Lusty on 13-JUL-16 @ 09:10								
Matrix: Non-Treated-Municipal								
MB Chemistry for PWS								
Alkalinity, Bicarbonate								
Bicarbonate (HCO3)		68.9		1.2	mg/L		22-JUL-16	
Alkalinity, Carbonate								
Carbonate (CO3)		<0.60		0.60	mg/L		22-JUL-16	
Alkalinity, Hydroxide								
Hydroxide (OH)		<0.34		0.34	mg/L		22-JUL-16	
Alkalinity, Total (as CaCO3)								
Alkalinity, Total (as CaCO3)		56.5		1.0	mg/L		20-JUL-16	R3509699
Ammonia by colour								
Ammonia, Total (as N)		0.013		0.010	mg/L		26-JUL-16	R3512863
Bromide in Water by IC (Low Level)								
Bromide (Br)		0.050		0.010	mg/L		16-JUL-16	R3506585
Chloride in Water by IC (Low Level)								
Chloride (Cl)		48.9		0.10	mg/L		16-JUL-16	R3506585
Colour, True								
Colour, True		9.3		5.0	CU		17-JUL-16	R3507952

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1798782-2 TREATED WATER							
Sampled By: Megan Lusty on 13-JUL-16 @ 09:10							
Matrix: Non-Treated-Municipal							
Conductivity							
Conductivity	292		1.0	umhos/cm		20-JUL-16	R3509699
Dissolved Organic Carbon by Combustion							
Dissolved Organic Carbon	4.20		0.50	mg/L		26-JUL-16	R3514036
Fluoride in Water by IC							
Fluoride (F)	0.048		0.020	mg/L		16-JUL-16	R3506585
Hardness Calculated							
Hardness (as CaCO3)	79.7		0.30	mg/L		27-JUL-16	
Langelier Index 4C							
Langelier Index (4 C)	-0.72					27-JUL-16	
Langelier Index 60C							
Langelier Index (60 C)	0.052					27-JUL-16	
Nitrate in Water by IC (Low Level)							
Nitrate (as N)	<0.0050		0.0050	mg/L		16-JUL-16	R3506585
Nitrite in Water by IC (Low Level)							
Nitrite (as N)	<0.0010		0.0010	mg/L		16-JUL-16	R3506585
Sulfate in Water by IC							
Sulfate (SO4)	9.34		0.30	mg/L		16-JUL-16	R3506585
Total Dissolved Solids (TDS)							
Total Dissolved Solids	171		20	mg/L		19-JUL-16	R3508715
Total Metals by ICP-MS							
Aluminum (Al)-Total	0.0116		0.0050	mg/L	26-JUL-16	26-JUL-16	R3512533
Antimony (Sb)-Total	<0.00020		0.00020	mg/L	26-JUL-16	26-JUL-16	R3512533
Arsenic (As)-Total	0.00030		0.00020	mg/L	26-JUL-16	26-JUL-16	R3512533
Barium (Ba)-Total	0.0100		0.00020	mg/L	26-JUL-16	26-JUL-16	R3512533
Beryllium (Be)-Total	<0.00020		0.00020	mg/L	26-JUL-16	26-JUL-16	R3512533
Bismuth (Bi)-Total	<0.00020		0.00020	mg/L	26-JUL-16	26-JUL-16	R3512533
Boron (B)-Total	0.037		0.010	mg/L	26-JUL-16	26-JUL-16	R3512533
Cadmium (Cd)-Total	<0.000010		0.000010	mg/L	26-JUL-16	26-JUL-16	R3512533
Calcium (Ca)-Total	24.7		0.10	mg/L	26-JUL-16	26-JUL-16	R3512533
Cesium (Cs)-Total	<0.00010		0.00010	mg/L	26-JUL-16	26-JUL-16	R3512533
Chromium (Cr)-Total	<0.0010		0.0010	mg/L	26-JUL-16	26-JUL-16	R3512533
Cobalt (Co)-Total	<0.00020		0.00020	mg/L	26-JUL-16	26-JUL-16	R3512533
Copper (Cu)-Total	0.00585		0.00020	mg/L	26-JUL-16	26-JUL-16	R3512533
Iron (Fe)-Total	0.057		0.010	mg/L	26-JUL-16	26-JUL-16	R3512533
Lead (Pb)-Total	0.000364		0.000090	mg/L	26-JUL-16	26-JUL-16	R3512533
Lithium (Li)-Total	<0.0020		0.0020	mg/L	26-JUL-16	26-JUL-16	R3512533
Magnesium (Mg)-Total	4.36		0.010	mg/L	26-JUL-16	26-JUL-16	R3512533
Manganese (Mn)-Total	0.00750		0.00030	mg/L	26-JUL-16	26-JUL-16	R3512533
Molybdenum (Mo)-Total	0.00137		0.00020	mg/L	26-JUL-16	26-JUL-16	R3512533
Nickel (Ni)-Total	<0.0020		0.0020	mg/L	26-JUL-16	26-JUL-16	R3512533
Phosphorus (P)-Total	<0.10		0.10	mg/L	26-JUL-16	26-JUL-16	R3512533
Potassium (K)-Total	1.81		0.020	mg/L	26-JUL-16	26-JUL-16	R3512533
Rubidium (Rb)-Total	0.00190		0.00020	mg/L	26-JUL-16	26-JUL-16	R3512533
Selenium (Se)-Total	<0.0010		0.0010	mg/L	26-JUL-16	26-JUL-16	R3512533
Silicon (Si)-Total	0.43		0.10	mg/L	26-JUL-16	26-JUL-16	R3512533
Silver (Ag)-Total	<0.00010		0.00010	mg/L	26-JUL-16	26-JUL-16	R3512533
Sodium (Na)-Total	26.5		0.030	mg/L	26-JUL-16	26-JUL-16	R3512533
Strontium (Sr)-Total	0.125		0.00010	mg/L	26-JUL-16	26-JUL-16	R3512533
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	26-JUL-16	26-JUL-16	R3512533
Thallium (Tl)-Total	<0.00010		0.00010	mg/L	26-JUL-16	26-JUL-16	R3512533
Thorium (Th)-Total	<0.00010		0.00010	mg/L	26-JUL-16	26-JUL-16	R3512533
Tin (Sn)-Total	<0.00020		0.00020	mg/L	26-JUL-16	26-JUL-16	R3512533

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-CO3CO3-CALC-WP	Water	Alkalinity, Carbonate	CALCULATION
The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by carbonate is calculated and reported as mg CO ₃ 2-/L.			
ALK-HCO3HCO3-CALC-WP	Water	Alkalinity, Bicarbonate	CALCULATION
The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by bicarbonate is calculated and reported as mg HCO ₃ -/L			
ALK-OHOH-CALC-WP	Water	Alkalinity, Hydroxide	CALCULATION
The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by hydroxide is calculated and reported as mg OH-/L.			
ALK-TITR-WP	Water	Alkalinity, Total (as CaCO ₃)	APHA 2320B
The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. Total alkalinity is determined by titration with a strong standard mineral acid to the successive HCO ₃ - and H ₂ CO ₃ endpoints indicated electrometrically.			
BR-L-IC-N-WP	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
C-DOC-HTC-WP	Water	Dissolved Organic Carbon by Combustion	APHA 5310 B-WP
Filtered (0.45 um) sample is acidified and purged to remove inorganic carbon, then injected into a heated reaction chamber where organic carbon is oxidized to CO ₂ which is then transported in the carrier gas stream and measured via a non-dispersive infrared analyzer.			
C-TOC-HTC-WP	Water	Total Organic Carbon by Combustion	APHA 5310 B-WP
Sample is acidified and purged to remove inorganic carbon, then injected into a heated reaction chamber where organic carbon is oxidized to CO ₂ which is then transported in the carrier gas stream and measured via a non-dispersive infrared analyzer.			
CL-L-IC-N-WP	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
COLOUR-TRUE-WP	Water	Colour, True	APHA 2120C
True Colour is measured spectrophotometrically by comparison to platinum-cobalt standards using the single wavelength method (450 - 465 nm) after filtration of sample through a 0.45 um filter. Colour measurements can be highly pH dependent, and apply to the pH of the sample as received (at time of testing), without pH adjustment. Concurrent measurement of sample pH is recommended.			
EC-WP	Water	Conductivity	APHA 2510B
Conductivity of an aqueous solution refers to its ability to carry an electric current. Conductance of a solution is measured between two spatially fixed and chemically inert electrodes.			
ETL-HARDNESS-TOT-WP	Water	Hardness Calculated	HARDNESS CALCULATED
ETL-LANGELIER-4-WP	Water	Langelier Index 4C	Calculated
ETL-LANGELIER-60-WP	Water	Langelier Index 60C	Calculated
F-IC-N-WP	Water	Fluoride in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HAA-WP	Water	Haloacetic Acids	EPA 552 (modified)
HAA concentration is determined using liquid-liquid extraction, capillary column, GC/electron capture techniques.			
HAA5-SUM-CALC-WP	Water	Total Haloacetic Acids 5 (HAA5)	CALCULATION
Total Haloacetic Acids 5 (HAA5) represents the sum of monobromoacetic acid, monochloroacetic acid, dibromoacetic acid, dichloroacetic acid and trichloroacetic acid. For the purpose of calculation, results less than the detection limit (DL) are treated as zero.			
IONBALANCE-CALC-WP	Water	Ion Balance Calculation	APHA 1030E
MET-T-L-MS-WP	Water	Total Metals by ICP-MS	APHA 3030E/EPA 6020A-TL
This analysis involves preliminary sample treatment by hotblock acid digestion (APHA 3030E). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).			

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
NH3-COL-WP	Water	Ammonia by colour	APHA 4500 NH3 F
Ammonia in water samples forms indophenol when reacted with hypochlorite and phenol. The intensity is amplified by the addition of sodium nitroprusside and measured colourmetrically.			
NO2-L-IC-N-WP	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
NO3-L-IC-N-WP	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
PH-WP	Water	pH	APHA 4500H
The pH of a sample is the determination of the activity of the hydrogen ions by potentiometric measurement using a standard hydrogen electrode and a reference electrode.			
SO4-IC-N-WP	Water	Sulfate in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
TDS-WP	Water	Total Dissolved Solids (TDS)	APHA 2540 SOLIDS C,E
A well-mixed sample is filtered through a glass fiber filter paper. The filtrate is then evaporated to dryness in a pre-weighed vial and dried at 180 – 2C. The increase in vial weight represents the total dissolved solids.			
THM-SUM-CALC-WP	Water	Total Trihalomethanes (THMs)	CALCULATION
Total Trihalomethanes (THMs) represents the sum of bromodichloromethane, bromoform, chlorodibromomethane and chloroform. For the purpose of calculation, results less than the detection limit (DL) are treated as zero.			
TURBIDITY-WP	Water	Turbidity	APHA 2130B (modified)
Turbidity in aqueous matrices is determined by the nephelometric method.			
UV-%TRANS-WP	Water	UV Transmittance (Calculated)	APHA 5910B
Test method is adapted from APHA Method 5910B. A sample is filtered through a 0.45 um filter and its UV Absorbance is measured in a quartz cell at 254 nm. UV Transmittance is calculated from the UV Absorbance result and reported as UV Transmittance per cm. The analysis is carried out without pH adjustment.			
VOC+F1-HSMS-WP	Water	VOC plus F1 by GCMS	EPA 8260C / EPA 5021A
In this method samples are analyzed using a headspace autosampler interfaced to a dual column gas chromatograph with MS and Flame Ionization detectors.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

Chain of Custody Numbers:

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
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GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.

mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.

< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



L1798782-COFC

Environmental Division

Chain of Custody / Analytical Request Form
CHEMISTRY INFO: (204) 255 9739
MICRO INFO: (204) 255 9740 OR (204) 255 9737

WORK ORDER NO:

FOR LABORATORY USE ONLY (SHADED AREAS)

Sample Condition Upon Receipt: ☐ ACCEPTABLE ☐ NON ACCEPTABLE **19**
☐ Frozen ☐ Cold ☐ Ambient ☐ Broken ☐ Leakage ☐ Incorrect Sample Container

COMMENT:

LAB NO.: **L1798782**
DATE RECEIVED: **1630**
TIME RECEIVED: **147-16**
BY: **B**

Date Sampled: **July 13, 2016** Time: **9** : **10** A.M. ☒ P.M. ☐

Date Required: **ASAP**

Location: **Whale Cove**
(Town, Community, City)

Submitter's Name Printed: **Megan Lusty**

Sample Submitted By: **my**

Community Code Number:

Rural Municipality/LGC/UVI:

SAMPLE TYPE

DRINKING WATER

- ☐ Untreated Well
☐ Treated Well
☒ Treated Municipal
☒ Non-Treated Municipal
☐ Water-Surface-Raw
☐ Water-Surface-Treated

PURPOSE OF TEST

- ☐ Private ☐ Real Estate ☐ Water Main

PLEASE PRINT & PRESS FIRMLY

NON-DRINKING WATER

- ☐ Sewage/Waste Water
☐ Lake/River
☐ Swimming Pool
☐ Whirl Pool
☐ Other

NOTES & CONDITIONS

1. Quote number must be provided to insure proper pricing.
2. Failure to properly complete all portions of this form may delay analysis.
3. ALS's liability limited to cost of analysis.

SERVICE REQUESTED

- ☒ REGULAR ☐ PRIORITY ☐ EMERGENCY
(50% SURCHARGE) (100% SURCHARGE)

LAB NUMBER	SAMPLE IDENTIFICATION
	Raw Water 10:45AM
	Treated Water 9:10AM
	- Routine
	- Carbon
	- Metals
	- Nutrients
	- THM
	- HAA

ALS CUSTOMER #: **W8133** QUOTE #:

REPORT TO BE SENT TO

NAME: **Paul Voisey**
COMPANY: **GN-CGS**
ADDRESS: **P.O. Box 96**
CITY/TOWN: **Whale Cove** / PROV.: **NU**
POSTAL CODE: **X0C 0J0**
PHONE: **867-896-9305**
BY: MAIL ☐ FAX ☐
PICKUP ☐ E-MAIL ☒ **pvoisey@gov.nu.ca**
CC: **strickland@gov.nu.ca**
mlusty@gov.nu.ca
gnelson@gov.nu.ca
NAME:
ADDRESS:
CITY/TOWN: / PROV.:
POSTAL CODE:
PHONE:
BY: MAIL ☐ FAX ☐
PICKUP ☐ E-MAIL ☐

Analyses required **M2 - Drinking Water Analysis**

Treated Water only: THM + HAA

SAMPLING INSTRUCTIONS ON REVERSE SIDE

Manitoba Technology Centre Ltd.
Part of the **ALS Laboratory Group**
12 - 1329 Niakwa Rd. E., Winnipeg, MB Canada R2J 3T4
Phone: +1 204 255 9720 Fax: +1 204 255 9721 www.alsglobal.com
A Campbell Brothers Limited Company

ACCOUNT COPY

BILLING ADDRESS SAME AS REPORT TO ☒

NAME:
COMPANY:
ADDRESS:
CITY/TOWN: / PROV.:
POSTAL CODE:

PAYMENT PARTICULARS

☐ INVOICE NEEDED / CLIENT'S P.O. NO.
☐ INTERAC
☐ CASH Subtotal \$
☐ CHEQUE G.S.T. \$
☐ VISA / MASTERCARD Total \$

* OUR POLICY IS NOT TO ACCEPT SAMPLES FROM THE PRIVATE CITIZEN WITHOUT PREPAYMENT

ENTERED IN LIMS BY:



Nunavut Community & Government
Services - Rankin Inlet
ATTN: PAUL VOISEY
Whale Cove Health Unit
Whale Cove NU X0C 0J0

Date Received: 17-MAY-17
Report Date: 31-MAY-17 14:58 (MT)
Version: FINAL

Client Phone: 867-896-9305

Certificate of Analysis

Lab Work Order #: L1927694

Project P.O. #: NOT SUBMITTED

Job Reference: WHALE COVE WTP - CHEMISTRY

C of C Numbers:

Legal Site Desc:



Hua Wo
Chemistry Laboratory Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 1329 Niakwa Road East, Unit 12, Winnipeg, MB R2J 3T4 Canada | Phone: +1 204 255 9720 | Fax: +1 204 255 9721
ALS CANADA LTD Part of the ALS Group An ALS Limited Company

Physical Tests (WATER)

		ALS ID		L1927694-1	L1927694-2
		Sampled Date		16-MAY-17	16-MAY-17
		Sampled Time		09:43	10:43
		Sample ID		WHALE COVE WTP - RAW WATER	WHALE COVE - TREATED WATER TRUCK AFTER 20MINS
Analyte	Unit	Guide Limit #1	Guide Limit #2		
Colour, True	CU	15	-	14.3	7.2
Conductivity	umhos/cm	-	-	397	403
Hardness (as CaCO3)	mg/L	-	-	110 HTC	111 HTC
Langelier Index (4 C)	No Unit	-	-	-0.75	-0.68
Langelier Index (60 C)	No Unit	-	-	0.023	0.089
pH	pH units	7.00-10.5	-	7.40	7.46
Total Dissolved Solids	mg/L	500	-	223	245
Transmittance, UV (254 nm)	%T/cm	-	-	74.1	80.0
Turbidity	NTU	-	-	1.08	1.02

Federal Guidelines for Canadian Drinking Water Quality (MAR, 2015)

#1: GCDWQ - Aesthetic Objective/Other Value

#2: GCDWQ - Maximum Acceptable Concentrations (Pre-2003)

Anions and Nutrients (WATER)

		ALS ID		L1927694-1	L1927694-2
		Sampled Date		16-MAY-17	16-MAY-17
		Sampled Time		09:43	10:43
		Sample ID		WHALE COVE WTP - RAW WATER	WHALE COVE - TREATED WATER TRUCK AFTER 20MINS
Analyte	Unit	Guide Limit #1	Guide Limit #2		
Alkalinity, Total (as CaCO3)	mg/L	-	-	92.7	92.9
Ammonia, Total (as N)	mg/L	-	-	<0.010	<0.010
Bicarbonate (HCO3)	mg/L	-	-	113	113
Bromide (Br)	mg/L	-	-	0.235	0.081
Carbonate (CO3)	mg/L	-	-	<0.60	<0.60
Chloride (Cl)	mg/L	250	-	64.4	66.4
Fluoride (F)	mg/L	-	1.5	0.056	0.051
Hydroxide (OH)	mg/L	-	-	<0.34	<0.34
Nitrate (as N)	mg/L	-	10	<0.0050	<0.0050
Nitrite (as N)	mg/L	-	1	<0.0010	<0.0010
Sulfate (SO4)	mg/L	500	-	14.4	14.4

Federal Guidelines for Canadian Drinking Water Quality (MAR, 2015)

#1: GCDWQ - Aesthetic Objective/Other Value

#2: GCDWQ - Maximum Acceptable Concentrations (Pre-2003)

Organic / Inorganic Carbon (WATER)

		ALS ID		L1927694-1	L1927694-2
		Sampled Date		16-MAY-17	16-MAY-17
		Sampled Time		09:43	10:43
		Sample ID		WHALE COVE WTP - RAW WATER	WHALE COVE - TREATED WATER TRUCK AFTER 20MINS
Analyte	Unit	Guide Limit #1	Guide Limit #2		
Dissolved Organic Carbon	mg/L	-	-	5.54	5.59
Total Organic Carbon	mg/L	-	-	5.26	5.14

Federal Guidelines for Canadian Drinking Water Quality (MAR, 2015)

#1: GCDWQ - Aesthetic Objective/Other Value

#2: GCDWQ - Maximum Acceptable Concentrations (Pre-2003)

 Detection Limit for result exceeds Guide Limit. Assessment against Guide Limit cannot be made.

 Analytical result for this parameter exceeds Guide Limit listed on this report.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

Total Metals (WATER)

		ALS ID		L1927694-1	L1927694-2
		Sampled Date		16-MAY-17	16-MAY-17
		Sampled Time		09:43	10:43
		Sample ID		WHALE COVE	WHALE COVE -
				WTP - RAW	TREATED
				WATER	WATER TRUCK
					AFTER 20MINS
Analyte	Unit	Guide Limit #1	Guide Limit #2		
Aluminum (Al)-Total	mg/L	0.1	-	<0.0050	0.0092
Antimony (Sb)-Total	mg/L	-	0.006	<0.00020	<0.00020
Arsenic (As)-Total	mg/L	-	0.01	0.00041	0.00035
Barium (Ba)-Total	mg/L	-	1	0.0137	0.0133
Beryllium (Be)-Total	mg/L	-	-	<0.00020	<0.00020
Bismuth (Bi)-Total	mg/L	-	-	<0.00020	<0.00020
Boron (B)-Total	mg/L	-	-	0.046	0.045
Cadmium (Cd)-Total	mg/L	-	0.005	<0.000010	<0.000010
Calcium (Ca)-Total	mg/L	-	-	33.5	34.0
Cesium (Cs)-Total	mg/L	-	-	<0.00010	<0.00010
Chromium (Cr)-Total	mg/L	-	0.05	<0.0010	<0.0010
Cobalt (Co)-Total	mg/L	-	-	<0.00020	<0.00020
Copper (Cu)-Total	mg/L	1	-	0.00327	0.00530
Iron (Fe)-Total	mg/L	0.3	-	0.049	0.051
Lead (Pb)-Total	mg/L	-	0.01	<0.000090	0.000112
Lithium (Li)-Total	mg/L	-	-	0.0025	0.0025
Magnesium (Mg)-Total	mg/L	-	-	6.47	6.42
Manganese (Mn)-Total	mg/L	0.05	-	0.00400	0.00399
Molybdenum (Mo)-Total	mg/L	-	-	0.00215	0.00210
Nickel (Ni)-Total	mg/L	-	-	<0.0020	<0.0020
Phosphorus (P)-Total	mg/L	-	-	<0.10	<0.10
Potassium (K)-Total	mg/L	-	-	2.62	2.59
Rubidium (Rb)-Total	mg/L	-	-	0.00268	0.00274
Selenium (Se)-Total	mg/L	-	0.05	<0.0010	<0.0010
Silicon (Si)-Total	mg/L	-	-	0.88	0.80
Silver (Ag)-Total	mg/L	-	-	<0.00010	<0.00010
Sodium (Na)-Total	mg/L	200	-	40.0	40.1
Strontium (Sr)-Total	mg/L	-	-	0.184	0.181
Tellurium (Te)-Total	mg/L	-	-	<0.00020	<0.00020
Thallium (Tl)-Total	mg/L	-	-	<0.00010	<0.00010
Thorium (Th)-Total	mg/L	-	-	<0.00010	<0.00010
Tin (Sn)-Total	mg/L	-	-	<0.00020	<0.00020
Titanium (Ti)-Total	mg/L	-	-	<0.00050	<0.00050

Federal Guidelines for Canadian Drinking Water Quality (MAR, 2015)

#1: GCDWQ - Aesthetic Objective/Other Value

#2: GCDWQ - Maximum Acceptable Concentrations (Pre-2003)

 Detection Limit for result exceeds Guide Limit. Assessment against Guide Limit cannot be made.

 Analytical result for this parameter exceeds Guide Limit listed on this report.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

Total Metals (WATER)

		ALS ID		L1927694-1	L1927694-2
		Sampled Date		16-MAY-17	16-MAY-17
		Sampled Time		09:43	10:43
		Sample ID		WHALE COVE WTP - RAW WATER	WHALE COVE - TREATED WATER TRUCK AFTER 20MINS
Analyte	Unit	Guide Limit #1	Guide Limit #2		
Tungsten (W)-Total	mg/L	-	-	<0.00010	<0.00010
Uranium (U)-Total	mg/L	-	0.02	0.00013	0.00013
Vanadium (V)-Total	mg/L	-	-	<0.00020	<0.00020
Zinc (Zn)-Total	mg/L	5	-	0.0052	0.0105
Zirconium (Zr)-Total	mg/L	-	-	<0.00040	<0.00040

Federal Guidelines for Canadian Drinking Water Quality (MAR, 2015)

#1: GCDWQ - Aesthetic Objective/Other Value

#2: GCDWQ - Maximum Acceptable Concentrations (Pre-2003)

Volatile Organic Compounds (WATER)

		ALS ID		L1927694-2
		Sampled Date		16-MAY-17
		Sampled Time		10:43
		Sample ID		WHALE COVE - TREATED WATER TRUCK AFTER 20MINS
Analyte	Unit	Guide Limit #1	Guide Limit #2	
Bromodichloromethane	mg/L	-	-	0.0123
Bromoform	mg/L	-	-	0.00126
Dibromochloromethane	mg/L	-	-	0.0107
Chloroform	mg/L	-	-	0.0276
Surrogate: 4-Bromofluorobenzene (SS)	%	-	-	94.2
Surrogate: 1,4-Difluorobenzene (SS) %		-	-	96.4

Federal Guidelines for Canadian Drinking Water Quality (MAR, 2015)

#1: GCDWQ - Aesthetic Objective/Other Value

#2: GCDWQ - Maximum Acceptable Concentrations (Pre-2003)

Trihalomethanes (WATER)

		ALS ID		L1927694-2
		Sampled Date		16-MAY-17
		Sampled Time		10:43
		Sample ID		WHALE COVE - TREATED WATER TRUCK AFTER 20MINS
Analyte	Unit	Guide Limit #1	Guide Limit #2	
Total THMs	mg/L	-	0.1	0.0519

Federal Guidelines for Canadian Drinking Water Quality (MAR, 2015)

#1: GCDWQ - Aesthetic Objective/Other Value

#2: GCDWQ - Maximum Acceptable Concentrations (Pre-2003)

 Detection Limit for result exceeds Guide Limit. Assessment against Guide Limit cannot be made.

 Analytical result for this parameter exceeds Guide Limit listed on this report.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

Haloacetic Acids (WATER)

		ALS ID		L1927694-2
		Sampled Date		16-MAY-17
		Sampled Time		10:43
		Sample ID		
		Guide		WHALE COVE - TREATED WATER TRUCK AFTER 20MINS
Analyte	Unit	Limit #1	Limit #2	
Bromochloroacetic Acid	mg/L	-	-	0.0173
Dibromoacetic Acid	mg/L	-	-	0.0065
Dichloroacetic Acid	mg/L	-	-	0.0224
Total Haloacetic Acids 5	mg/L	-	0.08	0.0482
Monobromoacetic Acid	mg/L	-	-	<0.0010
Monochloroacetic Acid	mg/L	-	-	<0.0050
Trichloroacetic Acid	mg/L	-	-	0.0194
Surrogate: 2,3-Dibromopropionic Acid (SS)	%	-	-	117.6

Federal Guidelines for Canadian Drinking Water Quality (MAR, 2015)

#1: GCDWQ - Aesthetic Objective/Other Value

#2: GCDWQ - Maximum Acceptable Concentrations (Pre-2003)

 Detection Limit for result exceeds Guide Limit. Assessment against Guide Limit cannot be made.

 Analytical result for this parameter exceeds Guide Limit listed on this report.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

Reference Information

Qualifiers for Individual Parameters Listed:

Qualifier	Description
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable).

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-CO3CO3-CALC-WP	Water	Alkalinity, Carbonate	CALCULATION
The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by carbonate is calculated and reported as mg CO ₃ 2-/L.			
ALK-HCO3HCO3-CALC-WP	Water	Alkalinity, Bicarbonate	CALCULATION
The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by bicarbonate is calculated and reported as mg HCO ₃ -/L.			
ALK-OHOH-CALC-WP	Water	Alkalinity, Hydroxide	CALCULATION
The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by hydroxide is calculated and reported as mg OH-/L.			
ALK-TITR-WP	Water	Alkalinity, Total (as CaCO ₃)	APHA 2320B
The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. Total alkalinity is determined by titration with a strong standard mineral acid to the successive HCO ₃ - and H ₂ CO ₃ endpoints indicated electrometrically.			
BR-L-IC-N-WP	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)-LR
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
C-DOC-HTC-WP	Water	Dissolved Organic Carbon by Combustion	APHA 5310 B-WP
Filtered (0.45 um) sample is acidified and purged to remove inorganic carbon, then injected into a heated reaction chamber where organic carbon is oxidized to CO ₂ which is then transported in the carrier gas stream and measured via a non-dispersive infrared analyzer.			
C-TOC-HTC-WP	Water	Total Organic Carbon by Combustion	APHA 5310 B-WP
Sample is acidified and purged to remove inorganic carbon, then injected into a heated reaction chamber where organic carbon is oxidized to CO ₂ which is then transported in the carrier gas stream and measured via a non-dispersive infrared analyzer.			
CL-L-IC-N-WP	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
COLOUR-TRUE-WP	Water	Colour, True	APHA 2120C
True Colour is measured spectrophotometrically by comparison to platinum-cobalt standards using the single wavelength method (450 - 465 nm) after filtration of sample through a 0.45 um filter. Colour measurements can be highly pH dependent, and apply to the pH of the sample as received (at time of testing), without pH adjustment. Concurrent measurement of sample pH is recommended.			
EC-WP	Water	Conductivity	APHA 2510B
Conductivity of an aqueous solution refers to its ability to carry an electric current. Conductance of a solution is measured between two spatially fixed and chemically inert electrodes.			
ETL-LANGELIER-4-WP	Water	Langelier Index 4C	Calculated
ETL-LANGELIER-60-WP	Water	Langelier Index 60C	Calculated
F-IC-N-WP	Water	Fluoride in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HAA-WP	Water	Haloacetic Acids	EPA 552 (modified)
HAA concentration is determined using liquid-liquid extraction, capillary column, GC/electron capture techniques.			
HAA5-SUM-CALC-WP	Water	Total Haloacetic Acids 5 (HAA5)	CALCULATION
Total Haloacetic Acids 5 (HAA5) represents the sum of monobromoacetic acid, monochloroacetic acid, dibromoacetic acid, dichloroacetic acid and trichloroacetic acid. For the purpose of calculation, results less than the detection limit (DL) are treated as zero.			

Reference Information

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-WP	Water	Hardness Calculated	APHA 2340B
Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO ₃ equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.			
IONBALANCE-CALC-WP	Water	Ion Balance Calculation	APHA 1030E
Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.			
Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance (as % difference) cannot be calculated accurately for waters with very low electrical conductivity (EC), and is reported as "Low EC" where EC < 100 uS/cm (umhos/cm). Ion Balance is calculated as:			
Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]			
MET-T-L-MS-WP	Water	Total Metals by ICP-MS	APHA 3030E/EPA 6020A-TL
This analysis involves preliminary sample treatment by hotblock acid digestion (APHA 3030E). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).			
NH3-COL-WP	Water	Ammonia by colour	APHA 4500 NH ₃ F
Ammonia in water samples forms indophenol when reacted with hypochlorite and phenol. The intensity is amplified by the addition of sodium nitroprusside and measured colourmetrically.			
NO2-L-IC-N-WP	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
NO3-L-IC-N-WP	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
PH-WP	Water	pH	APHA 4500H
The pH of a sample is the determination of the activity of the hydrogen ions by potentiometric measurement using a standard hydrogen electrode and a reference electrode.			
SO4-IC-N-WP	Water	Sulfate in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
TDS-WP	Water	Total Dissolved Solids (TDS)	APHA 2540 SOLIDS C,E
A well-mixed sample is filtered through a glass fiber filter paper. The filtrate is then evaporated to dryness in a pre-weighed vial and dried at 180 – 2C. The increase in vial weight represents the total dissolved solids.			
THM-SUM-CALC-WP	Water	Total Trihalomethanes (THMs)	CALCULATION
Total Trihalomethanes (THMs) represents the sum of bromodichloromethane, bromoform, chlorodibromomethane and chloroform. For the purpose of calculation, results less than the detection limit (DL) are treated as zero.			
TURBIDITY-WP	Water	Turbidity	APHA 2130B (modified)
Turbidity in aqueous matrices is determined by the nephelometric method.			
UV-%TRANS-WP	Water	UV Transmittance (Calculated)	APHA 5910B
Test method is adapted from APHA Method 5910B. A sample is filtered through a 0.45 um polyethersulfone (PES) filter and its UV Absorbance is measured in a quartz cell at 254 nm. UV Transmittance is calculated from the UV Absorbance result and reported as UV Transmittance per cm. The analysis is carried out without pH adjustment.			
VOC+F1-HSMS-WP	Water	VOC plus F1 by GCMS	EPA 8260C / EPA 5021A
In this method samples are analyzed using a headspace autosampler interfaced to a dual column gas chromatograph with MS and Flame Ionization detectors.			

**ALS test methods may incorporate modifications from specified reference methods to improve performance.

Chain of Custody Numbers:

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
----------------------------	---------------------

Reference Information

WP

ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.

mg/kg - milligrams per kilogram based on dry weight of sample

mg/kg ww - milligrams per kilogram based on wet weight of sample

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight

mg/L - unit of concentration based on volume, parts per million.

< - Less than.

D.L. - The reporting limit.

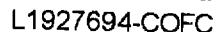
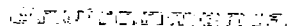
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

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Page of

Special Instructions / Regulation with water or land use (CCME-Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/etc) / Hazardous Details									
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By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY

YELLOW - CLIENT COPY

GENF 18.01 Front



Nunavut Community & Government
Services - Rankin Inlet
ATTN: PAUL VOISEY
Box 96
Whale Cove NU X0C 0J0

Date Received: 14-JUL-17
Report Date: 31-JUL-17 16:36 (MT)
Version: FINAL REV. 2

Client Phone: 867-896-9305

Certificate of Analysis

Lab Work Order #: L1958846

Project P.O. #: NOT SUBMITTED

Job Reference: WHALE COVE - DRINKING WATER

C of C Numbers:

Legal Site Desc:



Hua Wo
Chemistry Laboratory Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 1329 Niakwa Road East, Unit 12, Winnipeg, MB R2J 3T4 Canada | Phone: +1 204 255 9720 | Fax: +1 204 255 9721
ALS CANADA LTD Part of the ALS Group An ALS Limited Company

Physical Tests (WATER)

		ALS ID		L1958846-1	L1958846-2
		Sampled Date		13-JUL-17	13-JUL-17
		Sampled Time		10:10	10:25
		Sample ID			
Analyte	Unit	Guide Limit #1	Guide Limit #2	WHALE COVE - RAW WATER	WHALE COVE - TREATED WATER
Colour, True	CU	15	-	9.0	<5.0
Conductivity	umhos/cm	-	-	252	262
Hardness (as CaCO ₃)	mg/L	-	-	78.8 ^{HTC}	86.2 ^{HTC}
Langelier Index (4 C)	No Unit	-	-	-0.62	-0.40
Langelier Index (60 C)	No Unit	-	-	0.16	0.37
pH	pH units	7.00-10.5	-	7.88	8.04
Total Dissolved Solids	mg/L	500	-	157	168
Transmittance, UV (254 nm)	%T/cm	-	-	80.7	86.7
Turbidity	NTU	-	-	1.02	0.65

Federal Guidelines for Canadian Drinking Water Quality (MAR, 2015)

#1: GCDWQ - Aesthetic Objective/Other Value

#2: GCDWQ - Maximum Acceptable Concentrations (Pre-2003)

Anions and Nutrients (WATER)

		ALS ID		L1958846-1	L1958846-2
		Sampled Date		13-JUL-17	13-JUL-17
		Sampled Time		10:10	10:25
		Sample ID			
Analyte	Unit	Guide Limit #1	Guide Limit #2	WHALE COVE - RAW WATER	WHALE COVE - TREATED WATER
Alkalinity, Total (as CaCO ₃)	mg/L	-	-	57.4	57.6
Ammonia, Total (as N)	mg/L	-	-	<0.010	0.015
Bicarbonate (HCO ₃)	mg/L	-	-	70.0	70.3
Bromide (Br)	mg/L	-	-	0.162	<0.010
Carbonate (CO ₃)	mg/L	-	-	<0.60	<0.60
Chloride (Cl)	mg/L	250	-	46.1	48.4
Fluoride (F)	mg/L	-	1.5	0.037	0.041
Hydroxide (OH)	mg/L	-	-	<0.34	<0.34
Nitrate (as N)	mg/L	-	10	<0.0050	<0.0050
Nitrite (as N)	mg/L	-	1	<0.0010	<0.0010
Sulfate (SO ₄)	mg/L	500	-	9.14	9.20

Federal Guidelines for Canadian Drinking Water Quality (MAR, 2015)

#1: GCDWQ - Aesthetic Objective/Other Value

#2: GCDWQ - Maximum Acceptable Concentrations (Pre-2003)

Organic / Inorganic Carbon (WATER)

		ALS ID		L1958846-1	L1958846-2
		Sampled Date		13-JUL-17	13-JUL-17
		Sampled Time		10:10	10:25
		Sample ID			
Analyte	Unit	Guide Limit #1	Guide Limit #2	WHALE COVE - RAW WATER	WHALE COVE - TREATED WATER
Dissolved Organic Carbon	mg/L	-	-	4.20	4.11
Total Organic Carbon	mg/L	-	-	4.14	3.96

Federal Guidelines for Canadian Drinking Water Quality (MAR, 2015)

#1: GCDWQ - Aesthetic Objective/Other Value

#2: GCDWQ - Maximum Acceptable Concentrations (Pre-2003)

 Detection Limit for result exceeds Guide Limit. Assessment against Guide Limit cannot be made.

 Analytical result for this parameter exceeds Guide Limit listed on this report.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

Total Metals (WATER)

		ALS ID		L1958846-1	L1958846-2
		Sampled Date		13-JUL-17	13-JUL-17
		Sampled Time		10:10	10:25
		Sample ID		WHALE COVE - RAW WATER	WHALE COVE - TREATED WATER
Analyte	Unit	Guide Limit #1	Guide Limit #2		
Aluminum (Al)-Total	mg/L	0.1	-	0.0060	0.0303
Antimony (Sb)-Total	mg/L	-	0.006	<0.00020	<0.00020
Arsenic (As)-Total	mg/L	-	0.01	0.00030	0.00029
Barium (Ba)-Total	mg/L	-	1	0.00928	0.00915
Beryllium (Be)-Total	mg/L	-	-	<0.00020	<0.00020
Bismuth (Bi)-Total	mg/L	-	-	<0.00020	<0.00020
Boron (B)-Total	mg/L	-	-	0.038	0.035
Cadmium (Cd)-Total	mg/L	-	0.005	<0.000010	<0.000010
Calcium (Ca)-Total	mg/L	-	-	23.1	26.2
Cesium (Cs)-Total	mg/L	-	-	<0.00010	<0.00010
Chromium (Cr)-Total	mg/L	-	0.05	<0.0010	<0.0010
Cobalt (Co)-Total	mg/L	-	-	<0.00020	<0.00020
Copper (Cu)-Total	mg/L	1	-	0.00255	0.00435
Iron (Fe)-Total	mg/L	0.3	-	0.033	0.033
Lead (Pb)-Total	mg/L	-	0.01	<0.000090	0.000213
Lithium (Li)-Total	mg/L	-	-	<0.0020	<0.0020
Magnesium (Mg)-Total	mg/L	-	-	5.11	5.08
Manganese (Mn)-Total	mg/L	0.05	-	0.00419	0.00396
Molybdenum (Mo)-Total	mg/L	-	-	0.00155	0.00152
Nickel (Ni)-Total	mg/L	-	-	<0.0020	<0.0020
Phosphorus (P)-Total	mg/L	-	-	<0.10	<0.10
Potassium (K)-Total	mg/L	-	-	2.05	2.03
Rubidium (Rb)-Total	mg/L	-	-	0.00181	0.00187
Selenium (Se)-Total	mg/L	-	0.05	<0.0010	<0.0010
Silicon (Si)-Total	mg/L	-	-	0.24	0.23
Silver (Ag)-Total	mg/L	-	-	<0.00010	<0.00010
Sodium (Na)-Total	mg/L	200	-	32.8	32.5
Strontium (Sr)-Total	mg/L	-	-	0.124	0.118
Tellurium (Te)-Total	mg/L	-	-	<0.00020	<0.00020
Thallium (Tl)-Total	mg/L	-	-	<0.00010	<0.00010
Thorium (Th)-Total	mg/L	-	-	<0.00010	<0.00010
Tin (Sn)-Total	mg/L	-	-	<0.00020	<0.00020
Titanium (Ti)-Total	mg/L	-	-	<0.00050	<0.00050

Federal Guidelines for Canadian Drinking Water Quality (MAR, 2015)

#1: GCDWQ - Aesthetic Objective/Other Value

#2: GCDWQ - Maximum Acceptable Concentrations (Pre-2003)

 Detection Limit for result exceeds Guide Limit. Assessment against Guide Limit cannot be made.

 Analytical result for this parameter exceeds Guide Limit listed on this report.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

Total Metals (WATER)

		ALS ID		L1958846-1	L1958846-2
		Sampled Date		13-JUL-17	13-JUL-17
		Sampled Time		10:10	10:25
		Sample ID		WHALE COVE - RAW WATER	WHALE COVE - TREATED WATER
Analyte	Unit	Guide Limit #1	Guide Limit #2		
Tungsten (W)-Total	mg/L	-	-	<0.00010	<0.00010
Uranium (U)-Total	mg/L	-	0.02	<0.00010	<0.00010
Vanadium (V)-Total	mg/L	-	-	<0.00020	<0.00020
Zinc (Zn)-Total	mg/L	5	-	0.0033	0.0238
Zirconium (Zr)-Total	mg/L	-	-	<0.00040	<0.00040

Federal Guidelines for Canadian Drinking Water Quality (MAR, 2015)

#1: GCDWQ - Aesthetic Objective/Other Value

#2: GCDWQ - Maximum Acceptable Concentrations (Pre-2003)

Volatile Organic Compounds (WATER)

		ALS ID		L1958846-2
		Sampled Date		13-JUL-17
		Sampled Time		10:25
		Sample ID		WHALE COVE - TREATED WATER
Analyte	Unit	Guide Limit #1	Guide Limit #2	
Bromodichloromethane	mg/L	-	-	0.0432
Bromoform	mg/L	-	-	0.00183
Dibromochloromethane	mg/L	-	-	0.0232
Chloroform	mg/L	-	-	0.0612
Surrogate: 4-Bromofluorobenzene (SS)	%	-	-	97.9
Surrogate: 1,4-Difluorobenzene (SS) %		-	-	102.1

Federal Guidelines for Canadian Drinking Water Quality (MAR, 2015)

#1: GCDWQ - Aesthetic Objective/Other Value

#2: GCDWQ - Maximum Acceptable Concentrations (Pre-2003)

Trihalomethanes (WATER)

		ALS ID		L1958846-2
		Sampled Date		13-JUL-17
		Sampled Time		10:25
		Sample ID		WHALE COVE - TREATED WATER
Analyte	Unit	Guide Limit #1	Guide Limit #2	
Total THMs	mg/L	-	0.1	0.129

Federal Guidelines for Canadian Drinking Water Quality (MAR, 2015)

#1: GCDWQ - Aesthetic Objective/Other Value

#2: GCDWQ - Maximum Acceptable Concentrations (Pre-2003)

 Detection Limit for result exceeds Guide Limit. Assessment against Guide Limit cannot be made.

 Analytical result for this parameter exceeds Guide Limit listed on this report.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

Haloacetic Acids (WATER)

		ALS ID		L1958846-2
		Sampled Date		13-JUL-17
		Sampled Time		10:25
		Sample ID		
Analyte	Unit	Guide Limit #1	Guide Limit #2	WHALE COVE - TREATED WATER
Bromochloroacetic Acid	mg/L	-	-	
Dibromoacetic Acid	mg/L	-	-	
Dichloroacetic Acid	mg/L	-	-	
Total Haloacetic Acids 5	mg/L	-	0.08	
Monobromoacetic Acid	mg/L	-	-	
Monochloroacetic Acid	mg/L	-	-	
Trichloroacetic Acid	mg/L	-	-	
Surrogate: 2,3-Dibromopropionic Acid (SS)	%	-	-	

Federal Guidelines for Canadian Drinking Water Quality (MAR, 2015)

#1: GCDWQ - Aesthetic Objective/Other Value

#2: GCDWQ - Maximum Acceptable Concentrations (Pre-2003)

Detection Limit for result exceeds Guide Limit. Assessment against Guide Limit cannot be made.

Analytical result for this parameter exceeds Guide Limit listed on this report.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

Reference Information

Qualifiers for Individual Parameters Listed:

Qualifier	Description
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable).

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-CO3CO3-CALC-WP	Water	Alkalinity, Carbonate	CALCULATION
The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by carbonate is calculated and reported as mg CO ₃ 2-/L.			
ALK-HCO3HCO3-CALC-WP	Water	Alkalinity, Bicarbonate	CALCULATION
The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by bicarbonate is calculated and reported as mg HCO ₃ -/L.			
ALK-OH-OH-CALC-WP	Water	Alkalinity, Hydroxide	CALCULATION
The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by hydroxide is calculated and reported as mg OH-/L.			
ALK-TITR-WP	Water	Alkalinity, Total (as CaCO ₃)	APHA 2320B
The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. Total alkalinity is determined by titration with a strong standard mineral acid to the successive HCO ₃ ⁻ and H ₂ CO ₃ endpoints indicated electrometrically.			
BR-L-IC-N-WP	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)-LR
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
C-DOC-HTC-WP	Water	Dissolved Organic Carbon by Combustion	APHA 5310 B-WP
Filtered (0.45 um) sample is acidified and purged to remove inorganic carbon, then injected into a heated reaction chamber where organic carbon is oxidized to CO ₂ which is then transported in the carrier gas stream and measured via a non-dispersive infrared analyzer.			
C-TOC-HTC-WP	Water	Total Organic Carbon by Combustion	APHA 5310 B-WP
Sample is acidified and purged to remove inorganic carbon, then injected into a heated reaction chamber where organic carbon is oxidized to CO ₂ which is then transported in the carrier gas stream and measured via a non-dispersive infrared analyzer.			
CL-L-IC-N-WP	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
COLOUR-TRUE-WP	Water	Colour, True	APHA 2120C
True Colour is measured spectrophotometrically by comparison to platinum-cobalt standards using the single wavelength method (450 - 465 nm) after filtration of sample through a 0.45 um filter. Colour measurements can be highly pH dependent, and apply to the pH of the sample as received (at time of testing), without pH adjustment. Concurrent measurement of sample pH is recommended.			
EC-WP	Water	Conductivity	APHA 2510B
Conductivity of an aqueous solution refers to its ability to carry an electric current. Conductance of a solution is measured between two spatially fixed and chemically inert electrodes.			
ETL-LANGELIER-4-WP	Water	Langelier Index 4C	Calculated
ETL-LANGELIER-60-WP	Water	Langelier Index 60C	Calculated
F-IC-N-WP	Water	Fluoride in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HAA-WP	Water	Haloacetic Acids	EPA 552 (modified)
HAA concentration is determined using liquid-liquid extraction, capillary column, GC/electron capture techniques.			
HAA5-SUM-CALC-WP	Water	Total Haloacetic Acids 5 (HAA5)	CALCULATION
Total Haloacetic Acids 5 (HAA5) represents the sum of monobromoacetic acid, monochloroacetic acid, dibromoacetic acid, dichloroacetic acid and trichloroacetic acid. For the purpose of calculation, results less than the detection limit (DL) are treated as zero.			

Reference Information

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-WP	Water	Hardness Calculated	APHA 2340B
Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO ₃ equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.			
IONBALANCE-CALC-WP	Water	Ion Balance Calculation	APHA 1030E
Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.			
Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance (as % difference) cannot be calculated accurately for waters with very low electrical conductivity (EC), and is reported as "Low EC" where EC < 100 uS/cm (umhos/cm). Ion Balance is calculated as:			
Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]			
MET-T-L-MS-WP	Water	Total Metals by ICP-MS	APHA 3030E/EPA 6020A-TL
This analysis involves preliminary sample treatment by hotblock acid digestion (APHA 3030E). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).			
NH3-COL-WP	Water	Ammonia by colour	APHA 4500 NH ₃ F
Ammonia in water samples forms indophenol when reacted with hypochlorite and phenol. The intensity is amplified by the addition of sodium nitroprusside and measured colourmetrically.			
NO2-L-IC-N-WP	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
NO3-L-IC-N-WP	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
PH-WP	Water	pH	APHA 4500H
The pH of a sample is the determination of the activity of the hydrogen ions by potentiometric measurement using a standard hydrogen electrode and a reference electrode.			
SO4-IC-N-WP	Water	Sulfate in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
TDS-WP	Water	Total Dissolved Solids (TDS)	APHA 2540 SOLIDS C,E
A well-mixed sample is filtered through a glass fiber filter paper. The filtrate is then evaporated to dryness in a pre-weighed vial and dried at 180 – 2C. The increase in vial weight represents the total dissolved solids.			
THM-SUM-CALC-WP	Water	Total Trihalomethanes (THMs)	CALCULATION
Total Trihalomethanes (THMs) represents the sum of bromodichloromethane, bromoform, chlorodibromomethane and chloroform. For the purpose of calculation, results less than the detection limit (DL) are treated as zero.			
TURBIDITY-WP	Water	Turbidity	APHA 2130B (modified)
Turbidity in aqueous matrices is determined by the nephelometric method.			
UV-%TRANS-WP	Water	UV Transmittance (Calculated)	APHA 5910B
Test method is adapted from APHA Method 5910B. A sample is filtered through a 0.45 um polyethersulfone (PES) filter and its UV Absorbance is measured in a quartz cell at 254 nm. UV Transmittance is calculated from the UV Absorbance result and reported as UV Transmittance per cm. The analysis is carried out without pH adjustment.			
VOC+F1-HSMS-WP	Water	VOC plus F1 by GCMS	EPA 8260C / EPA 5021A
In this method samples are analyzed using a headspace autosampler interfaced to a dual column gas chromatograph with MS and Flame Ionization detectors.			

**ALS test methods may incorporate modifications from specified reference methods to improve performance.

Chain of Custody Numbers:

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
----------------------------	---------------------

Reference Information

WP

ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.

mg/kg - milligrams per kilogram based on dry weight of sample

mg/kg ww - milligrams per kilogram based on wet weight of sample

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight

mg/L - unit of concentration based on volume, parts per million.

< - Less than.

D.L. - The reporting limit.

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

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Page 1 of 2

NA File 032-408 Exempt 4 January 201

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.



Nunavut Community & Government Services - Rankin Inlet
Whale Cove Health Unit
Whale Cove NU X0C 0J0
ATTN: PAUL VOISEY

Date: 17-DEC-18
PO No.:
WO No.: L2210736
Project Ref: WHALE COVE
Sample ID: HEALTH CENTRE
Sampled By: Ethan
Date Collected: 12-DEC-18
Lab Sample ID: L2210736-1
Matrix: WATER

PAGE 1 of 8

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli						
Total Coliforms	0	PEHR	MPN/100mL	0		14-DEC-18
Escherichia Coli	0	PEHR	MPN/100mL	0		14-DEC-18
CDWQG = Health Canada Guideline Limits updated MAY 2018						
* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit. * Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality - A blank entry designates no known limit. - A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.						
Approved by 						
Hua Wo Account Manager						

ADDRESS: 1329 Niakwa Road East, Unit 12, Winnipeg, MB R2J 3T4 Canada | Phone: +1 204 255 9720 | Fax: +1 204 255 9721
ALS CANADA LTD Part of the ALS Group A Campbell Brothers Limited Company



Nunavut Community & Government Services - Rankin Inlet
Whale Cove Health Unit
Whale Cove NU X0C 0J0
ATTN: PAUL VOISEY

Date: 17-DEC-18
PO No.:
WO No.: L2210736
Project Ref: WHALE COVE
Sample ID: SCHOOL
Sampled By: Ethan
Date Collected: 12-DEC-18
Lab Sample ID: L2210736-2
Matrix: WATER

PAGE 2 of 8

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli						
Total Coliforms	0	PEHR	MPN/100mL	0		14-DEC-18
Escherichia Coli	0	PEHR	MPN/100mL	0		14-DEC-18
CDWQG = Health Canada Guideline Limits updated MAY 2018						
* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit. * Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality - A blank entry designates no known limit. - A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.						
Approved by 						
Hua Wo Account Manager						

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Nunavut Community & Government Services - Rankin Inlet
Whale Cove Health Unit
Whale Cove NU X0C 0J0
ATTN: PAUL VOISEY

Date: 17-DEC-18
PO No.:
WO No.: L2210736
Project Ref: WHALE COVE
Sample ID: HOTEL
Sampled By: Ethan
Date Collected: 12-DEC-18
Lab Sample ID: L2210736-3
Matrix: WATER

PAGE 3 of 8

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli						
Total Coliforms	0	PEHR	MPN/100mL	0		14-DEC-18
Escherichia Coli	0	PEHR	MPN/100mL	0		14-DEC-18
CDWQG = Health Canada Guideline Limits updated MAY 2018						
* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit. * Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality - A blank entry designates no known limit. - A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.						
Approved by 						
Hua Wo Account Manager						

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ALS CANADA LTD Part of the ALS Group A Campbell Brothers Limited Company



Nunavut Community & Government Services - Rankin Inlet
Whale Cove Health Unit
Whale Cove NU X0C 0J0
ATTN: PAUL VOISEY

Date: 17-DEC-18
PO No.:
WO No.: L2210736
Project Ref: WHALE COVE
Sample ID: COMMUNITY HALL
Sampled By: Ethan
Date Collected: 12-DEC-18
Lab Sample ID: L2210736-4
Matrix: WATER

PAGE 4 of 8

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli						
Total Coliforms	0	PEHR	MPN/100mL	0		14-DEC-18
Escherichia Coli	0	PEHR	MPN/100mL	0		14-DEC-18
CDWQG = Health Canada Guideline Limits updated MAY 2018						
* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit. * Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality - A blank entry designates no known limit. - A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.						
Approved by 						
Hua Wo Account Manager						

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ALS CANADA LTD Part of the ALS Group A Campbell Brothers Limited Company



Nunavut Community & Government Services - Rankin Inlet
Whale Cove Health Unit
Whale Cove NU X0C 0J0
ATTN: PAUL VOISEY

Date: 17-DEC-18
PO No.:
WO No.: L2210736
Project Ref: WHALE COVE
Sample ID: NEW WATER TRUCK
Sampled By: Ethan
Date Collected: 12-DEC-18
Lab Sample ID: L2210736-5
Matrix: WATER

PAGE 5 of 8

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli						
Total Coliforms	0	PEHR	MPN/100mL	0		14-DEC-18
Escherichia Coli	0	PEHR	MPN/100mL	0		14-DEC-18
CDWQG = Health Canada Guideline Limits updated MAY 2018						
* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit. * Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality - A blank entry designates no known limit. - A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.						
Approved by 						
Hua Wo Account Manager						

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ALS CANADA LTD Part of the ALS Group A Campbell Brothers Limited Company



Nunavut Community & Government Services - Rankin Inlet
Whale Cove Health Unit
Whale Cove NU X0C 0J0
ATTN: PAUL VOISEY

Date: 17-DEC-18
PO No.:
WO No.: L2210736
Project Ref: WHALE COVE
Sample ID: HAMLET OFFICE
Sampled By: Ethan
Date Collected: 12-DEC-18
Lab Sample ID: L2210736-6
Matrix: WATER

PAGE 6 of 8

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli						
Total Coliforms	165	PEHR	MPN/100mL	0		14-DEC-18
Escherichia Coli	0	PEHR	MPN/100mL	0		14-DEC-18
CDWQG = Health Canada Guideline Limits updated MAY 2018						
* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit. * Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality - A blank entry designates no known limit. - A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.						
Approved by 						
Hua Wo Account Manager						

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ALS CANADA LTD Part of the ALS Group A Campbell Brothers Limited Company



Nunavut Community & Government Services - Rankin Inlet
Whale Cove Health Unit
Whale Cove NU X0C 0J0
ATTN: PAUL VOISEY

Date: 17-DEC-18
PO No.:
WO No.: L2210736
Project Ref: WHALE COVE
Sample ID: RAW WATER
Sampled By: Ethan
Date Collected: 12-DEC-18
Lab Sample ID: L2210736-7
Matrix: WATER

PAGE 7 of 8

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli						
Total Coliforms	59	PEHR	MPN/100mL	0		14-DEC-18
Escherichia Coli	0	PEHR	MPN/100mL	0		14-DEC-18
CDWQG = Health Canada Guideline Limits updated MAY 2018						
* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit. * Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality - A blank entry designates no known limit. - A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.						
Approved by 						
Hua Wo Account Manager						

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ALS CANADA LTD Part of the ALS Group A Campbell Brothers Limited Company

Guidelines & Objectives

Sample Parameter Qualifier key listed:

Qualifier	Description
PEHR	Parameter Exceeded Recommended Holding Time On Receipt: Proceed With Analysis As Requested.

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO ₃ -1
Carbonate	See Alkalinity. Reported at the anion CO ₃ -2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).The aesthetic objective (not related to health) for sodium in drinking water is 200 mg/L. However, where sodium concentration of the drinking water exceeds 20 mg/L, it is recommended that any person on a sodium restricted diet consult with his/her physician or Medical Officer of Health concerning the use of that water.
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Manganese	Elevated levels may cause staining of laundry and porcelain.
Heterotrophic	
Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.

mg/kg - milligrams per kilogram based on dry weight of sample

mg/kg wwt - milligrams per kilogram based on wet weight of sample

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight

mg/L - unit of concentration based on volume, parts per million.

< - Less than.

D.L. - The reporting limit.

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L2210736

Report Date: 17-DEC-18

Page 1 of 3

Client: Nunavut Community & Government Services - Rankin Inlet

Whale Cove Health Unit

Whale Cove NU X0C 0J0

Contact: PAUL VOISEY

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TC,EC-QT51-WP		Water						
Batch	R4396386							
WG2954355-1		MB						
Total Coliforms			0		MPN/100mL		1	14-DEC-18
Escherichia Coli			0		MPN/100mL		1	14-DEC-18

Quality Control Report

Workorder: L2210736

Report Date: 17-DEC-18

Page 2 of 3

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Quality Control Report

Workorder: L2210736

Report Date: 17-DEC-18

Page 3 of 3

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Bacteriological Tests							
Total Coliform and E.coli							
	1	12-DEC-18 09:00	14-DEC-18 15:20	30	54	hours	EHTR
	2	12-DEC-18 09:10	14-DEC-18 15:20	30	54	hours	EHTR
	3	12-DEC-18 09:38	14-DEC-18 15:20	30	54	hours	EHTR
	4	12-DEC-18 09:50	14-DEC-18 15:20	30	54	hours	EHTR
	5	12-DEC-18 10:41	14-DEC-18 15:20	30	53	hours	EHTR
	6	12-DEC-18 09:30	14-DEC-18 15:20	30	54	hours	EHTR
	7	12-DEC-18 08:50	14-DEC-18 15:20	30	54	hours	EHTR

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:

Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.

Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2210736 were received on 14-DEC-18 13:00.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.



L2210736-COFC

Service Requested (Rush for routine analysis subject to availability)

☐ Regular (Standard Turnaround Times - Business Days)

☐ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT

☒ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT

☐ Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Analysis Request	
Please indicate below Filtered, Preserved or both (F, P, F/P)	

[illegible]

Report To		Reported By	
Company:	Nunavut - Community & Gov't Services (W8133)	Company:	
Contact:	PAUL VOISEY	Contact:	
Address:	Box 96	Address:	
	Whale Cove, NU, X0C 0J0		
Phone:	867-898-9305	Fax:	867-898-9304
Invoice To	Same as Report ? ☒ Yes ☐ No	Invoice To	
Hardcopy of Invoice with Report?	☐ Yes ☐ No	Hardcopy of Invoice with Report?	
Company:		Company:	
Contact:		Contact:	
Address:		Address:	
Phone:		Fax:	

Lab Work Order # (lab use only):	L2210736	ALS Contact: Craig Riddell	Sampled By: EK
-------------------------------------	----------	-------------------------------	----------------

Sample #	Sample Identification (This description will appear on the report)	Date Sampled	Time Sampled	Sample Type
1	Raw Water	Dec 12 2018	8:50 AM	Surface Water
2	Water Truck		10:41 AM	Water
3	Health Centre Free 0.99		9:00 AM	Water
4	School Free 0.15		9:10 AM	Water
5	Hotel Free 0.058		9:38 AM	Water
6	Hamlet Office Free 0.05		9:30 AM	Water
7	Community Hall Free 0.05		9:50 AM	Water
PLEASE CROSS OUT ANY SAMPLE LOCATIONS NOT TAKEN				

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

TC, EC-QT97-WP With 1:10 dilution for Raw Water Sample

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.

Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (mm-dd-yy)	Time (h-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
Ethan Kendrick	12/12/18	10:50 AM	AAL	1:00	Dec. 14	8-7 °C				

Report ID: 304798-IAS
Report Date: 06-Mar-19
Date Received: 25-Feb-19

CERTIFICATE OF ANALYSIS

for

Dillon Consulting Limited
274 Sydney Street, Suite 200
Saint John, NB E2L 0A8

rpc

921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Dave McKenna

Project #: 18-8932-5000

Location: Whale Cove

Analysis of Potable Water

RPC Sample ID:					304798-1
Client Sample ID:					Raw
Date Sampled:					21-Feb-19
Analytes	Units	RL	MAC	AO	
Alkalinity (as CaCO ₃)	mg/L	2	-	-	89
Chloride	mg/L	0.5	-	250	80.4
Colour	TCU	5	-	15	8
Conductivity	µS/cm	1	-	-	457
Fluoride	mg/L	0.05	1.5	-	0.15
Nitrate + Nitrite (as N)	mg/L	0.05	10	-	< 0.05
pH	units	-	-	-	7.1
Phosphorus	mg/L	0.02	-	-	< 0.02
Sulfate	mg/L	1	-	500	16
Turbidity	NTU	0.1	-	-	0.5
Calculated Parameters					
Hardness (as CaCO ₃)	mg/L	0.2	-	-	107
TDS (calc)	mg/L	-	-	500	236
Saturation pH (5°C)	units	-	-	-	8.2
Langelier Index (5°C)	-	-	-	-	-1.08

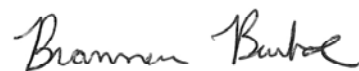
This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit; MAC = Maximum Acceptable Concentration; AO = Aesthetic Objective

Guidelines are from Guidelines for Canadian Drinking Water Quality (February 2017).



Ross Kean
Department Head
Inorganic Analytical Chemistry



Brannen Burhoe
Chemical Technician
Inorganic Analytical Services

POTABLE WATER CHEM

Page 1 of 4

Report ID: 304798-IAS
 Report Date: 06-Mar-19
 Date Received: 25-Feb-19

CERTIFICATE OF ANALYSIS

for

Dillon Consulting Limited
 274 Sydney Street, Suite 200
 Saint John, NB E2L 0A8



921 College Hill Rd
 Fredericton NB
 Canada E3B 6Z9
 Tel: 506.452.1212
 Fax: 506.452.0594
 www.rpc.ca

Attention: Dave McKenna

Project #: 18-8932-5000

Location: Whale Cove

Analysis of Metals in Potable Water

RPC Sample ID:					304798-1
Client Sample ID:					Raw
Date Sampled:					21-Feb-19
Analytes	Units	RL	MAC	AO	
Aluminum	mg/L	0.001	-	-	0.001
Antimony	mg/L	0.0001	0.006	-	< 0.0001
Arsenic	mg/L	0.001	0.01	-	< 0.001
Barium	mg/L	0.001	1	-	0.016
Beryllium	mg/L	0.0001	-	-	< 0.0001
Bismuth	mg/L	0.001	-	-	< 0.001
Boron	mg/L	0.001	5	-	0.050
Cadmium	mg/L	0.00001	0.005	-	< 0.00001
Calcium	mg/L	0.05	-	-	31.4
Chromium	mg/L	0.001	0.05	-	< 0.001
Cobalt	mg/L	0.0001	-	-	< 0.0001
Copper	mg/L	0.001	-	1	0.002
Iron	mg/L	0.02	-	0.3	0.07
Lead	mg/L	0.0001	0.01	-	< 0.0001
Lithium	mg/L	0.0001	-	-	0.0026
Magnesium	mg/L	0.01	-	-	6.84
Manganese	mg/L	0.001	-	0.05	0.009
Mercury	mg/L	0.000025	0.001	-	< 0.000025
Molybdenum	mg/L	0.0001	-	-	0.0016
Nickel	mg/L	0.001	-	-	< 0.001
Potassium	mg/L	0.02	-	-	2.85
Rubidium	mg/L	0.0001	-	-	0.0028
Selenium	mg/L	0.001	0.05	-	< 0.001
Silver	mg/L	0.0001	-	-	< 0.0001
Sodium	mg/L	0.05	-	200	43.8
Strontium	mg/L	0.001	-	-	0.200
Tellurium	mg/L	0.0001	-	-	< 0.0001
Thallium	mg/L	0.0001	-	-	< 0.0001
Tin	mg/L	0.0001	-	-	< 0.0001
Uranium	mg/L	0.0001	0.02	-	0.0002
Vanadium	mg/L	0.001	-	-	< 0.001
Zinc	mg/L	0.001	-	5	0.006

POTABLE WATER METALS

Report ID: 304798-IAS
Report Date: 06-Mar-19
Date Received: 25-Feb-19

CERTIFICATE OF ANALYSIS

for
Dillon Consulting Limited
274 Sydney Street, Suite 200
Saint John, NB E2L 0A8



921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Dave McKenna

Project #: 18-8932-5000

Location: Whale Cove

Analysis of Water

RPC Sample ID:					304798-1
Client Sample ID:					Raw
Date Sampled:					21-Feb-19
Analytes	Units	RL	MAC	AO	
Carbon - Dissolved Organic	mg/L	0.5	-	-	4.2

Report ID: 304798-IAS
Report Date: 06-Mar-19
Date Received: 25-Feb-19

CERTIFICATE OF ANALYSIS

for
Dillon Consulting Limited
274 Sydney Street, Suite 200
Saint John, NB E2L 0A8



921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Methods

<u>Analyte</u>	<u>RPC SOP #</u>	<u>Method Reference</u>	<u>Method Principle</u>
pH	4.M03	APHA 4500-H ⁺ B	pH Electrode - Electrometric
Alkalinity (as CaCO ₃)	4.M43	EPA 310.2	Methyl Orange Colourimetry
Chloride	4.M44	APHA 4500-CL E	Ferricyanide Colourimetry
Fluoride	4.M30	APHA 4500-F- D	SPADNS Colourimetry
Sulfate	4.M45	APHA 4500-SO ₄ E	Turbidimetry
Nitrate + Nitrite (as N)	4.M48	APHA 4500-NO ₃ H	Hydrazine Red., Derivatization, Colourimetry
Carbon - Dissolved Organic	4.M38	APHA 5310 C	UV-Persulfate Digestion, NDIR Detection
Turbidity	4.M06	APHA 2130 B	Nephelometry
Colour	4.M55	APHA 2120 Color (A,C)	Single Wavelength Spectrophotometry
Conductivity	4.M04	APHA 2510 B	Conductivity Meter, Pt Electrode
Trace Metals	4.M01/4.M29	EPA 200.8/EPA 200.7	ICP-MS/ICP-ES
Mercury	4.M52	EPA 245.1	Cold Vapor AAS

Your Project #: 18-8932
Site#: WHALE COVE, NU
Your C.O.C. #: M104276

Attention: Kyle MacIntyre

Dillon Consulting Limited
137 Chain Lake Dr
Suite 100
Halifax, NS
CANADA B3S 1B3

Report Date: 2019/04/23
Report #: R2712940
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B925245

Received: 2019/04/06, 10:40

Sample Matrix: Water
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	2	N/A	2019/04/09	AB SOP-00005	SM 23 2320 B m
BTEX/F1 in Water by HS GC/MS/FID	2	N/A	2019/04/09	AB SOP-00039	CCME CWS/EPA 8260d m
F1-BTEX	2	N/A	2019/04/09	AB SOP-00039	Auto Calc
Cadmium - low level CCME - Dissolved	2	N/A	2019/04/12	AB WI-00065	Auto Calc
Cadmium - low level CCME (Total)	2	N/A	2019/04/10	AB WI-00065	Auto Calc
Chloride by Automated Colourimetry	2	N/A	2019/04/09	AB SOP-00020	SM 23 4500-Cl-E m
Fecal Coliforms (MF)	2	2019/04/06	2019/04/07	EENVSOP-00157	SM 23 9222 D m
Total Coliforms and E.Coli	2	2019/04/06	2019/04/07	AB SOP-00089	SM 23 9223 A,B m
Carbon (DOC) -Lab Filtered (2)	2	N/A	2019/04/15	AB SOP-00087	MMCW 119 1996 m
Conductivity @25C	2	N/A	2019/04/09	AB SOP-00005	SM 23 2510 B m
CCME Hydrocarbons (F2-F4 in water) (3)	2	2019/04/15	2019/04/15	AB SOP-00037 / AB SOP-00040	CCME PHC-CWS m
Hardness	2	N/A	2019/04/10	AB WI-00065	Auto Calc
Elements by ICP - Dissolved (4)	2	N/A	2019/04/10	AB SOP-00042	EPA 6010d R5 m
Elements by ICP - Total	2	2019/04/09	2019/04/10	AB SOP-00014 / AB SOP-00042	EPA 6010d R4 m
Elements by ICPMS - Dissolved (4)	1	N/A	2019/04/10	AB SOP-00043	EPA 6020b R2 m
Elements by ICPMS - Dissolved (4)	1	N/A	2019/04/15	AB SOP-00043	EPA 6020b R2 m
Elements by ICPMS - Total	2	2019/04/09	2019/04/10	AB SOP-00014 / AB SOP-00043	EPA 6020b R2 m
Ion Balance	2	N/A	2019/04/09	AB WI-00065	Auto Calc
Sum of cations, anions	2	N/A	2019/04/10	AB WI-00065	Auto Calc
Ammonia-N (Total)	2	N/A	2019/04/09	AB SOP-00007	SM 23 4500 NH3 A G m
Nitrate and Nitrite	2	N/A	2019/04/11	AB WI-00065	Auto Calc
Nitrate + Nitrite-N (calculated)	2	N/A	2019/04/11	AB WI-00065	Auto Calc
Nitrogen (Nitrite - Nitrate) by IC	2	N/A	2019/04/09	AB SOP-00023	SM 23 4110 B m
pH @25°C (5)	2	N/A	2019/04/09	AB SOP-00005	SM 23 4500 H+ B m
Orthophosphate by Konelab (6)	2	N/A	2019/04/09	AB SOP-00025	SM 23 4500-P A,F m
Sat. pH and Langelier Index (@ 20C)	2	N/A	2019/04/10		
Sat. pH and Langelier Index (@ 4C)	2	N/A	2019/04/10		
Silica (Reactive)	2	N/A	2019/04/13	AB SOP-00011	EPA 370.1 R1978 m

Your Project #: 18-8932
Site#: WHALE COVE, NU
Your C.O.C. #: M104276

Attention: Kyle MacIntyre

Dillon Consulting Limited
137 Chain Lake Dr
Suite 100
Halifax, NS
CANADA B3S 1B3

Report Date: 2019/04/23
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MAXXAM JOB #: B925245

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Sample Matrix: Water
Samples Received: 2

Analyses	Date		Date Analyzed	Laboratory Method	Analytical Method
	Quantity	Extracted			
Sulphate by Automated Colourimetry	2	N/A	2019/04/09	AB SOP-00018	SM 23 4500-SO4 E m
Total Dissolved Solids (Calculated)	2	N/A	2019/04/10	AB WI-00065	Auto Calc
Total Trihalomethanes Calculation	2	N/A	2019/04/10	AB SOP-00056	Auto Calc
Carbon (Total Organic) (7)	2	N/A	2019/04/15	AB SOP-00087	MMCW 119 1996 m
Turbidity	2	N/A	2019/04/09	EENVSOP-00066	SM 23 2130 B m
VOCs in Water by HS GC/MS (Std List)	2	N/A	2019/04/09	AB SOP-00056	EPA 5021a/8260d m
Haloacetic Acids in Water (1)	2	2019/04/15	2019/04/16	ATL SOP 00129	EPA 552.2 m

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing. Maxxam is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.

Results relate to samples tested. When sampling is not conducted by Maxxam, results relate to the supplied samples tested.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) This test was performed by Maxxam Bedford(From Edmonton)

(2) DOC present in the sample should be considered as non-purgeable DOC. Dissolved > Total Imbalance: When applicable, Dissolved and Total results were reviewed and data quality meets acceptable levels unless otherwise noted.

(3) Silica gel clean up employed.

(4) Dissolved > Total Imbalance: When applicable, Dissolved and Total results were reviewed and data quality meets acceptable levels unless otherwise noted.

Your Project #: 18-8932
Site#: WHALE COVE, NU
Your C.O.C. #: M104276

Attention: Kyle MacIntyre

Dillon Consulting Limited
137 Chain Lake Dr
Suite 100
Halifax, NS
CANADA B3S 1B3

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(5) The CCME method requires pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the CCME holding time. Maxxam endeavours to analyze samples as soon as possible after receipt.

(6) Orthophosphate > Total Phosphorus Imbalance: When applicable, Orthophosphate, Total Phosphorus and dissolved Phosphorus results were reviewed and data quality meets acceptable levels unless otherwise noted.

(7) TOC present in the sample should be considered as non-purgeable TOC.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Amanda Hung, B.Sc., Project Manager

Email: AHung@maxxam.ca

Phone# (204)772-7276 Ext:7062215

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This report has been generated and distributed using a secure automated process.

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B925245
Report Date: 2019/04/23

Dillon Consulting Limited
Client Project #: 18-8932
Sampler Initials: JB

AT1 BTEX AND F1-F4 IN WATER (WATER)

Maxxam ID		VM3236	VM3237		
Sampling Date		2019/04/05 10:30	2019/04/04 13:00		
COC Number		M104276	M104276		
	UNITS	1 BOTTLE - TREATED	2 - RAW WATER	RDL	QC Batch
Ext. Pet. Hydrocarbon					
F2 (C10-C16 Hydrocarbons)	mg/L	ND (1)	ND (1)	0.27	9380863
F3 (C16-C34 Hydrocarbons)	mg/L	ND (1)	ND (1)	0.27	9380863
F4 (C34-C50 Hydrocarbons)	mg/L	ND (1)	ND (1)	0.55	9380863
Volatiles					
Benzene	ug/L	ND	ND	0.40	9374475
Toluene	ug/L	ND	ND	0.40	9374475
Ethylbenzene	ug/L	ND	ND	0.40	9374475
m & p-Xylene	ug/L	ND	ND	0.80	9374475
o-Xylene	ug/L	ND	ND	0.40	9374475
Xylenes (Total)	ug/L	ND	ND	0.89	9374421
F1 (C6-C10) - BTEX	ug/L	ND	ND	100	9374421
F1 (C6-C10)	ug/L	ND	ND	100	9374475
Surrogate Recovery (%)					
1,4-Difluorobenzene (sur.)	%	99	99		9374475
4-Bromofluorobenzene (sur.)	%	100	100		9374475
D4-1,2-Dichloroethane (sur.)	%	96	96		9374475
O-TERPHENYL (sur.)	%	97	101		9380863
RDL = Reportable Detection Limit					
ND = Not detected					
(1) Detection limit raised based on sample volume used for analysis.					

Maxxam Job #: B925245
Report Date: 2019/04/23

Dillon Consulting Limited
Client Project #: 18-8932
Sampler Initials: JB

ROUTINE WATER & DISS. REGULATED METALS (WATER)

Maxxam ID		VM3236		VM3237		
Sampling Date		2019/04/05 10:30		2019/04/04 13:00		
COC Number		M104276		M104276		
	UNITS	1 BOTTLE - TREATED	QC Batch	2 - RAW WATER	RDL	QC Batch
Calculated Parameters						
Anion Sum	meq/L	4.8	9374232	4.7	N/A	9374232
Cation Sum	meq/L	4.7	9374232	4.5	N/A	9374232
Hardness (CaCO ₃)	mg/L	120	9374119	110	0.50	9374119
Ion Balance (% Difference)	%	1.4	9374231	2.2	N/A	9374231
Dissolved Nitrate (NO ₃)	mg/L	0.21	9374233	0.25	0.044	9374233
Nitrate plus Nitrite (N)	mg/L	0.047	9374234	0.056	0.014	9374234
Dissolved Nitrite (NO ₂)	mg/L	ND	9374233	ND	0.033	9374233
Calculated Total Dissolved Solids	mg/L	270	9374236	260	10	9374236
Misc. Inorganics						
Conductivity	uS/cm	500	9375363	500	2.0	9375363
pH	pH	7.50	9375361	7.50	N/A	9375361
Low Level Elements						
Dissolved Cadmium (Cd)	ug/L	0.024	9374115	ND	0.020	9374115
Anions						
Alkalinity (PP as CaCO ₃)	mg/L	ND	9375362	ND	1.0	9375362
Alkalinity (Total as CaCO ₃)	mg/L	95	9375362	95	1.0	9375362
Bicarbonate (HCO ₃)	mg/L	120	9375362	120	1.0	9375362
Carbonate (CO ₃)	mg/L	ND	9375362	ND	1.0	9375362
Hydroxide (OH)	mg/L	ND	9375362	ND	1.0	9375362
Dissolved Sulphate (SO ₄)	mg/L	17	9375365	17	1.0	9375365
Dissolved Chloride (Cl)	mg/L	91	9375364	88	1.0	9375364
Nutrients						
Dissolved Nitrite (N)	mg/L	ND	9375320	ND	0.010	9375320
Dissolved Nitrate (N)	mg/L	0.047	9375320	0.056	0.010	9375320
Elements						
Dissolved Aluminum (Al)	mg/L	0.0048	9377892	ND	0.0030	9382421
Dissolved Antimony (Sb)	mg/L	ND	9377892	ND	0.00060	9382421
Dissolved Arsenic (As)	mg/L	0.00040	9377892	0.00037	0.00020	9382421
Dissolved Barium (Ba)	mg/L	0.016	9375955	0.016	0.010	9375955
Dissolved Beryllium (Be)	mg/L	ND	9377892	ND	0.0010	9382421
RDL = Reportable Detection Limit						
N/A = Not Applicable						
ND = Not detected						

Maxxam Job #: B925245
Report Date: 2019/04/23

Dillon Consulting Limited
Client Project #: 18-8932
Sampler Initials: JB

ROUTINE WATER & DISS. REGULATED METALS (WATER)

Maxxam ID		VM3236		VM3237		
Sampling Date		2019/04/05 10:30		2019/04/04 13:00		
COC Number		M104276		M104276		
	UNITS	1 BOTTLE - TREATED	QC Batch	2 - RAW WATER	RDL	QC Batch
Dissolved Boron (B)	mg/L	0.053	9375955	0.052	0.020	9375955
Dissolved Calcium (Ca)	mg/L	36	9375955	34	0.30	9375955
Dissolved Chromium (Cr)	mg/L	ND	9377892	ND	0.0010	9382421
Dissolved Cobalt (Co)	mg/L	ND	9377892	ND	0.00030	9382421
Dissolved Copper (Cu)	mg/L	0.0080	9377892	0.015	0.00020	9382421
Dissolved Iron (Fe)	mg/L	ND	9375955	ND	0.060	9375955
Dissolved Lead (Pb)	mg/L	0.00021	9377892	ND	0.00020	9382421
Dissolved Lithium (Li)	mg/L	ND	9375955	ND	0.020	9375955
Dissolved Magnesium (Mg)	mg/L	7.3	9375955	7.2	0.20	9375955
Dissolved Manganese (Mn)	mg/L	0.0062	9375955	0.0067	0.0040	9375955
Dissolved Molybdenum (Mo)	mg/L	0.0017	9377892	0.0015	0.00020	9382421
Dissolved Nickel (Ni)	mg/L	0.00057	9377892	0.00082	0.00050	9382421
Dissolved Phosphorus (P)	mg/L	ND	9375955	ND	0.10	9375955
Dissolved Potassium (K)	mg/L	3.1	9375955	3.0	0.30	9375955
Dissolved Selenium (Se)	mg/L	ND	9377892	ND	0.00020	9382421
Dissolved Silicon (Si)	mg/L	0.93	9375955	0.90	0.10	9375955
Dissolved Silver (Ag)	mg/L	ND	9377892	ND	0.00010	9382421
Dissolved Sodium (Na)	mg/L	51	9375955	50	0.50	9375955
Dissolved Strontium (Sr)	mg/L	0.20	9375955	0.20	0.020	9375955
Dissolved Sulphur (S)	mg/L	5.5	9375955	5.4	0.20	9375955
Dissolved Thallium (Tl)	mg/L	ND	9377892	ND	0.00020	9382421
Dissolved Tin (Sn)	mg/L	ND	9377892	ND	0.0010	9382421
Dissolved Titanium (Ti)	mg/L	ND	9377892	0.0018	0.0010	9382421
Dissolved Uranium (U)	mg/L	0.00011	9377892	ND	0.00010	9382421
Dissolved Vanadium (V)	mg/L	ND	9377892	ND	0.0010	9382421
Dissolved Zinc (Zn)	mg/L	0.029	9377892	0.031	0.0030	9382421
RDL = Reportable Detection Limit						
ND = Not detected						

Maxxam Job #: B925245
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Dillon Consulting Limited
Client Project #: 18-8932
Sampler Initials: JB

REGULATED METALS (CCME/AT1) - TOTAL

Maxxam ID		VM3236	VM3237		
Sampling Date		2019/04/05 10:30	2019/04/04 13:00		
COC Number		M104276	M104276		
	UNITS	1 BOTTLE - TREATED	2 - RAW WATER	RDL	QC Batch
Low Level Elements					
Total Cadmium (Cd)	ug/L	ND	ND	0.020	9374116
Elements					
Total Aluminum (Al)	mg/L	0.016	0.0045	0.0030	9375641
Total Antimony (Sb)	mg/L	ND	ND	0.00060	9375641
Total Arsenic (As)	mg/L	0.00048	0.00059	0.00020	9375641
Total Barium (Ba)	mg/L	0.016	0.018	0.010	9375645
Total Beryllium (Be)	mg/L	ND	ND	0.0010	9375641
Total Boron (B)	mg/L	0.059	0.058	0.020	9375645
Total Calcium (Ca)	mg/L	37	35	0.30	9375645
Total Chromium (Cr)	mg/L	ND	ND	0.0010	9375641
Total Cobalt (Co)	mg/L	ND	ND	0.00030	9375641
Total Copper (Cu)	mg/L	0.011	0.083	0.00020	9375641
Total Iron (Fe)	mg/L	0.11	0.11	0.060	9375645
Total Lead (Pb)	mg/L	0.00045	ND	0.00020	9375641
Total Lithium (Li)	mg/L	ND	ND	0.020	9375645
Total Magnesium (Mg)	mg/L	7.4	7.4	0.20	9375645
Total Manganese (Mn)	mg/L	0.011	0.011	0.0040	9375645
Total Molybdenum (Mo)	mg/L	0.0017	0.0017	0.00020	9375641
Total Nickel (Ni)	mg/L	0.0010	0.00057	0.00050	9375641
Total Phosphorus (P)	mg/L	ND	ND	0.10	9375645
Total Potassium (K)	mg/L	3.2	3.1	0.30	9375645
Total Selenium (Se)	mg/L	ND	ND	0.00020	9375641
Total Silicon (Si)	mg/L	0.95	0.94	0.10	9375645
Total Silver (Ag)	mg/L	ND	ND	0.00010	9375641
Total Sodium (Na)	mg/L	52	51	0.50	9375645
Total Strontium (Sr)	mg/L	0.20	0.20	0.020	9375645
Total Sulphur (S)	mg/L	5.5	5.5	0.20	9375645
Total Thallium (Tl)	mg/L	ND	ND	0.00020	9375641
Total Tin (Sn)	mg/L	ND	ND	0.0010	9375641
Total Titanium (Ti)	mg/L	ND	ND	0.0010	9375641
Total Uranium (U)	mg/L	ND	0.00010	0.00010	9375641
RDL = Reportable Detection Limit					
ND = Not detected					

Maxxam Job #: B925245
Report Date: 2019/04/23

Dillon Consulting Limited
Client Project #: 18-8932
Sampler Initials: JB

REGULATED METALS (CCME/AT1) - TOTAL

Maxxam ID		VM3236	VM3237		
Sampling Date		2019/04/05 10:30	2019/04/04 13:00		
COC Number		M104276	M104276		
	UNITS	1 BOTTLE - TREATED	2 - RAW WATER	RDL	QC Batch
Total Vanadium (V)	mg/L	ND	0.0012	0.0010	9375641
Total Zinc (Zn)	mg/L	0.031	0.011	0.0030	9375641
RDL = Reportable Detection Limit ND = Not detected					

Maxxam Job #: B925245
Report Date: 2019/04/23

Dillon Consulting Limited
Client Project #: 18-8932
Sampler Initials: JB

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		VM3236	VM3237		
Sampling Date		2019/04/05 10:30	2019/04/04 13:00		
COC Number		M104276	M104276		
	UNITS	1 BOTTLE - TREATED	2 - RAW WATER	RDL	QC Batch
Misc. Inorganics					
Reactive Silica	mg/L	1.9	1.9	0.050	9381316
Total Organic Carbon (C)	mg/L	4.9	5.0	0.50	9382028
Lab Filtered Inorganics					
Dissolved Organic Carbon (C)	mg/L	3.5	4.1	0.50	9382031
Microbiological Param.					
Fecal Coliforms	CFU/100mL	ND (1)	ND (2)	1.0	9373670
Total Coliforms DST	MPN/100mL	ND (1)	17 (2)	1.0	9373669
MISCELLANEOUS					
Monochloroacetic Acid	ug/L	ND	ND	5.0	9385281
Monobromoacetic Acid	ug/L	ND	ND	5.0	9385281
Dichloroacetic Acid	ug/L	18	ND	5.0	9385281
Trichloroacetic Acid	ug/L	17	ND	5.0	9385281
Bromochloroacetic Acid	ug/L	14	ND	5.0	9385281
Dibromoacetic Acid	ug/L	5.4	ND	5.0	9385281
Total Haloacetic Acids	ug/L	41	ND	5.0	9385281
Nutrients					
Total Ammonia (N)	mg/L	ND	0.067	0.015	9375922
Orthophosphate (P)	mg/L	0.0031	0.0032	0.0030	9375789
Physical Properties					
Turbidity	NTU	0.47	0.52	0.10	9375217
Surrogate Recovery (%)					
2,3-Dibromopropionic Acid	%	85	84		9385281
RDL = Reportable Detection Limit ND = Not detected (1) Sample analyzed over hold time. Sample analysis is recommended within 24 hours of sampling. (2) Sample was past hold time when received.					

Maxxam Job #: B925245
Report Date: 2019/04/23

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Sampler Initials: JB

VOLATILE ORGANICS BY GC-MS (WATER)

Maxxam ID		VM3236	VM3237		
Sampling Date		2019/04/05 10:30	2019/04/04 13:00		
COC Number		M104276	M104276		
	UNITS	1 BOTTLE - TREATED	2 - RAW WATER	RDL	QC Batch
Volatiles					
Total Trihalomethanes	ug/L	94	11	1.3	9374488
Benzene	ug/L	ND	ND	0.40	9375220
Bromodichloromethane	ug/L	33	4.2	0.50	9375220
Bromoform	ug/L	2.4	0.68	0.50	9375220
Bromomethane	ug/L	ND	ND	2.0	9375220
Carbon tetrachloride	ug/L	ND	ND	0.50	9375220
Chlorobenzene	ug/L	ND	ND	0.50	9375220
Chlorodibromomethane	ug/L	21	3.7	1.0	9375220
Chloroethane	ug/L	ND	ND	1.0	9375220
Chloroform	ug/L	38	2.5	0.50	9375220
Chloromethane	ug/L	ND	ND	2.0	9375220
1,2-dibromoethane	ug/L	ND	ND	0.20	9375220
1,2-dichlorobenzene	ug/L	ND	ND	0.50	9375220
1,3-dichlorobenzene	ug/L	ND	ND	0.50	9375220
1,4-dichlorobenzene	ug/L	ND	ND	0.50	9375220
1,1-dichloroethane	ug/L	ND	ND	0.50	9375220
1,2-dichloroethane	ug/L	ND	ND	0.50	9375220
1,1-dichloroethene	ug/L	ND	ND	0.50	9375220
cis-1,2-dichloroethene	ug/L	ND	ND	0.50	9375220
trans-1,2-dichloroethene	ug/L	ND	ND	0.50	9375220
Dichloromethane	ug/L	ND	ND	2.0	9375220
1,2-dichloropropane	ug/L	ND	ND	0.50	9375220
cis-1,3-dichloropropene	ug/L	ND	ND	0.50	9375220
trans-1,3-dichloropropene	ug/L	ND	ND	0.50	9375220
Ethylbenzene	ug/L	ND	ND	0.40	9375220
Methyl methacrylate	ug/L	ND	ND	0.50	9375220
Methyl-tert-butylether (MTBE)	ug/L	ND	ND	0.50	9375220
Styrene	ug/L	ND	ND	0.50	9375220
1,1,1,2-tetrachloroethane	ug/L	ND	ND	1.0	9375220
1,1,2,2-tetrachloroethane	ug/L	ND	ND	2.0	9375220
Tetrachloroethene	ug/L	ND	ND	0.50	9375220
RDL = Reportable Detection Limit					
ND = Not detected					

Maxxam Job #: B925245
Report Date: 2019/04/23

Dillon Consulting Limited
Client Project #: 18-8932
Sampler Initials: JB

VOLATILE ORGANICS BY GC-MS (WATER)

Maxxam ID		VM3236	VM3237		
Sampling Date		2019/04/05 10:30	2019/04/04 13:00		
COC Number		M104276	M104276		
	UNITS	1 BOTTLE - TREATED	2 - RAW WATER	RDL	QC Batch
Toluene	ug/L	ND	ND	0.40	9375220
1,2,3-trichlorobenzene	ug/L	ND	ND	1.0	9375220
1,2,4-trichlorobenzene	ug/L	ND	ND	1.0	9375220
1,3,5-trichlorobenzene	ug/L	ND	ND	0.50	9375220
1,1,1-trichloroethane	ug/L	ND	ND	0.50	9375220
1,1,2-trichloroethane	ug/L	ND	ND	0.50	9375220
Trichloroethene	ug/L	ND	ND	0.50	9375220
Trichlorofluoromethane	ug/L	ND	ND	0.50	9375220
1,2,4-trimethylbenzene	ug/L	ND	ND	0.50	9375220
1,3,5-trimethylbenzene	ug/L	ND	ND	0.50	9375220
Vinyl chloride	ug/L	ND	ND	0.50	9375220
Xylenes (Total)	ug/L	ND	ND	0.80	9375220
m & p-Xylene	ug/L	ND	ND	0.80	9375220
o-Xylene	ug/L	ND	ND	0.40	9375220
Surrogate Recovery (%)					
1,4-Difluorobenzene (sur.)	%	99	100		9375220
4-Bromofluorobenzene (sur.)	%	98	98		9375220
D4-1,2-Dichloroethane (sur.)	%	97	99		9375220
RDL = Reportable Detection Limit					
ND = Not detected					

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CALCULATED PARAMETERS (WATER)

Maxxam ID		VM3236	VM3237	
Sampling Date		2019/04/05 10:30	2019/04/04 13:00	
COC Number		M104276	M104276	
	UNITS	1 BOTTLE - TREATED	2 - RAW WATER	QC Batch
Calculated Parameters				
Langelier Index (@ 20C)	N/A	-0.375	-0.400	9374822
Langelier Index (@ 4C)	N/A	-0.624	-0.650	9374823
Saturation pH (@ 20C)	N/A	7.88	7.90	9374822
Saturation pH (@ 4C)	N/A	8.13	8.15	9374823

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GENERAL COMMENTS

Temperatures upon receipt at Maxxam Bedford

Package 1: 15 degrees C

Each temperature is the average of up to three cooler temperatures taken at receipt

Total haloacetic acids refers to the total of monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid and dibromoacetic acid.

Results relate only to the items tested.

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QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
9373669	MHD	Method Blank	Total Coliforms DST	2019/04/07	ND, RDL=1.0		mpn/100mL	
9373669	MHD	RPD	Total Coliforms DST	2019/04/07	17		%	N/A
9373670	MHD	Method Blank	Fecal Coliforms	2019/04/07	ND, RDL=1.0		CFU/100mL	
9373670	MHD	RPD	Fecal Coliforms	2019/04/07	67		%	N/A
9374475	MF3	Matrix Spike	1,4-Difluorobenzene (sur.)	2019/04/08		90	%	50 - 140
			4-Bromofluorobenzene (sur.)	2019/04/08		110	%	50 - 140
			D4-1,2-Dichloroethane (sur.)	2019/04/08		128	%	50 - 140
			Benzene	2019/04/08		63	%	50 - 140
			Toluene	2019/04/08		84	%	50 - 140
			Ethylbenzene	2019/04/08		95	%	50 - 140
			m & p-Xylene	2019/04/08		84	%	50 - 140
			o-Xylene	2019/04/08		88	%	50 - 140
			F1 (C6-C10)	2019/04/08		95	%	60 - 140
9374475	MF3	Spiked Blank	1,4-Difluorobenzene (sur.)	2019/04/08		89	%	50 - 140
			4-Bromofluorobenzene (sur.)	2019/04/08		104	%	50 - 140
			D4-1,2-Dichloroethane (sur.)	2019/04/08		109	%	50 - 140
			Benzene	2019/04/08		85	%	60 - 130
			Toluene	2019/04/08		84	%	60 - 130
			Ethylbenzene	2019/04/08		95	%	60 - 130
			m & p-Xylene	2019/04/08		89	%	60 - 130
			o-Xylene	2019/04/08		91	%	60 - 130
			F1 (C6-C10)	2019/04/08		117	%	60 - 140
9374475	MF3	Method Blank	1,4-Difluorobenzene (sur.)	2019/04/08		94	%	50 - 140
			4-Bromofluorobenzene (sur.)	2019/04/08		107	%	50 - 140
			D4-1,2-Dichloroethane (sur.)	2019/04/08		111	%	50 - 140
			Benzene	2019/04/08	ND, RDL=0.40		ug/L	
			Toluene	2019/04/08	ND, RDL=0.40		ug/L	
			Ethylbenzene	2019/04/08	ND, RDL=0.40		ug/L	
			m & p-Xylene	2019/04/08	ND, RDL=0.80		ug/L	
			o-Xylene	2019/04/08	ND, RDL=0.40		ug/L	
			F1 (C6-C10)	2019/04/08	ND, RDL=100		ug/L	
9374475	MF3	RPD	Benzene	2019/04/08	20		%	30
			Toluene	2019/04/08	NC		%	30
			Ethylbenzene	2019/04/08	9.6		%	30
			m & p-Xylene	2019/04/08	NC		%	30
			o-Xylene	2019/04/08	NC		%	30
			F1 (C6-C10)	2019/04/08	19		%	30
9375217	VFE	Spiked Blank	Turbidity	2019/04/09		101	%	80 - 120
9375217	VFE	Method Blank	Turbidity	2019/04/09	ND, RDL=0.10		NTU	
9375217	VFE	RPD	Turbidity	2019/04/09	3.2		%	20
9375220	RC6	Matrix Spike	1,4-Difluorobenzene (sur.)	2019/04/09		101	%	50 - 140
			4-Bromofluorobenzene (sur.)	2019/04/09		98	%	50 - 140
			D4-1,2-Dichloroethane (sur.)	2019/04/09		102	%	50 - 140
			Benzene	2019/04/09		95	%	50 - 140
			Bromodichloromethane	2019/04/09		95	%	50 - 140

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
9375220	RC6	Spiked Blank	Bromoform	2019/04/09		90	%	50 - 140
			Bromomethane	2019/04/09		100	%	50 - 140
			Carbon tetrachloride	2019/04/09		93	%	50 - 140
			Chlorobenzene	2019/04/09		100	%	50 - 140
			Chlorodibromomethane	2019/04/09		95	%	50 - 140
			Chloroethane	2019/04/09		89	%	50 - 140
			Chloroform	2019/04/09		94	%	50 - 140
			Chloromethane	2019/04/09		66	%	50 - 140
			1,2-dibromoethane	2019/04/09		103	%	50 - 140
			1,2-dichlorobenzene	2019/04/09		100	%	50 - 140
			1,3-dichlorobenzene	2019/04/09		98	%	50 - 140
			1,4-dichlorobenzene	2019/04/09		99	%	50 - 140
			1,1-dichloroethane	2019/04/09		95	%	50 - 140
			1,2-dichloroethane	2019/04/09		100	%	50 - 140
			1,1-dichloroethene	2019/04/09		96	%	50 - 140
			cis-1,2-dichloroethene	2019/04/09		100	%	50 - 140
			trans-1,2-dichloroethene	2019/04/09		97	%	50 - 140
			Dichloromethane	2019/04/09		93	%	50 - 140
			1,2-dichloropropane	2019/04/09		97	%	50 - 140
			cis-1,3-dichloropropene	2019/04/09		101	%	50 - 140
			trans-1,3-dichloropropene	2019/04/09		107	%	50 - 140
			Ethylbenzene	2019/04/09		96	%	50 - 140
			Methyl methacrylate	2019/04/09		100	%	50 - 140
			Methyl-tert-butylether (MTBE)	2019/04/09		97	%	50 - 140
			Styrene	2019/04/09		97	%	50 - 140
			1,1,1,2-tetrachloroethane	2019/04/09		95	%	50 - 140
			1,1,2,2-tetrachloroethane	2019/04/09		99	%	50 - 140
			Tetrachloroethene	2019/04/09		96	%	50 - 140
			Toluene	2019/04/09		96	%	50 - 140
			1,2,3-trichlorobenzene	2019/04/09		96	%	50 - 140
			1,2,4-trichlorobenzene	2019/04/09		95	%	50 - 140
			1,3,5-trichlorobenzene	2019/04/09		93	%	50 - 140
			1,1,1-trichloroethane	2019/04/09		94	%	50 - 140
			1,1,2-trichloroethane	2019/04/09		102	%	50 - 140
			Trichloroethene	2019/04/09		99	%	50 - 140
			Trichlorofluoromethane	2019/04/09		93	%	50 - 140
			1,2,4-trimethylbenzene	2019/04/09		95	%	50 - 140
			1,3,5-trimethylbenzene	2019/04/09		96	%	50 - 140
			Vinyl chloride	2019/04/09		81	%	50 - 140
			m & p-Xylene	2019/04/09		99	%	50 - 140
			o-Xylene	2019/04/09		100	%	50 - 140
			1,4-Difluorobenzene (sur.)	2019/04/09		100	%	50 - 140
			4-Bromofluorobenzene (sur.)	2019/04/09		98	%	50 - 140
			D4-1,2-Dichloroethane (sur.)	2019/04/09		95	%	50 - 140
			Benzene	2019/04/09		93	%	60 - 130
			Bromodichloromethane	2019/04/09		91	%	60 - 130
			Bromoform	2019/04/09		87	%	60 - 130
			Bromomethane	2019/04/09		100	%	60 - 130
			Carbon tetrachloride	2019/04/09		95	%	60 - 130
			Chlorobenzene	2019/04/09		102	%	60 - 130
			Chlorodibromomethane	2019/04/09		94	%	60 - 130
			Chloroethane	2019/04/09		91	%	60 - 130
			Chloroform	2019/04/09		92	%	60 - 130
			Chloromethane	2019/04/09		82	%	60 - 130

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
9375220	RC6	Method Blank	1,2-dibromoethane	2019/04/09		98	%	60 - 130
			1,2-dichlorobenzene	2019/04/09		98	%	60 - 130
			1,3-dichlorobenzene	2019/04/09		97	%	60 - 130
			1,4-dichlorobenzene	2019/04/09		97	%	60 - 130
			1,1-dichloroethane	2019/04/09		95	%	60 - 130
			1,2-dichloroethane	2019/04/09		93	%	60 - 130
			1,1-dichloroethene	2019/04/09		98	%	60 - 130
			cis-1,2-dichloroethene	2019/04/09		97	%	60 - 130
			trans-1,2-dichloroethene	2019/04/09		96	%	60 - 130
			Dichloromethane	2019/04/09		88	%	60 - 130
			1,2-dichloropropane	2019/04/09		94	%	60 - 130
			cis-1,3-dichloropropene	2019/04/09		94	%	60 - 130
			trans-1,3-dichloropropene	2019/04/09		95	%	60 - 130
			Ethylbenzene	2019/04/09		101	%	60 - 130
			Methyl methacrylate	2019/04/09		89	%	60 - 130
			Methyl-tert-butylether (MTBE)	2019/04/09		93	%	60 - 130
			Styrene	2019/04/09		100	%	60 - 130
			1,1,1,2-tetrachloroethane	2019/04/09		98	%	60 - 130
			1,1,2,2-tetrachloroethane	2019/04/09		97	%	60 - 130
			Tetrachloroethene	2019/04/09		101	%	60 - 130
			Toluene	2019/04/09		101	%	60 - 130
			1,2,3-trichlorobenzene	2019/04/09		97	%	60 - 130
			1,2,4-trichlorobenzene	2019/04/09		95	%	60 - 130
			1,3,5-trichlorobenzene	2019/04/09		93	%	60 - 130
			1,1,1-trichloroethane	2019/04/09		95	%	60 - 130
			1,1,2-trichloroethane	2019/04/09		94	%	60 - 130
			Trichloroethene	2019/04/09		96	%	60 - 130
			Trichlorofluoromethane	2019/04/09		96	%	60 - 130
			1,2,4-trimethylbenzene	2019/04/09		97	%	60 - 130
			1,3,5-trimethylbenzene	2019/04/09		99	%	60 - 130
			Vinyl chloride	2019/04/09		88	%	60 - 130
			m & p-Xylene	2019/04/09		103	%	60 - 130
			o-Xylene	2019/04/09		105	%	60 - 130
			1,4-Difluorobenzene (sur.)	2019/04/09		100	%	50 - 140
			4-Bromofluorobenzene (sur.)	2019/04/09		97	%	50 - 140
			D4-1,2-Dichloroethane (sur.)	2019/04/09		98	%	50 - 140
			Benzene	2019/04/09	ND, RDL=0.40		ug/L	
			Bromodichloromethane	2019/04/09	ND, RDL=0.50		ug/L	
			Bromoform	2019/04/09	ND, RDL=0.50		ug/L	
			Bromomethane	2019/04/09	ND, RDL=2.0		ug/L	
			Carbon tetrachloride	2019/04/09	ND, RDL=0.50		ug/L	
			Chlorobenzene	2019/04/09	ND, RDL=0.50		ug/L	
			Chlorodibromomethane	2019/04/09	ND, RDL=1.0		ug/L	
			Chloroethane	2019/04/09	ND, RDL=1.0		ug/L	
			Chloroform	2019/04/09	ND, RDL=0.50		ug/L	

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Chloromethane	2019/04/09	ND, RDL=2.0		ug/L	
			1,2-dibromoethane	2019/04/09	ND, RDL=0.20		ug/L	
			1,2-dichlorobenzene	2019/04/09	ND, RDL=0.50		ug/L	
			1,3-dichlorobenzene	2019/04/09	ND, RDL=0.50		ug/L	
			1,4-dichlorobenzene	2019/04/09	ND, RDL=0.50		ug/L	
			1,1-dichloroethane	2019/04/09	ND, RDL=0.50		ug/L	
			1,2-dichloroethane	2019/04/09	ND, RDL=0.50		ug/L	
			1,1-dichloroethene	2019/04/09	ND, RDL=0.50		ug/L	
			cis-1,2-dichloroethene	2019/04/09	ND, RDL=0.50		ug/L	
			trans-1,2-dichloroethene	2019/04/09	ND, RDL=0.50		ug/L	
			Dichloromethane	2019/04/09	ND, RDL=2.0		ug/L	
			1,2-dichloropropane	2019/04/09	ND, RDL=0.50		ug/L	
			cis-1,3-dichloropropene	2019/04/09	ND, RDL=0.50		ug/L	
			trans-1,3-dichloropropene	2019/04/09	ND, RDL=0.50		ug/L	
			Ethylbenzene	2019/04/09	ND, RDL=0.40		ug/L	
			Methyl methacrylate	2019/04/09	ND, RDL=0.50		ug/L	
			Methyl-tert-butylether (MTBE)	2019/04/09	ND, RDL=0.50		ug/L	
			Styrene	2019/04/09	ND, RDL=0.50		ug/L	
			1,1,1,2-tetrachloroethane	2019/04/09	ND, RDL=1.0		ug/L	
			1,1,2,2-tetrachloroethane	2019/04/09	ND, RDL=2.0		ug/L	
			Tetrachloroethene	2019/04/09	ND, RDL=0.50		ug/L	
			Toluene	2019/04/09	ND, RDL=0.40		ug/L	
			1,2,3-trichlorobenzene	2019/04/09	ND, RDL=1.0		ug/L	
			1,2,4-trichlorobenzene	2019/04/09	ND, RDL=1.0		ug/L	
			1,3,5-trichlorobenzene	2019/04/09	ND, RDL=0.50		ug/L	
			1,1,1-trichloroethane	2019/04/09	ND, RDL=0.50		ug/L	
			1,1,2-trichloroethane	2019/04/09	ND, RDL=0.50		ug/L	

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
9375220	RC6	RPD	Trichloroethene	2019/04/09	ND, RDL=0.50		ug/L	
			Trichlorofluoromethane	2019/04/09	ND, RDL=0.50		ug/L	
			1,2,4-trimethylbenzene	2019/04/09	ND, RDL=0.50		ug/L	
			1,3,5-trimethylbenzene	2019/04/09	ND, RDL=0.50		ug/L	
			Vinyl chloride	2019/04/09	ND, RDL=0.50		ug/L	
			Xylenes (Total)	2019/04/09	ND, RDL=0.80		ug/L	
			m & p-Xylene	2019/04/09	ND, RDL=0.80		ug/L	
			o-Xylene	2019/04/09	ND, RDL=0.40		ug/L	
			Benzene	2019/04/09	NC		%	30
			Bromodichloromethane	2019/04/09	NC		%	30
			Bromoform	2019/04/09	NC		%	30
			Bromomethane	2019/04/09	NC		%	30
			Carbon tetrachloride	2019/04/09	NC		%	30
			Chlorobenzene	2019/04/09	NC		%	30
			Chlorodibromomethane	2019/04/09	NC		%	30
			Chloroethane	2019/04/09	NC		%	30
			Chloroform	2019/04/09	NC		%	30
			Chloromethane	2019/04/09	NC		%	30
			1,2-dibromoethane	2019/04/09	NC		%	30
			1,2-dichlorobenzene	2019/04/09	NC		%	30
			1,3-dichlorobenzene	2019/04/09	NC		%	30
			1,4-dichlorobenzene	2019/04/09	NC		%	30
			1,1-dichloroethane	2019/04/09	NC		%	30
			1,2-dichloroethane	2019/04/09	NC		%	30
			1,1-dichloroethene	2019/04/09	NC		%	30
			cis-1,2-dichloroethene	2019/04/09	NC		%	30
			trans-1,2-dichloroethene	2019/04/09	NC		%	30
			Dichloromethane	2019/04/09	NC		%	30
			1,2-dichloropropane	2019/04/09	NC		%	30
			cis-1,3-dichloropropene	2019/04/09	NC		%	30
			trans-1,3-dichloropropene	2019/04/09	NC		%	30
			Ethylbenzene	2019/04/09	NC		%	30
			Methyl methacrylate	2019/04/09	NC		%	30
			Methyl-tert-butylether (MTBE)	2019/04/09	NC		%	30
			Styrene	2019/04/09	NC		%	30
			1,1,1,2-tetrachloroethane	2019/04/09	NC		%	30
			1,1,2,2-tetrachloroethane	2019/04/09	NC		%	30
			Tetrachloroethene	2019/04/09	NC		%	30
			Toluene	2019/04/09	NC		%	30
			1,2,3-trichlorobenzene	2019/04/09	NC		%	30
			1,2,4-trichlorobenzene	2019/04/09	NC		%	30
			1,3,5-trichlorobenzene	2019/04/09	NC		%	30
			1,1,1-trichloroethane	2019/04/09	NC		%	30
			1,1,2-trichloroethane	2019/04/09	NC		%	30
			Trichloroethene	2019/04/09	NC		%	30
			Trichlorofluoromethane	2019/04/09	NC		%	30

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
9375320	KD5	Matrix Spike [VM3236-01]	1,2,4-trimethylbenzene	2019/04/09	NC		%	30
			1,3,5-trimethylbenzene	2019/04/09	NC		%	30
			Vinyl chloride	2019/04/09	NC		%	30
			Xylenes (Total)	2019/04/09	NC		%	30
			m & p-Xylene	2019/04/09	NC		%	30
			o-Xylene	2019/04/09	NC		%	30
			Dissolved Nitrite (N)	2019/04/09		100	%	80 - 120
9375320	KD5	Spiked Blank	Dissolved Nitrate (N)	2019/04/09		101	%	80 - 120
			Dissolved Nitrite (N)	2019/04/09		100	%	80 - 120
			Dissolved Nitrate (N)	2019/04/09		101	%	80 - 120
9375320	KD5	Method Blank	Dissolved Nitrite (N)	2019/04/09	ND, RDL=0.010		mg/L	
			Dissolved Nitrate (N)	2019/04/09	ND, RDL=0.010		mg/L	
			Dissolved Nitrite (N)	2019/04/09	NC		%	20
9375361	MA4	Spiked Blank	Dissolved Nitrate (N)	2019/04/09	0.34		%	20
			pH	2019/04/09		100	%	97 - 103
9375361	MA4	RPD [VM3236-01]	pH	2019/04/09	0.60		%	N/A
9375362	MA4	Spiked Blank	Alkalinity (Total as CaCO ₃)	2019/04/09		101	%	80 - 120
9375362	MA4	Method Blank	Alkalinity (PP as CaCO ₃)	2019/04/09	ND, RDL=1.0		mg/L	
			Alkalinity (Total as CaCO ₃)	2019/04/09	ND, RDL=1.0		mg/L	
			Bicarbonate (HCO ₃)	2019/04/09	ND, RDL=1.0		mg/L	
			Carbonate (CO ₃)	2019/04/09	ND, RDL=1.0		mg/L	
			Hydroxide (OH)	2019/04/09	ND, RDL=1.0		mg/L	
			Alkalinity (PP as CaCO ₃)	2019/04/09	NC		%	20
			Alkalinity (Total as CaCO ₃)	2019/04/09	0.35		%	20
9375362	MA4	RPD [VM3236-01]	Bicarbonate (HCO ₃)	2019/04/09	0.35		%	20
			Carbonate (CO ₃)	2019/04/09	NC		%	20
			Hydroxide (OH)	2019/04/09	NC		%	20
			Conductivity	2019/04/09		100	%	90 - 110
			Conductivity	2019/04/09	ND, RDL=2.0		uS/cm	
9375363	MA4	Spiked Blank	Conductivity	2019/04/09	0.79		%	10
9375364	CH7	Matrix Spike [VM3236-01]	Dissolved Chloride (Cl)	2019/04/09		NC	%	80 - 120
			Dissolved Chloride (Cl)	2019/04/09		103	%	80 - 120
9375364	CH7	Spiked Blank	Dissolved Chloride (Cl)	2019/04/09	ND, RDL=1.0		mg/L	
			Dissolved Chloride (Cl)	2019/04/09	1.8		%	20
9375365	CH7	RPD [VM3236-01]	Dissolved Chloride (Cl)	2019/04/09			%	20
9375365	CH7	Matrix Spike [VM3236-01]	Dissolved Sulphate (SO ₄)	2019/04/09		99	%	80 - 120
			Dissolved Sulphate (SO ₄)	2019/04/09		102	%	80 - 120
9375365	CH7	Spiked Blank	Dissolved Sulphate (SO ₄)	2019/04/09	ND, RDL=1.0		mg/L	
			Dissolved Sulphate (SO ₄)	2019/04/09	1.6		%	20
9375365	CH7	RPD [VM3236-01]	Dissolved Sulphate (SO ₄)	2019/04/09			%	20
9375641	APY	Matrix Spike	Total Aluminum (Al)	2019/04/10		NC	%	80 - 120
			Total Antimony (Sb)	2019/04/10		94	%	80 - 120
			Total Arsenic (As)	2019/04/10		99	%	80 - 120

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9375641	APY	Spiked Blank	Total Beryllium (Be)	2019/04/10		103	%	80 - 120
			Total Chromium (Cr)	2019/04/10		106	%	80 - 120
			Total Cobalt (Co)	2019/04/10		106	%	80 - 120
			Total Copper (Cu)	2019/04/10		104	%	80 - 120
			Total Lead (Pb)	2019/04/10		103	%	80 - 120
			Total Molybdenum (Mo)	2019/04/10		107	%	80 - 120
			Total Nickel (Ni)	2019/04/10		105	%	80 - 120
			Total Selenium (Se)	2019/04/10		106	%	80 - 120
			Total Silver (Ag)	2019/04/10		104	%	80 - 120
			Total Thallium (Tl)	2019/04/10		103	%	80 - 120
			Total Tin (Sn)	2019/04/10		101	%	80 - 120
			Total Titanium (Ti)	2019/04/10		106	%	80 - 120
			Total Uranium (U)	2019/04/10		102	%	80 - 120
			Total Vanadium (V)	2019/04/10		109	%	80 - 120
			Total Zinc (Zn)	2019/04/10		103	%	80 - 120
			Total Aluminum (Al)	2019/04/10		100	%	80 - 120
			Total Antimony (Sb)	2019/04/10		96	%	80 - 120
			Total Arsenic (As)	2019/04/10		96	%	80 - 120
			Total Beryllium (Be)	2019/04/10		96	%	80 - 120
			Total Chromium (Cr)	2019/04/10		103	%	80 - 120
			Total Cobalt (Co)	2019/04/10		104	%	80 - 120
			Total Copper (Cu)	2019/04/10		103	%	80 - 120
			Total Lead (Pb)	2019/04/10		103	%	80 - 120
			Total Molybdenum (Mo)	2019/04/10		102	%	80 - 120
			Total Nickel (Ni)	2019/04/10		103	%	80 - 120
			Total Selenium (Se)	2019/04/10		103	%	80 - 120
			Total Silver (Ag)	2019/04/10		100	%	80 - 120
			Total Thallium (Tl)	2019/04/10		103	%	80 - 120
			Total Tin (Sn)	2019/04/10		99	%	80 - 120
			Total Titanium (Ti)	2019/04/10		101	%	80 - 120
			Total Uranium (U)	2019/04/10		101	%	80 - 120
			Total Vanadium (V)	2019/04/10		104	%	80 - 120
			Total Zinc (Zn)	2019/04/10		100	%	80 - 120
9375641	APY	Method Blank	Total Aluminum (Al)	2019/04/10	ND, RDL=0.0030		mg/L	
			Total Antimony (Sb)	2019/04/10	ND, RDL=0.00060		mg/L	
			Total Arsenic (As)	2019/04/10	ND, RDL=0.00020		mg/L	
			Total Beryllium (Be)	2019/04/10	ND, RDL=0.0010		mg/L	
			Total Chromium (Cr)	2019/04/10	ND, RDL=0.0010		mg/L	
			Total Cobalt (Co)	2019/04/10	ND, RDL=0.00030		mg/L	
			Total Copper (Cu)	2019/04/10	ND, RDL=0.00020		mg/L	
			Total Lead (Pb)	2019/04/10	ND, RDL=0.00020		mg/L	
			Total Molybdenum (Mo)	2019/04/10	ND, RDL=0.00020		mg/L	
			Total Nickel (Ni)	2019/04/10	ND, RDL=0.00050		mg/L	

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9375641	APY	RPD	Total Selenium (Se)	2019/04/10	ND, RDL=0.00020		mg/L	
			Total Silver (Ag)	2019/04/10	ND, RDL=0.00010		mg/L	
			Total Thallium (Tl)	2019/04/10	ND, RDL=0.00020		mg/L	
			Total Tin (Sn)	2019/04/10	ND, RDL=0.0010		mg/L	
			Total Titanium (Ti)	2019/04/10	ND, RDL=0.0010		mg/L	
			Total Uranium (U)	2019/04/10	ND, RDL=0.00010		mg/L	
			Total Vanadium (V)	2019/04/10	ND, RDL=0.0010		mg/L	
			Total Zinc (Zn)	2019/04/10	ND, RDL=0.0030		mg/L	
			Total Aluminum (Al)	2019/04/10	3.6		%	20
			Total Antimony (Sb)	2019/04/10	0.96		%	20
			Total Arsenic (As)	2019/04/10	2.0		%	20
			Total Beryllium (Be)	2019/04/10	NC		%	20
			Total Chromium (Cr)	2019/04/10	3.7		%	20
			Total Cobalt (Co)	2019/04/10	2.1		%	20
			Total Copper (Cu)	2019/04/10	2.0		%	20
			Total Lead (Pb)	2019/04/10	2.4		%	20
			Total Molybdenum (Mo)	2019/04/10	3.1		%	20
			Total Nickel (Ni)	2019/04/10	0.30		%	20
			Total Selenium (Se)	2019/04/10	9.1		%	20
			Total Silver (Ag)	2019/04/10	1.1		%	20
9375645	ACY	Matrix Spike	Total Thallium (Tl)	2019/04/10	NC		%	20
			Total Tin (Sn)	2019/04/10	NC		%	20
			Total Titanium (Ti)	2019/04/10	11		%	20
			Total Uranium (U)	2019/04/10	0.99		%	20
			Total Vanadium (V)	2019/04/10	4.3		%	20
			Total Zinc (Zn)	2019/04/10	0.068		%	20
			Total Barium (Ba)	2019/04/10		111	%	80 - 120
			Total Boron (B)	2019/04/10		NC	%	80 - 120
			Total Calcium (Ca)	2019/04/10		NC	%	80 - 120
			Total Iron (Fe)	2019/04/10		NC	%	80 - 120
			Total Lithium (Li)	2019/04/10		115	%	80 - 120
			Total Magnesium (Mg)	2019/04/10		NC	%	80 - 120
			Total Manganese (Mn)	2019/04/10		NC	%	80 - 120
			Total Phosphorus (P)	2019/04/10		100	%	80 - 120
			Total Potassium (K)	2019/04/10		NC	%	80 - 120
9375645	ACY	Spiked Blank	Total Silicon (Si)	2019/04/10		NC	%	80 - 120
			Total Sodium (Na)	2019/04/10		NC	%	80 - 120
			Total Strontium (Sr)	2019/04/10		106	%	80 - 120
			Total Sulphur (S)	2019/04/10		NC	%	80 - 120
			Total Barium (Ba)	2019/04/10		104	%	80 - 120
			Total Boron (B)	2019/04/10		108	%	80 - 120
			Total Calcium (Ca)	2019/04/10		103	%	80 - 120
			Total Iron (Fe)	2019/04/10		106	%	80 - 120
			Total Lithium (Li)	2019/04/10		107	%	80 - 120
			Total Magnesium (Mg)	2019/04/10		102	%	80 - 120
			Total Manganese (Mn)	2019/04/10		102	%	80 - 120

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9375645	ACY	Method Blank	Total Phosphorus (P)	2019/04/10		98	%	80 - 120
			Total Potassium (K)	2019/04/10		107	%	80 - 120
			Total Silicon (Si)	2019/04/10		101	%	80 - 120
			Total Sodium (Na)	2019/04/10		110	%	80 - 120
			Total Strontium (Sr)	2019/04/10		102	%	80 - 120
			Total Sulphur (S)	2019/04/10		101	%	80 - 120
			Total Barium (Ba)	2019/04/10	ND, RDL=0.010		mg/L	
			Total Boron (B)	2019/04/10	ND, RDL=0.020		mg/L	
			Total Calcium (Ca)	2019/04/10	ND, RDL=0.30		mg/L	
			Total Iron (Fe)	2019/04/10	ND, RDL=0.060		mg/L	
			Total Lithium (Li)	2019/04/10	ND, RDL=0.020		mg/L	
			Total Magnesium (Mg)	2019/04/10	ND, RDL=0.20		mg/L	
			Total Manganese (Mn)	2019/04/10	ND, RDL=0.0040		mg/L	
			Total Phosphorus (P)	2019/04/10	ND, RDL=0.10		mg/L	
			Total Potassium (K)	2019/04/10	ND, RDL=0.30		mg/L	
			Total Silicon (Si)	2019/04/10	ND, RDL=0.10		mg/L	
			Total Sodium (Na)	2019/04/10	ND, RDL=0.50		mg/L	
			Total Strontium (Sr)	2019/04/10	ND, RDL=0.020		mg/L	
			Total Sulphur (S)	2019/04/10	ND, RDL=0.20		mg/L	
9375645	ACY	RPD	Total Barium (Ba)	2019/04/10	3.8		%	20
			Total Boron (B)	2019/04/10	2.3		%	20
			Total Calcium (Ca)	2019/04/10	0.60		%	20
			Total Iron (Fe)	2019/04/10	4.0		%	20
			Total Lithium (Li)	2019/04/10	3.2		%	20
			Total Magnesium (Mg)	2019/04/10	0.11		%	20
			Total Manganese (Mn)	2019/04/10	0.64		%	20
			Total Phosphorus (P)	2019/04/10	3.5		%	20
			Total Potassium (K)	2019/04/10	0.61		%	20
			Total Silicon (Si)	2019/04/10	3.9		%	20
			Total Sodium (Na)	2019/04/10	0.13		%	20
			Total Strontium (Sr)	2019/04/10	0.32		%	20
			Total Sulphur (S)	2019/04/10	0.090		%	20
			Orthophosphate (P)	2019/04/09		102	%	80 - 120
9375789	AL2	Matrix Spike [VM3236-01]	Orthophosphate (P)	2019/04/09		101	%	80 - 120
9375789	AL2	Spiked Blank	Orthophosphate (P)	2019/04/09	ND, RDL=0.0030		mg/L	
9375789	AL2	Method Blank	Orthophosphate (P)	2019/04/09				
9375789	AL2	RPD [VM3236-01]	Orthophosphate (P)	2019/04/09	2.3		%	20
9375922	AL2	Matrix Spike [VM3236-06]	Total Ammonia (N)	2019/04/09		104	%	80 - 120
9375922	AL2	Spiked Blank	Total Ammonia (N)	2019/04/09		100	%	80 - 120

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9375922	AL2	Method Blank	Total Ammonia (N)	2019/04/09	ND, RDL=0.015		mg/L	
9375922	AL2	RPD [VM3236-06]	Total Ammonia (N)	2019/04/09	NC		%	20
9375955	ACY	Matrix Spike	Dissolved Barium (Ba)	2019/04/10		70 (1)	%	80 - 120
			Dissolved Boron (B)	2019/04/10		101	%	80 - 120
			Dissolved Calcium (Ca)	2019/04/10		NC	%	80 - 120
			Dissolved Iron (Fe)	2019/04/10		96	%	80 - 120
			Dissolved Lithium (Li)	2019/04/10		97	%	80 - 120
			Dissolved Magnesium (Mg)	2019/04/10		NC	%	80 - 120
			Dissolved Manganese (Mn)	2019/04/10		97	%	80 - 120
			Dissolved Phosphorus (P)	2019/04/10		97	%	80 - 120
			Dissolved Potassium (K)	2019/04/10		99	%	80 - 120
			Dissolved Silicon (Si)	2019/04/10		78 (1)	%	80 - 120
			Dissolved Sodium (Na)	2019/04/10		NC	%	80 - 120
			Dissolved Strontium (Sr)	2019/04/10		NC	%	80 - 120
			Dissolved Sulphur (S)	2019/04/10		NC	%	80 - 120
9375955	ACY	Spiked Blank	Dissolved Barium (Ba)	2019/04/10		101	%	80 - 120
			Dissolved Boron (B)	2019/04/10		104	%	80 - 120
			Dissolved Calcium (Ca)	2019/04/10		98	%	80 - 120
			Dissolved Iron (Fe)	2019/04/10		100	%	80 - 120
			Dissolved Lithium (Li)	2019/04/10		103	%	80 - 120
			Dissolved Magnesium (Mg)	2019/04/10		97	%	80 - 120
			Dissolved Manganese (Mn)	2019/04/10		99	%	80 - 120
			Dissolved Phosphorus (P)	2019/04/10		97	%	80 - 120
			Dissolved Potassium (K)	2019/04/10		103	%	80 - 120
			Dissolved Silicon (Si)	2019/04/10		86	%	80 - 120
			Dissolved Sodium (Na)	2019/04/10		106	%	80 - 120
			Dissolved Strontium (Sr)	2019/04/10		98	%	80 - 120
			Dissolved Sulphur (S)	2019/04/10		97	%	80 - 120
9375955	ACY	Method Blank	Dissolved Barium (Ba)	2019/04/10	ND, RDL=0.010		mg/L	
			Dissolved Boron (B)	2019/04/10	ND, RDL=0.020		mg/L	
			Dissolved Calcium (Ca)	2019/04/10	ND, RDL=0.30		mg/L	
			Dissolved Iron (Fe)	2019/04/10	ND, RDL=0.060		mg/L	
			Dissolved Lithium (Li)	2019/04/10	ND, RDL=0.020		mg/L	
			Dissolved Magnesium (Mg)	2019/04/10	ND, RDL=0.20		mg/L	
			Dissolved Manganese (Mn)	2019/04/10	ND, RDL=0.0040		mg/L	
			Dissolved Phosphorus (P)	2019/04/10	ND, RDL=0.10		mg/L	
			Dissolved Potassium (K)	2019/04/10	ND, RDL=0.30		mg/L	
			Dissolved Silicon (Si)	2019/04/10	ND, RDL=0.10		mg/L	
			Dissolved Sodium (Na)	2019/04/10	ND, RDL=0.50		mg/L	
			Dissolved Strontium (Sr)	2019/04/10	ND, RDL=0.020		mg/L	
			Dissolved Sulphur (S)	2019/04/10	ND, RDL=0.20		mg/L	

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9375955	ACY	RPD	Dissolved Barium (Ba)	2019/04/10	NC		%	20
			Dissolved Boron (B)	2019/04/10	NC		%	20
			Dissolved Calcium (Ca)	2019/04/10	0.20		%	20
			Dissolved Iron (Fe)	2019/04/10	NC		%	20
			Dissolved Lithium (Li)	2019/04/10	1.9		%	20
			Dissolved Magnesium (Mg)	2019/04/10	0.058		%	20
			Dissolved Manganese (Mn)	2019/04/10	NC		%	20
			Dissolved Phosphorus (P)	2019/04/10	NC		%	20
			Dissolved Potassium (K)	2019/04/10	2.3		%	20
			Dissolved Silicon (Si)	2019/04/10	0.11		%	20
			Dissolved Sodium (Na)	2019/04/10	0.22		%	20
			Dissolved Strontium (Sr)	2019/04/10	0.11		%	20
			Dissolved Sulphur (S)	2019/04/10	0.13		%	20
			Dissolved Aluminum (Al)	2019/04/10		99	%	80 - 120
9377892	APY	Matrix Spike [VM3236-05]	Dissolved Antimony (Sb)	2019/04/10		91	%	80 - 120
			Dissolved Arsenic (As)	2019/04/10		96	%	80 - 120
			Dissolved Beryllium (Be)	2019/04/10		92	%	80 - 120
			Dissolved Chromium (Cr)	2019/04/10		94	%	80 - 120
			Dissolved Cobalt (Co)	2019/04/10		94	%	80 - 120
			Dissolved Copper (Cu)	2019/04/10		94	%	80 - 120
			Dissolved Lead (Pb)	2019/04/10		95	%	80 - 120
			Dissolved Molybdenum (Mo)	2019/04/10		95	%	80 - 120
			Dissolved Nickel (Ni)	2019/04/10		93	%	80 - 120
			Dissolved Selenium (Se)	2019/04/10		99	%	80 - 120
			Dissolved Silver (Ag)	2019/04/10		92	%	80 - 120
			Dissolved Thallium (Tl)	2019/04/10		99	%	80 - 120
			Dissolved Tin (Sn)	2019/04/10		94	%	80 - 120
			Dissolved Titanium (Ti)	2019/04/10		87	%	80 - 120
			Dissolved Uranium (U)	2019/04/10		94	%	80 - 120
			Dissolved Vanadium (V)	2019/04/10		101	%	80 - 120
			Dissolved Zinc (Zn)	2019/04/10		94	%	80 - 120
	APY	Spiked Blank	Dissolved Aluminum (Al)	2019/04/10		97	%	80 - 120
			Dissolved Antimony (Sb)	2019/04/10		90	%	80 - 120
			Dissolved Arsenic (As)	2019/04/10		93	%	80 - 120
			Dissolved Beryllium (Be)	2019/04/10		90	%	80 - 120
			Dissolved Chromium (Cr)	2019/04/10		93	%	80 - 120
			Dissolved Cobalt (Co)	2019/04/10		95	%	80 - 120
			Dissolved Copper (Cu)	2019/04/10		95	%	80 - 120
			Dissolved Lead (Pb)	2019/04/10		97	%	80 - 120
			Dissolved Molybdenum (Mo)	2019/04/10		95	%	80 - 120
			Dissolved Nickel (Ni)	2019/04/10		93	%	80 - 120
			Dissolved Selenium (Se)	2019/04/10		98	%	80 - 120
			Dissolved Silver (Ag)	2019/04/10		95	%	80 - 120
			Dissolved Thallium (Tl)	2019/04/10		97	%	80 - 120
			Dissolved Tin (Sn)	2019/04/10		92	%	80 - 120
			Dissolved Titanium (Ti)	2019/04/10		91	%	80 - 120
			Dissolved Uranium (U)	2019/04/10		91	%	80 - 120
			Dissolved Vanadium (V)	2019/04/10		101	%	80 - 120
			Dissolved Zinc (Zn)	2019/04/10		90	%	80 - 120
9377892	APY	Method Blank	Dissolved Aluminum (Al)	2019/04/11	ND, RDL=0.0030		mg/L	
			Dissolved Antimony (Sb)	2019/04/11	ND, RDL=0.00060		mg/L	

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			Dissolved Arsenic (As)	2019/04/11	ND, RDL=0.00020		mg/L	
			Dissolved Beryllium (Be)	2019/04/11	ND, RDL=0.0010		mg/L	
			Dissolved Chromium (Cr)	2019/04/11	ND, RDL=0.0010		mg/L	
			Dissolved Cobalt (Co)	2019/04/11	ND, RDL=0.00030		mg/L	
			Dissolved Copper (Cu)	2019/04/11	ND, RDL=0.00020		mg/L	
			Dissolved Lead (Pb)	2019/04/11	ND, RDL=0.00020		mg/L	
			Dissolved Molybdenum (Mo)	2019/04/11	ND, RDL=0.00020		mg/L	
			Dissolved Nickel (Ni)	2019/04/11	ND, RDL=0.00050		mg/L	
			Dissolved Selenium (Se)	2019/04/11	ND, RDL=0.00020		mg/L	
			Dissolved Silver (Ag)	2019/04/11	ND, RDL=0.00010		mg/L	
			Dissolved Thallium (Tl)	2019/04/11	ND, RDL=0.00020		mg/L	
			Dissolved Tin (Sn)	2019/04/11	ND, RDL=0.0010		mg/L	
			Dissolved Titanium (Ti)	2019/04/11	ND, RDL=0.0010		mg/L	
			Dissolved Uranium (U)	2019/04/11	ND, RDL=0.00010		mg/L	
			Dissolved Vanadium (V)	2019/04/11	ND, RDL=0.0010		mg/L	
			Dissolved Zinc (Zn)	2019/04/11	ND, RDL=0.0030		mg/L	
9377892	APY	RPD [VM3236-05]	Dissolved Aluminum (Al)	2019/04/10	4.3		%	20
			Dissolved Antimony (Sb)	2019/04/10	NC		%	20
			Dissolved Arsenic (As)	2019/04/10	8.6		%	20
			Dissolved Beryllium (Be)	2019/04/10	NC		%	20
			Dissolved Chromium (Cr)	2019/04/10	NC		%	20
			Dissolved Cobalt (Co)	2019/04/10	NC		%	20
			Dissolved Copper (Cu)	2019/04/10	4.6		%	20
			Dissolved Lead (Pb)	2019/04/10	3.9		%	20
			Dissolved Molybdenum (Mo)	2019/04/10	2.5		%	20
			Dissolved Nickel (Ni)	2019/04/10	5.2		%	20
			Dissolved Selenium (Se)	2019/04/10	NC		%	20
			Dissolved Silver (Ag)	2019/04/10	NC		%	20
			Dissolved Thallium (Tl)	2019/04/10	NC		%	20
			Dissolved Tin (Sn)	2019/04/10	NC		%	20
			Dissolved Titanium (Ti)	2019/04/10	NC		%	20
			Dissolved Uranium (U)	2019/04/10	7.7		%	20
			Dissolved Vanadium (V)	2019/04/10	NC		%	20
			Dissolved Zinc (Zn)	2019/04/10	0.81		%	20
9380863	JR1	Matrix Spike	O-TERPHENYL (sur.)	2019/04/15		102	%	60 - 140
			F2 (C10-C16 Hydrocarbons)	2019/04/15		111	%	60 - 140
			F3 (C16-C34 Hydrocarbons)	2019/04/15		116	%	60 - 140
			F4 (C34-C50 Hydrocarbons)	2019/04/15		114	%	60 - 140
9380863	JR1	Spiked Blank	O-TERPHENYL (sur.)	2019/04/15		96	%	60 - 140

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QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
9380863	JR1	Method Blank	F2 (C10-C16 Hydrocarbons)	2019/04/15		102	%	60 - 140
			F3 (C16-C34 Hydrocarbons)	2019/04/15		109	%	60 - 140
			F4 (C34-C50 Hydrocarbons)	2019/04/15		103	%	60 - 140
			O-TERPHENYL (sur.)	2019/04/15		94	%	60 - 140
			F2 (C10-C16 Hydrocarbons)	2019/04/15	ND, RDL=0.10		mg/L	
9380863	JR1	RPD	F3 (C16-C34 Hydrocarbons)	2019/04/15	ND, RDL=0.10		mg/L	
			F4 (C34-C50 Hydrocarbons)	2019/04/15	ND, RDL=0.20		mg/L	
			F2 (C10-C16 Hydrocarbons)	2019/04/15	NC		%	30
9381316	CH7	Matrix Spike [VM3236-01]	F3 (C16-C34 Hydrocarbons)	2019/04/15	NC		%	30
			F4 (C34-C50 Hydrocarbons)	2019/04/15	NC		%	30
			Reactive Silica	2019/04/13		101	%	80 - 120
9381316	CH7	Spiked Blank	Reactive Silica	2019/04/13		104	%	80 - 120
9381316	CH7	Method Blank	Reactive Silica	2019/04/13	ND, RDL=0.050		mg/L	
9381316	CH7	RPD [VM3236-01]	Reactive Silica	2019/04/13	0.88		%	20
9382028	YY	Matrix Spike [VM3236-02]	Total Organic Carbon (C)	2019/04/15		100	%	80 - 120
9382028	YY	Spiked Blank	Total Organic Carbon (C)	2019/04/15		104	%	80 - 120
9382028	YY	Method Blank	Total Organic Carbon (C)	2019/04/15	ND, RDL=0.50		mg/L	
9382028	YY	RPD [VM3236-02]	Total Organic Carbon (C)	2019/04/15	1.7		%	20
9382031	YY	Matrix Spike	Dissolved Organic Carbon (C)	2019/04/15		99	%	80 - 120
9382031	YY	Spiked Blank	Dissolved Organic Carbon (C)	2019/04/15		110	%	80 - 120
9382031	YY	Method Blank	Dissolved Organic Carbon (C)	2019/04/15	ND, RDL=0.50		mg/L	
9382031	YY	RPD	Dissolved Organic Carbon (C)	2019/04/15	4.2		%	20
9382421	JHS	Matrix Spike [VM3237-05]	Dissolved Aluminum (Al)	2019/04/15		105	%	80 - 120
9382421	JHS	Spiked Blank	Dissolved Antimony (Sb)	2019/04/15		100	%	80 - 120
			Dissolved Arsenic (As)	2019/04/15		98	%	80 - 120
			Dissolved Beryllium (Be)	2019/04/15		98	%	80 - 120
			Dissolved Chromium (Cr)	2019/04/15		96	%	80 - 120
			Dissolved Cobalt (Co)	2019/04/15		95	%	80 - 120
			Dissolved Copper (Cu)	2019/04/15		94	%	80 - 120
			Dissolved Lead (Pb)	2019/04/15		96	%	80 - 120
			Dissolved Molybdenum (Mo)	2019/04/15		102	%	80 - 120
			Dissolved Nickel (Ni)	2019/04/15		93	%	80 - 120
			Dissolved Selenium (Se)	2019/04/15		98	%	80 - 120
			Dissolved Silver (Ag)	2019/04/15		97	%	80 - 120
			Dissolved Thallium (Tl)	2019/04/15		96	%	80 - 120
			Dissolved Tin (Sn)	2019/04/15		102	%	80 - 120
			Dissolved Titanium (Ti)	2019/04/15		95	%	80 - 120
			Dissolved Uranium (U)	2019/04/15		93	%	80 - 120
			Dissolved Vanadium (V)	2019/04/15		98	%	80 - 120
			Dissolved Zinc (Zn)	2019/04/15		93	%	80 - 120
			Dissolved Aluminum (Al)	2019/04/15		116	%	80 - 120
			Dissolved Antimony (Sb)	2019/04/15		98	%	80 - 120
			Dissolved Arsenic (As)	2019/04/15		98	%	80 - 120
			Dissolved Beryllium (Be)	2019/04/15		97	%	80 - 120
			Dissolved Chromium (Cr)	2019/04/15		96	%	80 - 120

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QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
9382421	JHS	Method Blank	Dissolved Cobalt (Co)	2019/04/15		96	%	80 - 120
			Dissolved Copper (Cu)	2019/04/15		97	%	80 - 120
			Dissolved Lead (Pb)	2019/04/15		97	%	80 - 120
			Dissolved Molybdenum (Mo)	2019/04/15		100	%	80 - 120
			Dissolved Nickel (Ni)	2019/04/15		96	%	80 - 120
			Dissolved Selenium (Se)	2019/04/15		99	%	80 - 120
			Dissolved Silver (Ag)	2019/04/15		96	%	80 - 120
			Dissolved Thallium (Tl)	2019/04/15		97	%	80 - 120
			Dissolved Tin (Sn)	2019/04/15		99	%	80 - 120
			Dissolved Titanium (Ti)	2019/04/15		101	%	80 - 120
			Dissolved Uranium (U)	2019/04/15		93	%	80 - 120
			Dissolved Vanadium (V)	2019/04/15		99	%	80 - 120
			Dissolved Zinc (Zn)	2019/04/15		98	%	80 - 120
			Dissolved Aluminum (Al)	2019/04/15	ND, RDL=0.0030		mg/L	
			Dissolved Antimony (Sb)	2019/04/15	ND, RDL=0.00060		mg/L	
			Dissolved Arsenic (As)	2019/04/15	ND, RDL=0.00020		mg/L	
			Dissolved Beryllium (Be)	2019/04/15	ND, RDL=0.0010		mg/L	
			Dissolved Chromium (Cr)	2019/04/15	ND, RDL=0.0010		mg/L	
			Dissolved Cobalt (Co)	2019/04/15	ND, RDL=0.00030		mg/L	
			Dissolved Copper (Cu)	2019/04/15	ND, RDL=0.00020		mg/L	
			Dissolved Lead (Pb)	2019/04/15	ND, RDL=0.00020		mg/L	
			Dissolved Molybdenum (Mo)	2019/04/15	ND, RDL=0.00020		mg/L	
			Dissolved Nickel (Ni)	2019/04/15	ND, RDL=0.00050		mg/L	
			Dissolved Selenium (Se)	2019/04/15	ND, RDL=0.00020		mg/L	
			Dissolved Silver (Ag)	2019/04/15	ND, RDL=0.00010		mg/L	
			Dissolved Thallium (Tl)	2019/04/15	ND, RDL=0.00020		mg/L	
			Dissolved Tin (Sn)	2019/04/15	ND, RDL=0.0010		mg/L	
			Dissolved Titanium (Ti)	2019/04/15	ND, RDL=0.0010		mg/L	
			Dissolved Uranium (U)	2019/04/15	ND, RDL=0.00010		mg/L	
			Dissolved Vanadium (V)	2019/04/15	ND, RDL=0.0010		mg/L	
			Dissolved Zinc (Zn)	2019/04/15	ND, RDL=0.0030		mg/L	
9382421	JHS	RPD [VM3237-05]	Dissolved Aluminum (Al)	2019/04/15	NC		%	20
			Dissolved Antimony (Sb)	2019/04/15	NC		%	20
			Dissolved Arsenic (As)	2019/04/15	11		%	20
			Dissolved Beryllium (Be)	2019/04/15	NC		%	20
			Dissolved Chromium (Cr)	2019/04/15	NC		%	20
			Dissolved Cobalt (Co)	2019/04/15	NC		%	20

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QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
9385281	HIN	Matrix Spike	Dissolved Copper (Cu)	2019/04/15	4.0		%	20
			Dissolved Lead (Pb)	2019/04/15	NC		%	20
			Dissolved Molybdenum (Mo)	2019/04/15	3.3		%	20
			Dissolved Nickel (Ni)	2019/04/15	12		%	20
			Dissolved Selenium (Se)	2019/04/15	NC		%	20
			Dissolved Silver (Ag)	2019/04/15	NC		%	20
			Dissolved Thallium (Tl)	2019/04/15	NC		%	20
			Dissolved Tin (Sn)	2019/04/15	NC		%	20
			Dissolved Titanium (Ti)	2019/04/15	NC		%	20
			Dissolved Uranium (U)	2019/04/15	NC		%	20
			Dissolved Vanadium (V)	2019/04/15	NC		%	20
			Dissolved Zinc (Zn)	2019/04/15	3.5		%	20
			2,3-Dibromopropionic Acid	2019/04/16		84	%	70 - 130
			2,3-Dibromopropionic Acid	2019/04/16		84	%	70 - 130
			2,3-Dibromopropionic Acid	2019/04/16		84	%	70 - 130
			Monochloroacetic Acid	2019/04/16		88	%	70 - 130
			Monochloroacetic Acid	2019/04/16		88	%	70 - 130
			Monochloroacetic Acid	2019/04/16		88	%	70 - 130
			Monobromoacetic Acid	2019/04/16		84	%	70 - 130
			Monobromoacetic Acid	2019/04/16		84	%	70 - 130
			Monobromoacetic Acid	2019/04/16		84	%	70 - 130
			Dichloroacetic Acid	2019/04/16		85	%	70 - 130
			Dichloroacetic Acid	2019/04/16		85	%	70 - 130
			Dichloroacetic Acid	2019/04/16		85	%	70 - 130
			Trichloroacetic Acid	2019/04/16		NC	%	70 - 130
			Trichloroacetic Acid	2019/04/16		NC	%	70 - 130
			Trichloroacetic Acid	2019/04/16		NC	%	70 - 130
9385281	HIN	Spiked Blank	Bromochloroacetic Acid	2019/04/16		99	%	70 - 130
			Bromochloroacetic Acid	2019/04/16		99	%	70 - 130
			Bromochloroacetic Acid	2019/04/16		99	%	70 - 130
			Dibromoacetic Acid	2019/04/16		114	%	70 - 130
			Dibromoacetic Acid	2019/04/16		114	%	70 - 130
			Dibromoacetic Acid	2019/04/16		114	%	70 - 130
			2,3-Dibromopropionic Acid	2019/04/16		91	%	70 - 130
			2,3-Dibromopropionic Acid	2019/04/16		91	%	70 - 130
			2,3-Dibromopropionic Acid	2019/04/16		91	%	70 - 130
			Monochloroacetic Acid	2019/04/16		98	%	70 - 130
			Monochloroacetic Acid	2019/04/16		98	%	70 - 130
			Monochloroacetic Acid	2019/04/16		98	%	70 - 130
			Monobromoacetic Acid	2019/04/16		87	%	70 - 130
			Monobromoacetic Acid	2019/04/16		87	%	70 - 130
			Monobromoacetic Acid	2019/04/16		87	%	70 - 130
			Dichloroacetic Acid	2019/04/16		88	%	70 - 130
			Dichloroacetic Acid	2019/04/16		88	%	70 - 130
			Dichloroacetic Acid	2019/04/16		88	%	70 - 130
			Trichloroacetic Acid	2019/04/16		88	%	70 - 130
			Trichloroacetic Acid	2019/04/16		88	%	70 - 130
			Trichloroacetic Acid	2019/04/16		88	%	70 - 130
			Bromochloroacetic Acid	2019/04/16		94	%	70 - 130
			Bromochloroacetic Acid	2019/04/16		94	%	70 - 130
			Bromochloroacetic Acid	2019/04/16		94	%	70 - 130
			Dibromoacetic Acid	2019/04/16		127	%	70 - 130
			Dibromoacetic Acid	2019/04/16		127	%	70 - 130
			Dibromoacetic Acid	2019/04/16		127	%	70 - 130

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QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
9385281	HIN	Method Blank	2,3-Dibromopropionic Acid	2019/04/16		79	%	70 - 130
			2,3-Dibromopropionic Acid	2019/04/16		79	%	70 - 130
			2,3-Dibromopropionic Acid	2019/04/16		79	%	70 - 130
			Monochloroacetic Acid	2019/04/16	ND, RDL=5.0		ug/L	
			Monochloroacetic Acid	2019/04/16	ND, RDL=5.0		ug/L	
			Monochloroacetic Acid	2019/04/16	ND, RDL=5.0		ug/L	
			Monobromoacetic Acid	2019/04/16	ND, RDL=5.0		ug/L	
			Monobromoacetic Acid	2019/04/16	ND, RDL=5.0		ug/L	
			Monobromoacetic Acid	2019/04/16	ND, RDL=5.0		ug/L	
			Monobromoacetic Acid	2019/04/16	ND, RDL=5.0		ug/L	
			Dichloroacetic Acid	2019/04/16	ND, RDL=5.0		ug/L	
			Dichloroacetic Acid	2019/04/16	ND, RDL=5.0		ug/L	
			Dichloroacetic Acid	2019/04/16	ND, RDL=5.0		ug/L	
			Trichloroacetic Acid	2019/04/16	ND, RDL=5.0		ug/L	
			Trichloroacetic Acid	2019/04/16	ND, RDL=5.0		ug/L	
			Trichloroacetic Acid	2019/04/16	ND, RDL=5.0		ug/L	
			Bromochloroacetic Acid	2019/04/16	ND, RDL=5.0		ug/L	
			Bromochloroacetic Acid	2019/04/16	ND, RDL=5.0		ug/L	
			Bromochloroacetic Acid	2019/04/16	ND, RDL=5.0		ug/L	
			Dibromoacetic Acid	2019/04/16	ND, RDL=5.0		ug/L	
			Dibromoacetic Acid	2019/04/16	ND, RDL=5.0		ug/L	
			Dibromoacetic Acid	2019/04/16	ND, RDL=5.0		ug/L	
			Total Haloacetic Acids	2019/04/16	ND, RDL=5.0		ug/L	
			Total Haloacetic Acids	2019/04/16	ND, RDL=5.0		ug/L	
			Total Haloacetic Acids	2019/04/16	ND, RDL=5.0		ug/L	
9385281	HIN	RPD	Monochloroacetic Acid	2019/04/16	NC		%	40
			Monobromoacetic Acid	2019/04/16	NC		%	40
			Dichloroacetic Acid	2019/04/16	6.5		%	40
			Trichloroacetic Acid	2019/04/16	NC		%	40
			Bromochloroacetic Acid	2019/04/16	NC		%	40
			Dibromoacetic Acid	2019/04/16	NC		%	40

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QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Total Haloacetic Acids	2019/04/16	6.5		%	40
N/A = Not Applicable Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement. Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference. Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy. Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination. Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency. NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration) NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference $\leq 2 \times$ RDL). (1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.								

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VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



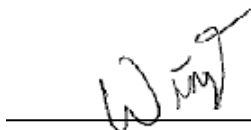
Daniel Reslan, cCT, QP, Organics Manager



Rosemarie MacDonald, Scientific Specialist (Organics)



Justin Geisel, B.Sc., Organics Supervisor

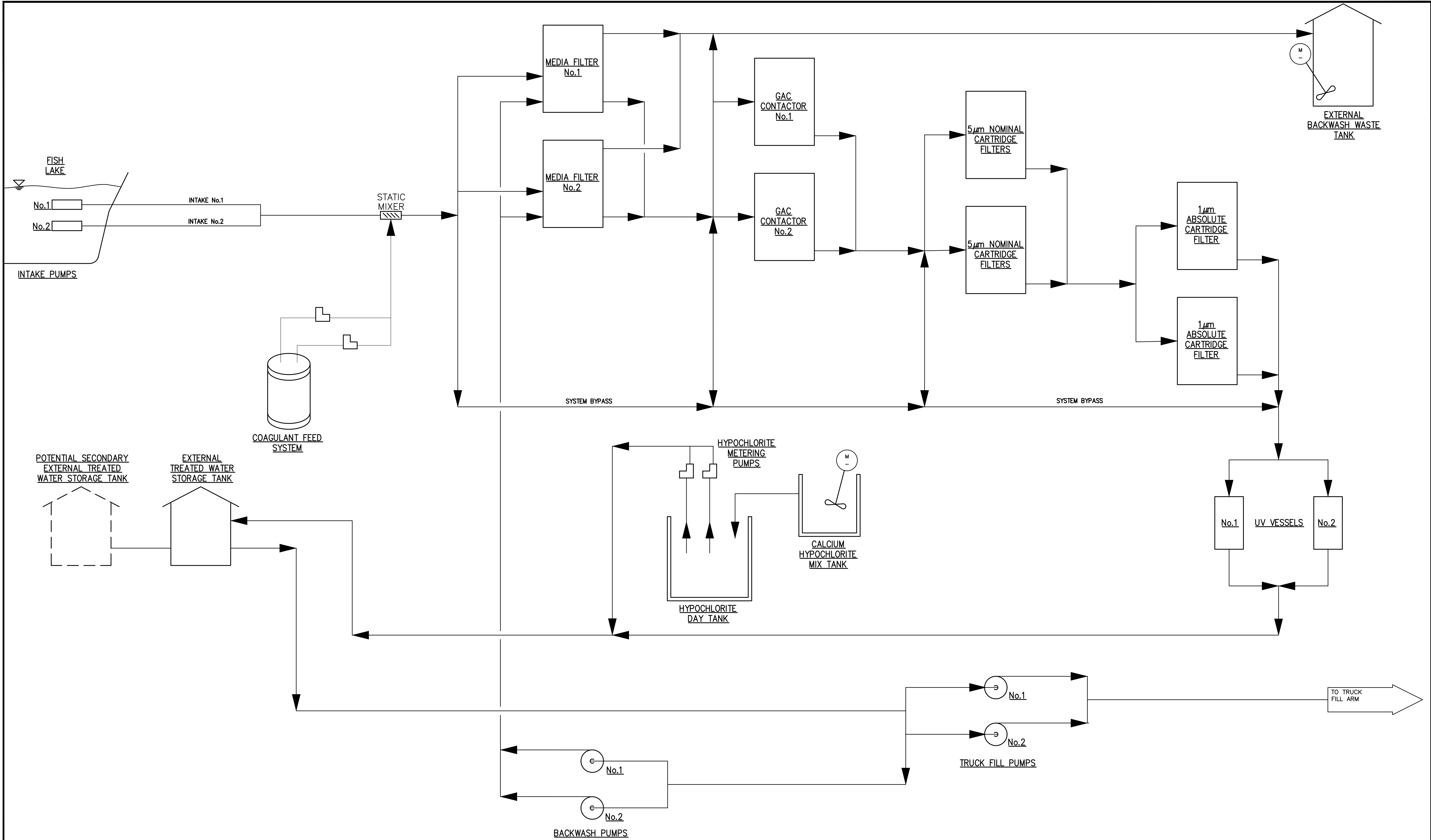


Winnie Au, B.Sc., QP, Scientific Specialist

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Appendix D

Schematic Drawings



Conditions of Use

Verify elevations and/or dimensions on drawing prior to use.
Report any discrepancies to Dillon Consulting Limited.

Do not scale dimensions from drawing.

Do not modify drawing, re-use it, or use it for purposes other than those intended at the time of its preparation without prior written permission from Dillon Consulting Limited.

NOT FOR CONSTRUCTION



2	FINAL REPORT	06/07/19	KRM
1	DRAFT REPORT	04/08/19	KRM
No.	ISSUED FOR	DATE	BY

DESIGN KRM	REVIEWED BY DM
DRAWN SMZ	CHECKED BY KRM
DATE JUNE 2019	
SCALE NTS	

WHALE COVE WTP PLANNING STUDY
WHALE COVE NUNAVUT

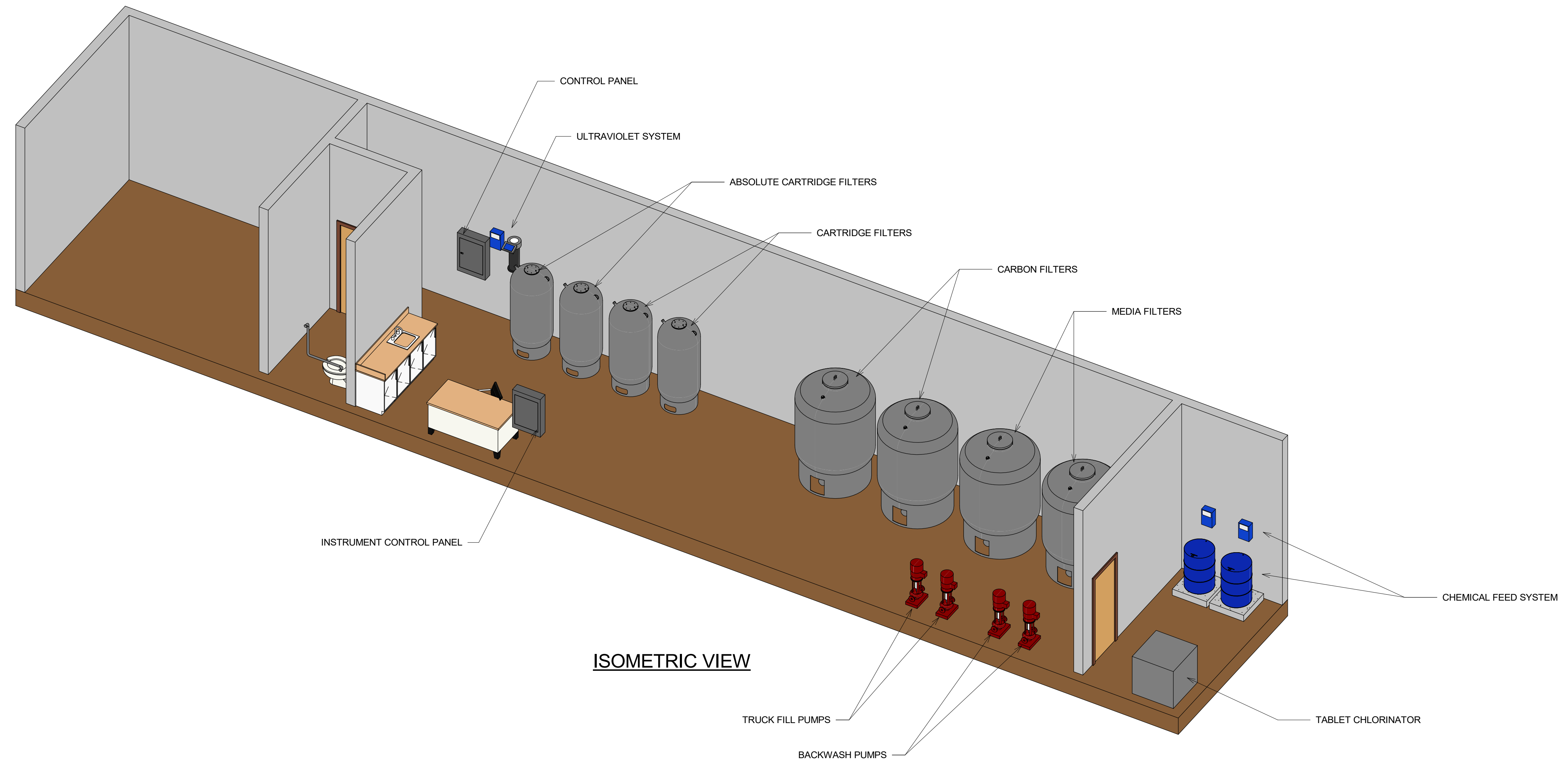
PROJECT NO.
18-8932

SHEET NO.

PROCESS FLOW DIAGRAM

P2

FLOOR PLAN
SCALE: 1 : 50



ISOMETRIC VIEW

Conditions of Use

Verify elevations and/or dimensions on drawing prior to use. Report any discrepancies to Dillon Consulting Limited.

Do not scale dimensions from drawing.

Do not modify drawing, re-use it, or use it for purposes other than those intended at the time of its preparation without prior written permission from Dillon Consulting Limited.

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[illegible]