Assessment of New Regional Water Source

FINAL Report

203000.00 • July 2022

	Final Report REV1	G. Sheppard	2022-07-29	J. Bursey & M. Fraser
	Final Report	G. Sheppard	2022-05-16	J. Bursey & M. Fraser
	Draft Final Report	G. Sheppard	2022-05-02	J. Bursey & M. Fraser
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Issue or Revision		Reviewed By:	Date	Issued By:

CBCL

Report: 203000.00

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July 29, 2022

Daniel Martin, P.Eng.
Manager, Regional Facilities
City of St. John's
P.O. Box 908
10 New Gower Street
St. John's, NL A1C 5M2

Dear Mr. Martin:

RE: ***Assessment of New Regional Water Source – FINAL Report REV 1***

Enclosed is the final report for the above-noted project. We look forward to discussing our findings with City staff.

Yours very truly,

CBCL Limited

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Project No: 203000.00

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Executive Summary

In 2016, CBCL Limited (CBCL) completed the St. John's Regional Drinking Water Study for the City. The study identified that the Maximum Day Demand (MDD) for Bay Bulls Big Pond water treatment plant exceeds the reliable yield of the watershed and is anticipated to continue to increase. The study identified two potential additional water sources: Thomas Pond and Big Triangle Pond/Southern Peak Pond. Preliminary reliable yield estimates for both potential sources were provided based on various assumptions concerning flows and storage availability. One of the study recommendations was to conduct further analysis of the potential sources to refine the reliable yield estimates for each.

In December 2019, CBCL was awarded the Assessment of a New Regional Water Source project by the City. The project is divided into two phases; the first phase is to refine the reliable yield estimates of the two potential sources identified in the 2016 study. The second phase is to complete other assessment work for one or both potential sources, including treatability assessments, water transmission infrastructure evaluations, and cost estimating.

The study objectives are summarized as follows:

- Assess reliable yields for Thomas Pond and Big Triangle/Southern Peak Pond.
- Conduct treatability assessment for Thomas Pond and/or Big Triangle/Southern Peak Pond.
- Recommend optimal treatment technologies for Thomas Pond and/or Big Triangle Pond/Southern Peak Pond.
- Identify the water transmission infrastructure required for Thomas Pond and/or Big Triangle Pond/Southern Peak Pond.
- Provide Class 'D' construction cost estimates for Thomas Pond and/or Big Triangle Pond/Southern Peak Pond WTP and regional water transmission upgrades required.
- Provide anticipated life cycle costs for Thomas Pond and/or Big Triangle Pond/Southern Peak Pond WTP and regional water transmission upgrades.
- Liaise with the City to develop a scoring matrix to evaluate the two potential sources.
- Provide a recommendation for the optimal future water source to develop (if any).
- Outline the municipalities to be serviced by the future water supply.

A summary of findings is presented in the following table.

Objective	Thomas Pond	Big Triangle Pond
Reliable Yield	21,000 m^3/d (see report for details)	Negligible without the construction of a dam (see report for details)
Treatment Technologies Specified based on Water Treatability Assessment	DAF Pre-treatment Potassium Permanganate for manganese oxidation PAC for taste and odour control Conventional Filtration UV for Primary Disinfection Chlorination for Secondary Disinfection Effluent pH adjustment and corrosion control	DAF Pre-treatment Potassium Permanganate for manganese oxidation PAC for taste and odour control Conventional Filtration UV for Primary Disinfection Chlorination for Secondary Disinfection Effluent pH adjustment and corrosion control
Water Transmission Infrastructure Required	5.9 km of transmission main	25.4 km of transmission main and CBS South pump station
Lifecycle Cost, HST Extra (Present value of capital and O&M costs over a selected timespan with a given interest rate)	$137,231,000	$235,912,000 (assuming that the reliable yield is increased to 21,000m^3/d)
Evaluated Score	84%	66%

The key study conclusion is:
Based on this evaluation, the City should focus on Thomas Pond as the source for development, if/when a new source is necessary. It is assumed that an agreement can be made with Newfoundland Power to extract 21,000 m^3/d from Thomas Pond.

The key study recommendations are:

- Contact Newfoundland Power to discuss the use of Thomas Pond as a potable water supply.
- Commence discussions with customers, regulatory agencies, and general public regarding the use of Thomas Pond as a potable water source.
- Continue monitoring water quality.
- Continue monitoring and limiting activities in the watershed.
- Continue and enhance water conservation measures.

Chapter 1 Project Overview

1.1 Background

The Regional Water System (RWS) is owned and operated by the City of St. John's (the City) and services the west end of the City as well as Mount Pearl, Paradise, Portugal Cove – St. Philip's, and Conception Bay South (CBS). Bay Bulls Big Pond (BBBP) supplies water to the RWS. The system includes the BBBP Water Treatment Plant (WTP), transmission mains, pump stations, storage reservoirs, pressure reducing valve stations, and meter stations.

In 2016, CBCL Limited (CBCL) completed the St. John's Regional Drinking Water Study for the City. The study identified that the Maximum Day Demand (MDD) for BBBP exceeds the reliable yield of the watershed, and is anticipated to continue to increase, as illustrated in Table 1.1. The study identified two potential additional water sources: Thomas Pond and Big Triangle Pond/Southern Peak Pond. Preliminary reliable yield estimates for both potential sources were provided based on various assumptions concerning flows and storage availability. One of the study recommendations was to conduct further analysis of the potential sources to refine the reliable yield estimates for each. Figure 1.1 shows the watershed locations with respect to the existing water sources.

Table 1.1: MDDs & BBBP Treatment Plant Capacity

Water System	Total MDD				Watershed Reliable Yield	WTP Capacity
	2014	2026	2036	2046		
	m^3/D	m^3/D	m^3/D	m^3/D	m^3/D	m^3/D
BBBP	91,763	99,599	106,130	108,407	90,700	85,000

In December 2019, CBCL was awarded the Assessment of a New Regional Water Source project by the City. The project is divided into two phases; the first phase is to refine the reliable yield estimates of the two potential sources identified in the 2016 study. The second phase is to complete other assessment work for one or both potential sources, including treatability assessments, water transmission infrastructure evaluations, and cost estimating.

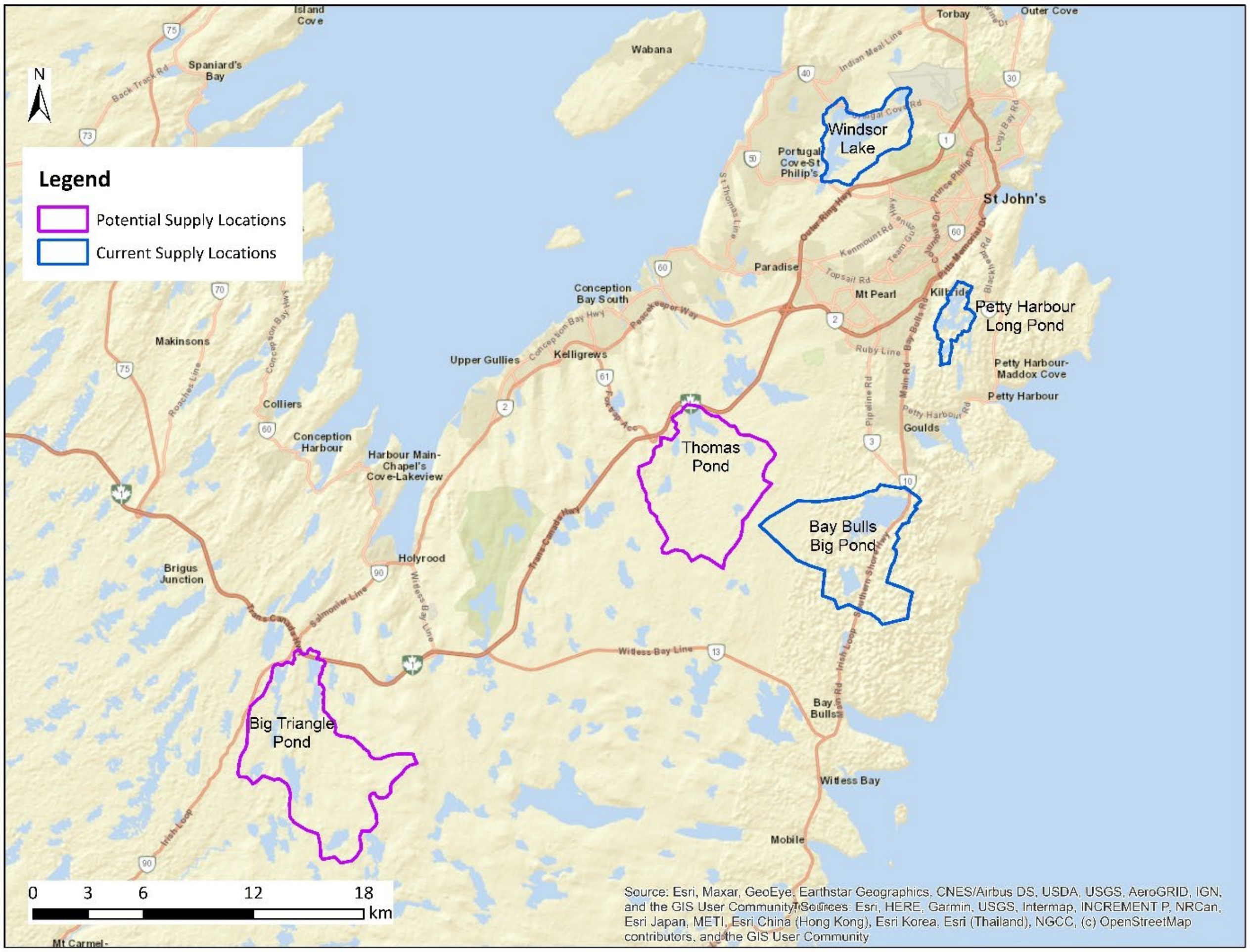

Figure 1.1: Existing & Potential Water Sources

1.2 Objectives

The study objectives are summarized as follows:

- Assess reliable yields for Thomas Pond and Big Triangle/Southern Peak Pond.
- Conduct treatability assessment for Thomas Pond and/or Big Triangle/Southern Peak Pond.
- Recommend optimal treatment technologies for Thomas Pond and/or Big Triangle Pond/Southern Peak Pond.
- Identify the water transmission infrastructure required for Thomas Pond and/or Big Triangle Pond/Southern Peak Pond.
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- Provide anticipated life cycle costs for Thomas Pond and/or Big Triangle Pond/Southern Peak Pond WTP and regional water transmission upgrades.
- Liaise with the City to develop a scoring matrix to evaluate the two potential sources.
- Provide a recommendation for the optimal future water source to develop (if any).
- Outline the municipalities to be serviced by the future water supply.

1.3 Summary of Potential Source Sites

1.3.1 Big Triangle Pond

Big Triangle Pond is located adjacent to the Trans-Canada Highway (TCH) near Holyrood. Two corrugated metal culverts, and two High-Density Polyethylene (HDPE) culverts cross the TCH that connects Big Triangle Pond to Little Triangle Pond (Figure 1.3). Directly upstream of Big Triangle Pond is Southern Peak Pond which drains into Big Triangle Pond through a series of streams and ponds (Figure 1.2). A watershed of approximately 50.4 km^2 drains to Big Triangle Pond. The watershed is primarily undeveloped, unregulated, and has a relatively high density of lakes. The watershed is within the potential water supply watershed of North Arm Brook, as shown on Figure 1.4.

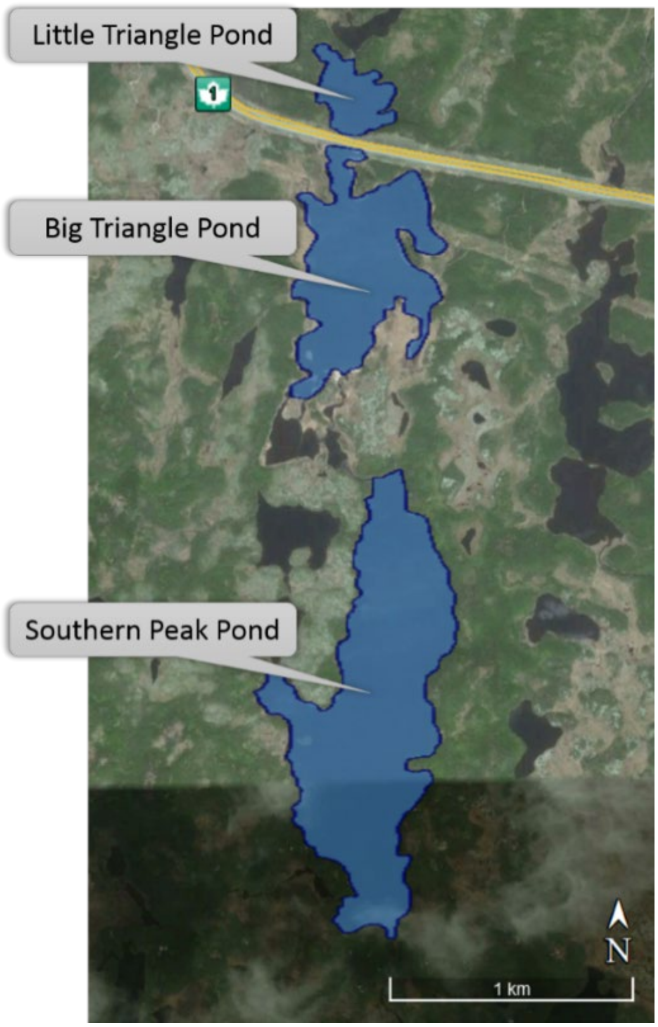


Figure 1.2: Configuration of Big Triangle Pond

Figure 1.3: Culverts at TCH at Big Triangle Pond

Newly collected Light Detection and Ranging (LiDAR) and topographic data was used to determine the levels of the lakes, which are summarized in Table 1.2.

Table 1.2: Areas of Southern Peak Pond, Big Triangle Pond, & Little Triangle Pond

Pond	Pond Area (ha)	Drainage Area (km^2)
Southern Peak Pond	75.0	47.9
Big Triangle Pond	37.9	50.4
Little Triangle Pond	8.1	50.7

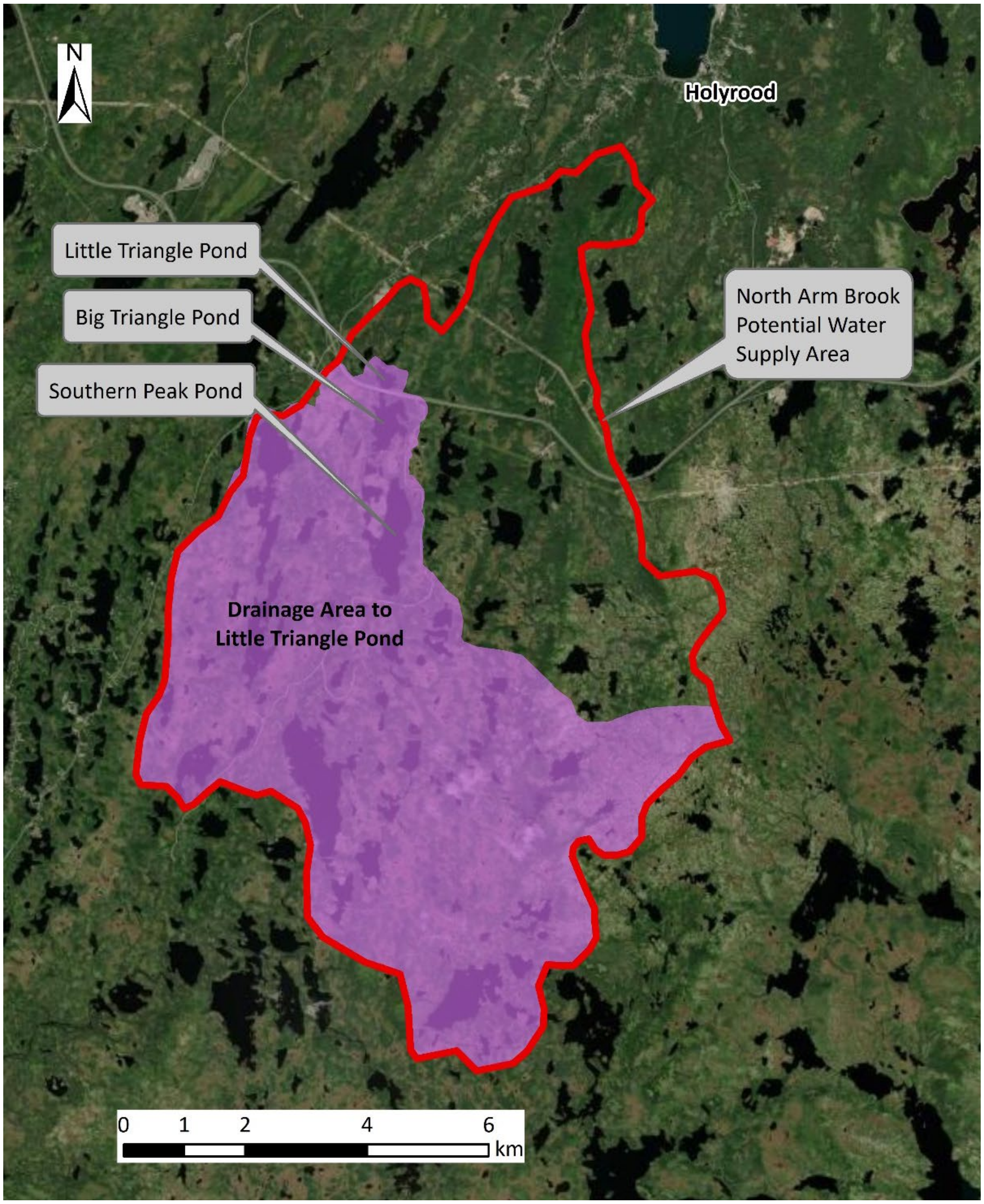


Figure 1.4: Big Triangle Pond Drainage Area

1.3.2 Thomas Pond

Thomas Pond is located adjacent to the TCH, near Foxtrap Access Road. Thomas Pond is part of Newfoundland Power's Topsail Pond Hydroelectric Power Generation System. Water is contained by a dam and flow is directed to Paddy's Pond through a sluice gate and rock cut channel, while spilled water is directed to Manuels River. The watershed area is approximately 40.4 km^2, and is primarily undeveloped, as illustrated in Figure 1.5. The area of Thomas Pond is approximately 148 ha.

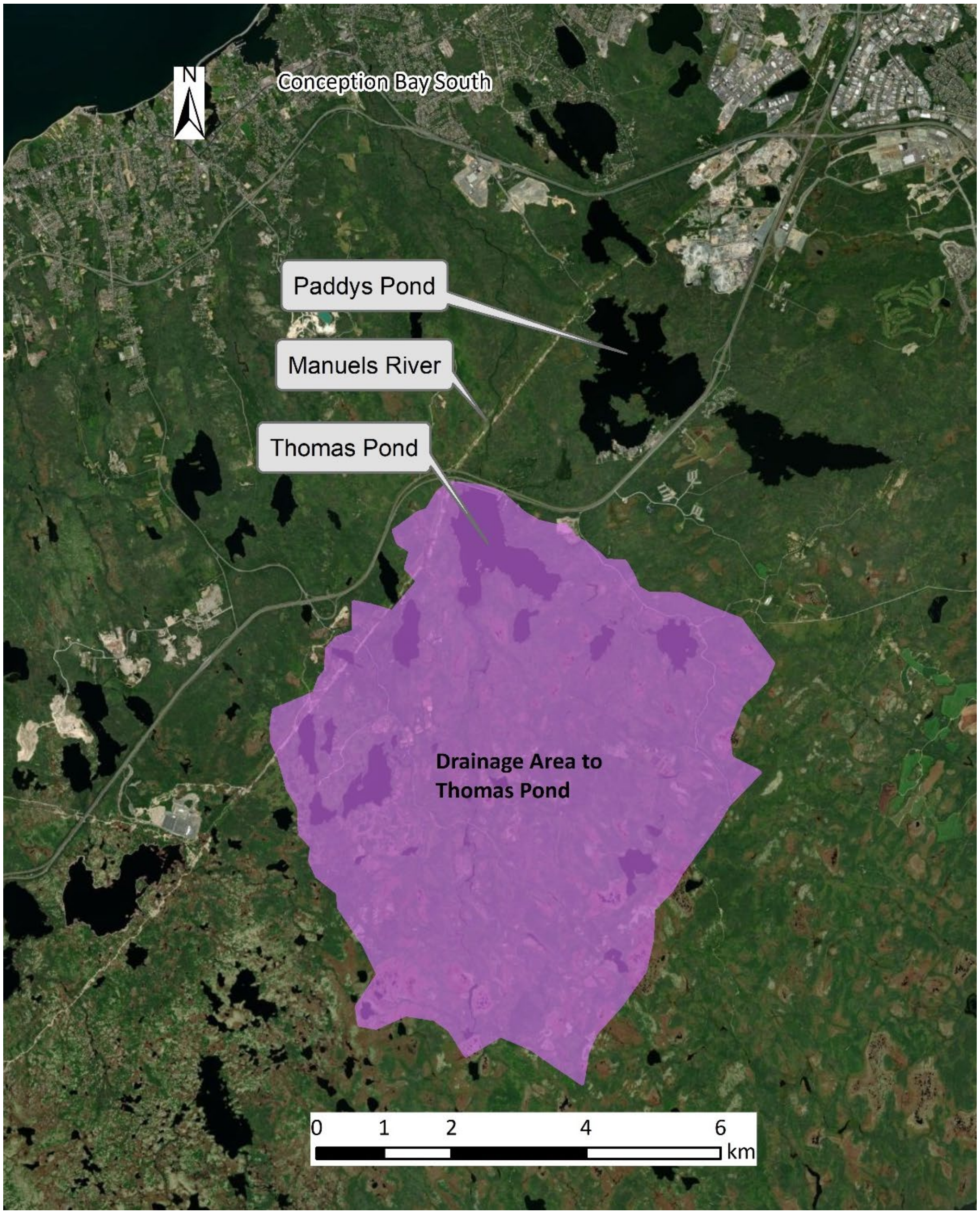


Figure 1.5: Thomas Pond Drainage Area

Chapter 2 Data Gathering

To estimate the reliable yield at Thomas Pond and Big Triangle Pond/Southern Peak Pond, extensive field work and data gathering were required first. In addition to topographic data, pond and stream levels were monitored for a period of one year, and stream velocity measurements were taken multiple times between June 2020 and June 2021. Topographic data of existing structures and features were surveyed, and as-built drawings were acquired where available. Hydrometric and precipitation data from nearby gauges were also downloaded from their respective sources.

To provide data for the treatability assessment raw water characterization, samples were collected four times over a period of one year (within three weeks of ice melting, between June 9-30, August 10-31, and November 10-December 7, or prior to water freezing) to provide samples representative of seasonal water quality changes.

2.1 Topographic Data

Topographic data of both sites was assembled using LiDAR data and surveyed bathymetric data. Both sources were combined to create a continuous Digital Elevation Model (DEM) for each site. Topographic survey data of existing features and structures was also collected.

2.1.1 Bathymetry

Bathymetric survey of Thomas Pond, Big Triangle Pond, Little Triangle Pond, and Southern Peak Pond were conducted by SEM Ltd. during the summer of 2020.

Table 2.1 illustrates the maximum depth of each pond.

Table 2.1: Maximum Pond Depths

Pond	Maximum Depth (m)
Thomas Pond	9.5
Big Triangle Pond	4.6
Little Triangle Pond	14.0
Southern Peak Pond	13.1

In June 2021, bathymetry of the channel between Thomas Pond and Western Pond was collected. This is a rock cut, man-made channel which was constructed in 1956 to divert water from Manuels River to Paddy's Pond - Topsail River to complement the Topsail Pond Hydroelectric Power Generation System.

2.1.2 LiDAR

LiDAR data captured for the City in 2017 was provided for Thomas Pond. New LiDAR around the perimeters of Big Triangle Pond, Little Triangle Pond, and Southern Peak Pond were collected during summer of 2020.

The bathymetric and LiDAR data sets were merged into seamless DEMs for each potential source location. The DEMs were used to create storage curves for the ponds which were subsequently used to estimate reliable yields.

2.1.3 Topographic Survey

Topographic survey was conducted to collect the following data:

- Thomas Pond.
    - Overflow spillway.
    - Dam (top and toe).
    - River cross-sections downstream of sluice gate and overflow spillway.
    - Bridges at TCH east and west bound lanes.
    - TCH edge of pavement.
    - Top of sluice gate (water was too deep to safely survey the gate openings).
- Big Triangle Pond, Little Triangle Pond, and Southern Peak Pond.
    - River cross-sections between Southern Peak Pond and Big Triangle Pond, and downstream of Little Triangle Pond.
    - Culverts at TCH east and west bound lanes.
    - TCH edge of pavement.
    - Utility pole guy wires.
    - Utility poles.
    - Guardrail posts.

2.2 Orthophotos

Orthophotos around the perimeters of Big Triangle Pond, Little Triangle Pond, and Southern Peak Pond were captured during the data collection. For Thomas Pond, orthophotos captured for the City in 2015 were provided by the City.

2.3 Water Level & Flow Gauging

Water levels were recorded for one year at each site. Stream flow measurements were taken at varying water levels throughout the year at the locations of the stream diver gauges.

2.3.1 Water Level Monitoring

In May 2020, level loggers were installed at Southern Peak Pond, Big Triangle Pond, Little Triangle Pond, and Thomas Pond. Barometric loggers were installed near Thomas Pond and Big Triangle Pond. Level loggers were also installed in the channel downstream of Little Triangle Pond, downstream of the sluice gate at Thomas Pond (under the TCH east bound lane bridge), and in the channel downstream of the Thomas Pond overflow spillway. The locations of the loggers are illustrated in Figure 2.1 and Figure 2.2, and summarized in Table 2.2. Monitored water surface elevations for Southern Peak Pond, Big Triangle Pond, Little Triangle Pond, and Little Triangle Pond Stream are presented in Figure 2.4 to Figure 2.6. Monitored water surface elevations for Thomas Pond, Thomas Pond Stream, and Thomas Pond Overflow Stream (i.e., spillway flow) are presented in Figure 2.7 to Figure 2.9. The water level in Thomas Pond dropped below the level logger elevation in July and August, and hence was moved to a deeper location on August 11, 2020. The water level in Thomas Pond again dropped below the level logger elevation near the end of August.

Table 2.2: Summary of Gauge Locations

Location	Gauge Type	Northing	Easting	Elevation (m)
Big Triangle Pond	Barometric	5244102.27	290212.37	87.92
Big Triangle Pond	Lake Diver	5244112.84	290205.84	86.39
Little Triangle Pond	Lake Diver	5244534.31	290094.47	86.30
Little Triangle Pond Stream	Stream Diver	5245294.67	290248.45	85.71
Southern Peak Pond	Lake Diver	5243005.92	290092.64	89.61
Thomas Pond	Barometric	5258488.77	310774.92	139.38
Thomas Pond	Lake Diver	5258057.72	311135.83	145.36
Thomas Pond	Stream Diver	5258089.00	311149.00	143.80
Thomas Pond Overflow Spillway	Stream Diver	5259500.64	310796.70	135.31

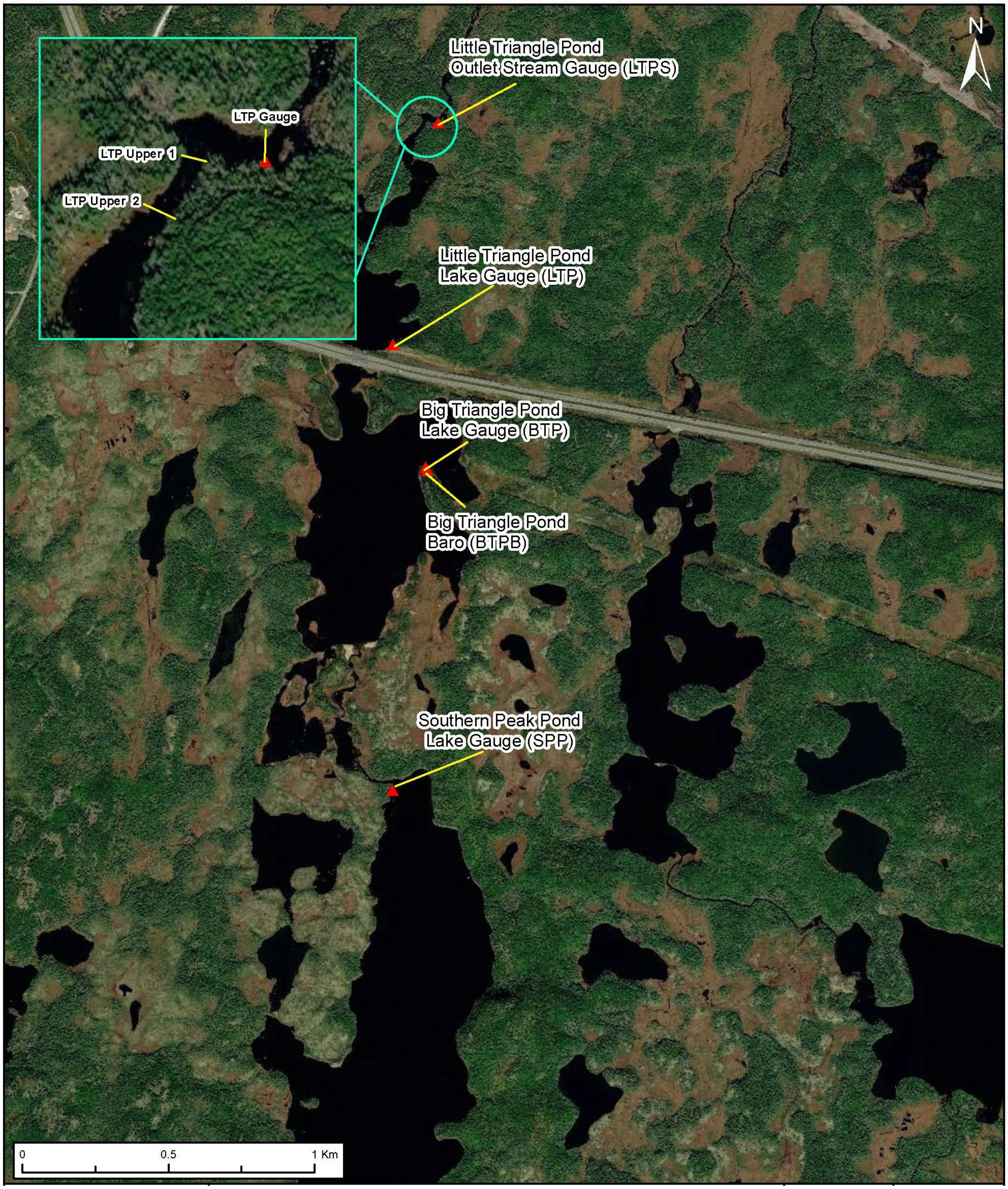


Figure 2.1: Big Triangle Pond Gauge Locations

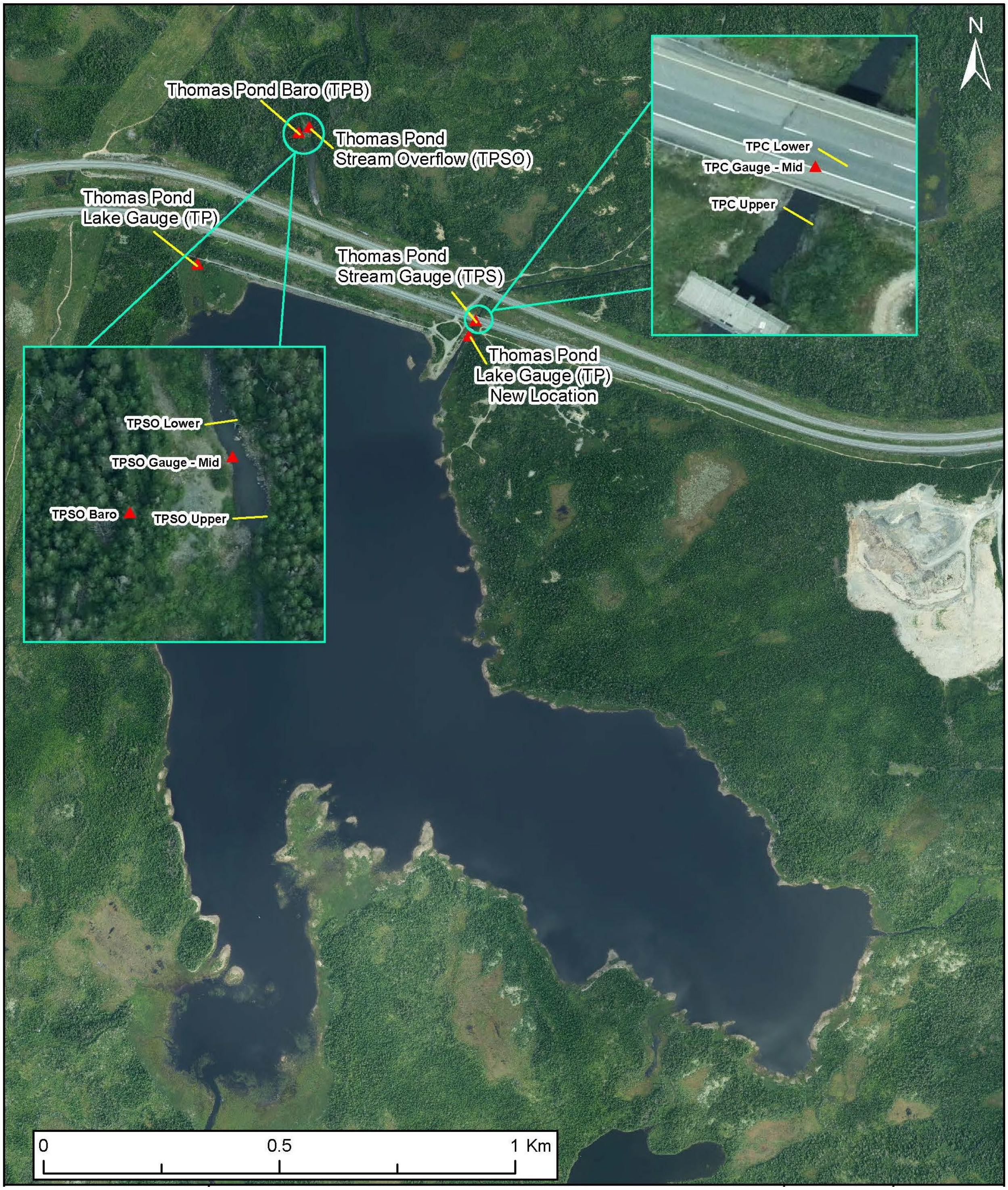


Figure 2.2: Thomas Pond Gauge Locations

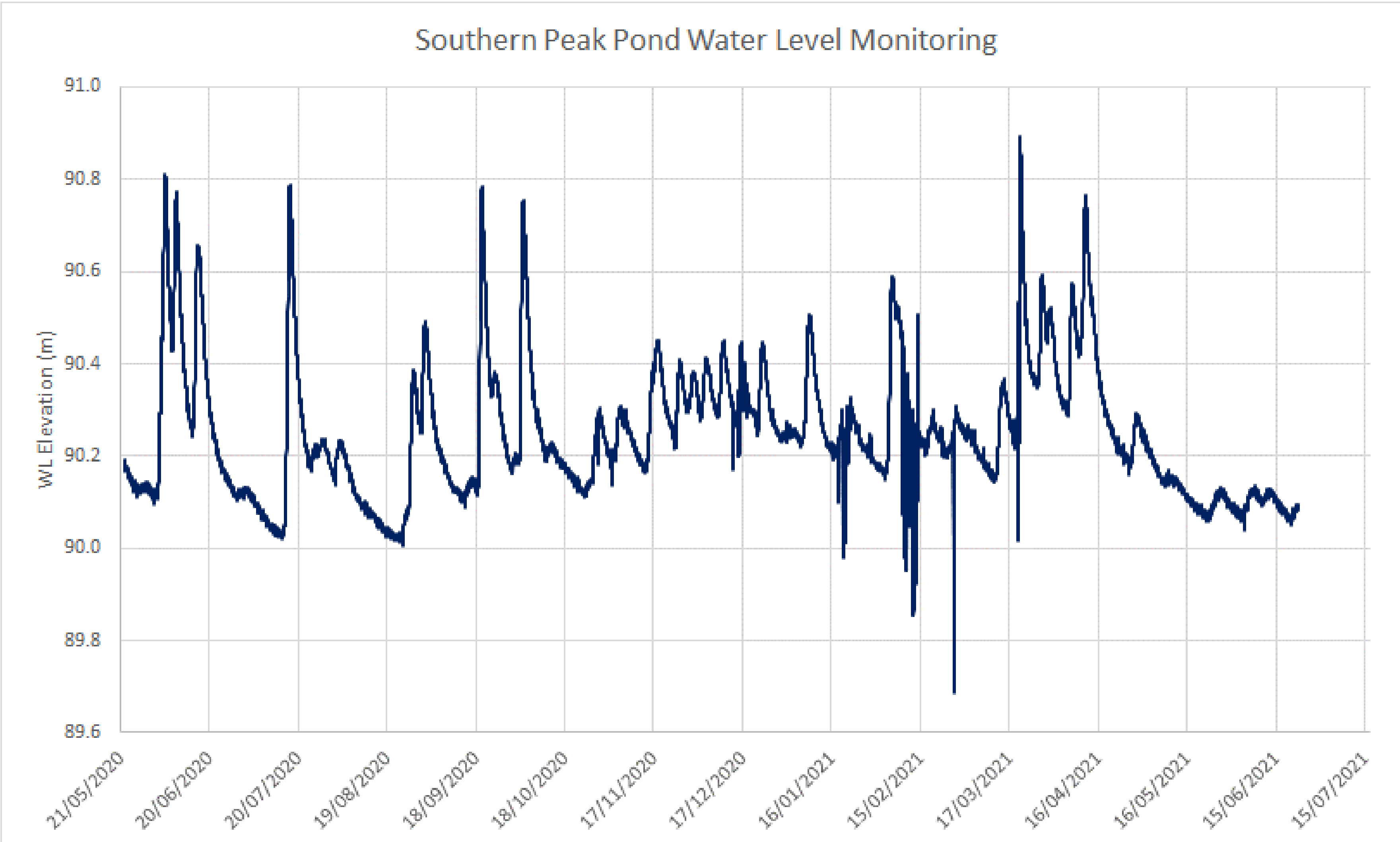


Figure 2.3: Southern Peak Pond Water Level Monitoring

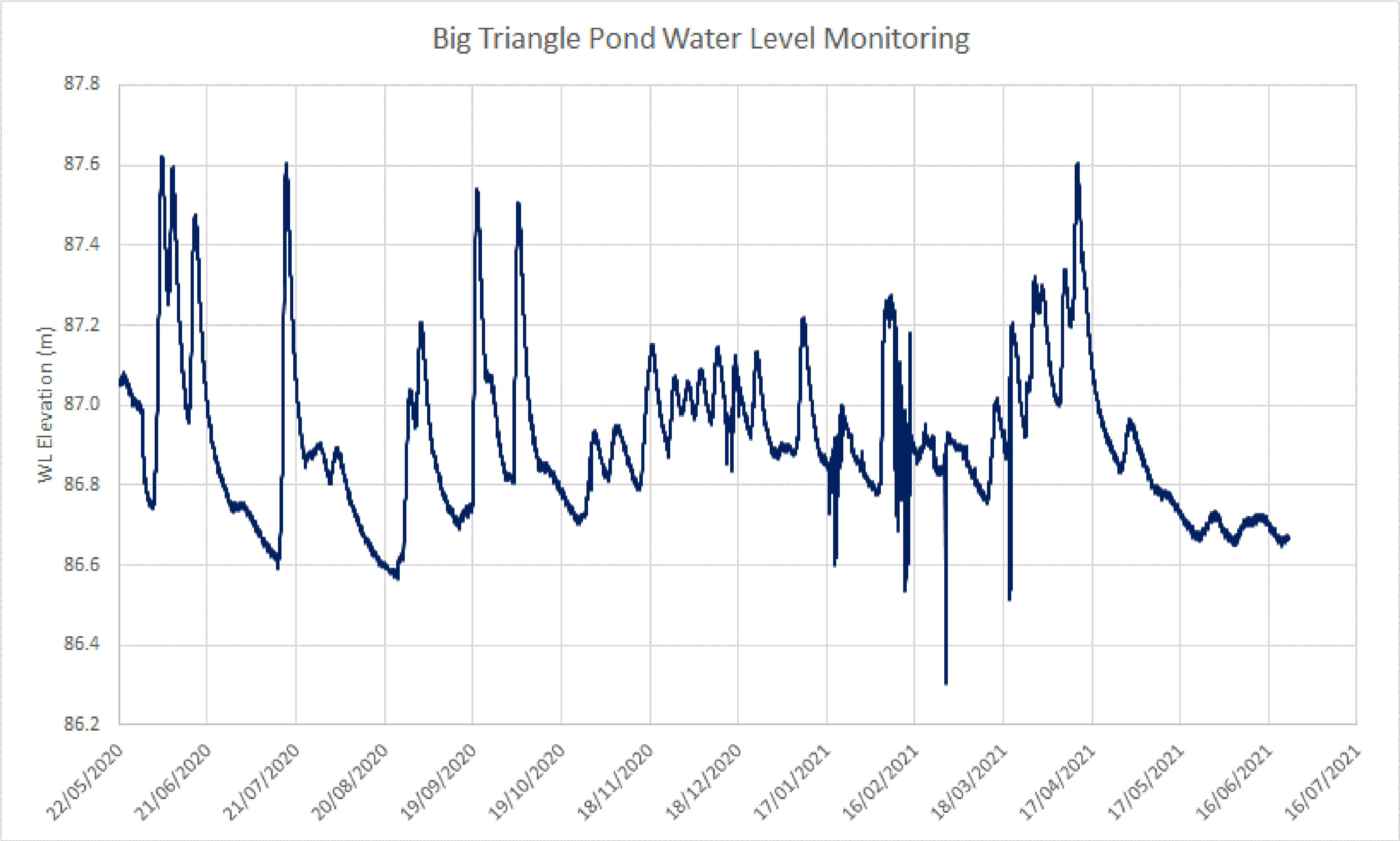


Figure 2.4: Big Triangle Pond Water Level Monitoring

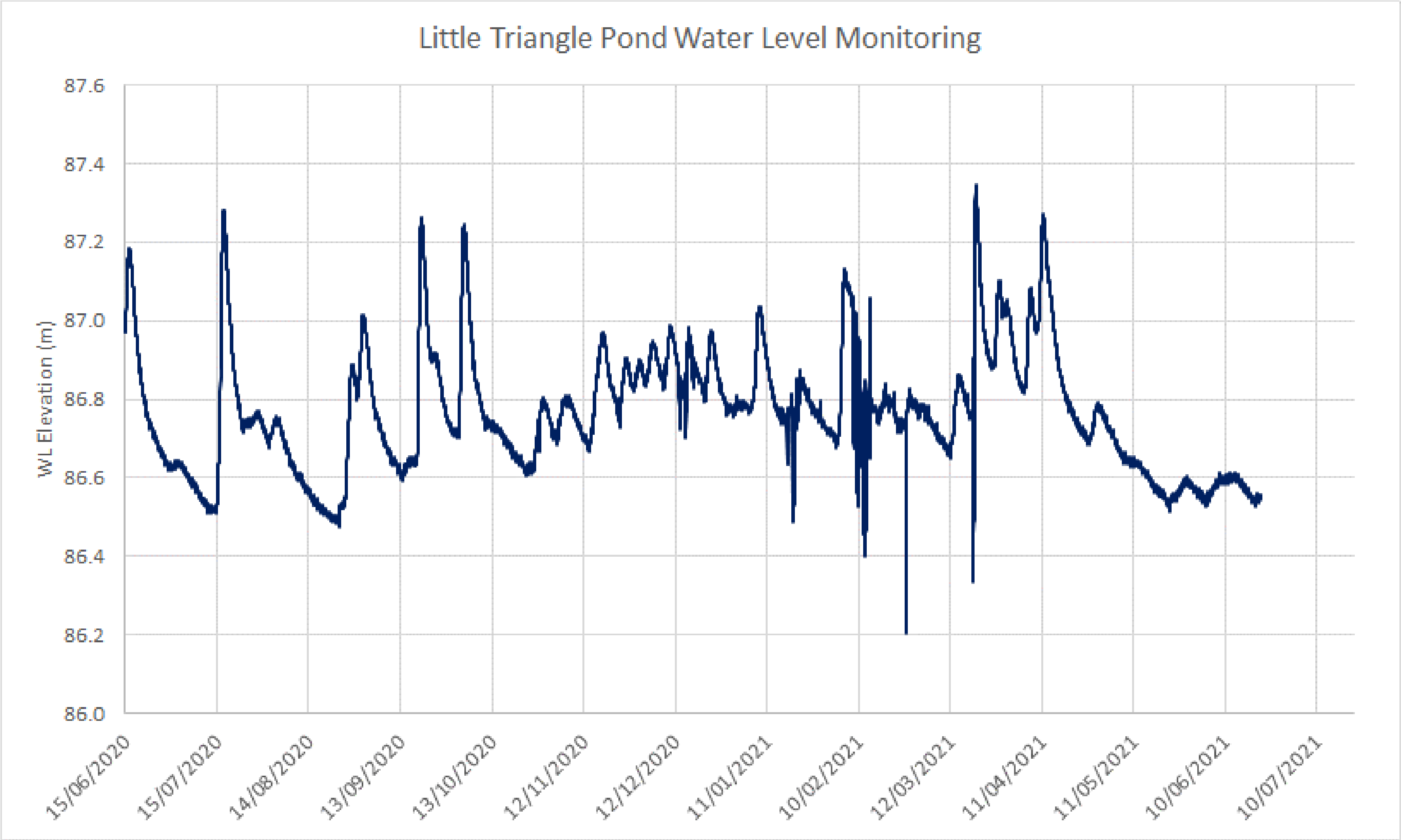


Figure 2.5: Little Triangle Pond Water Level Monitoring

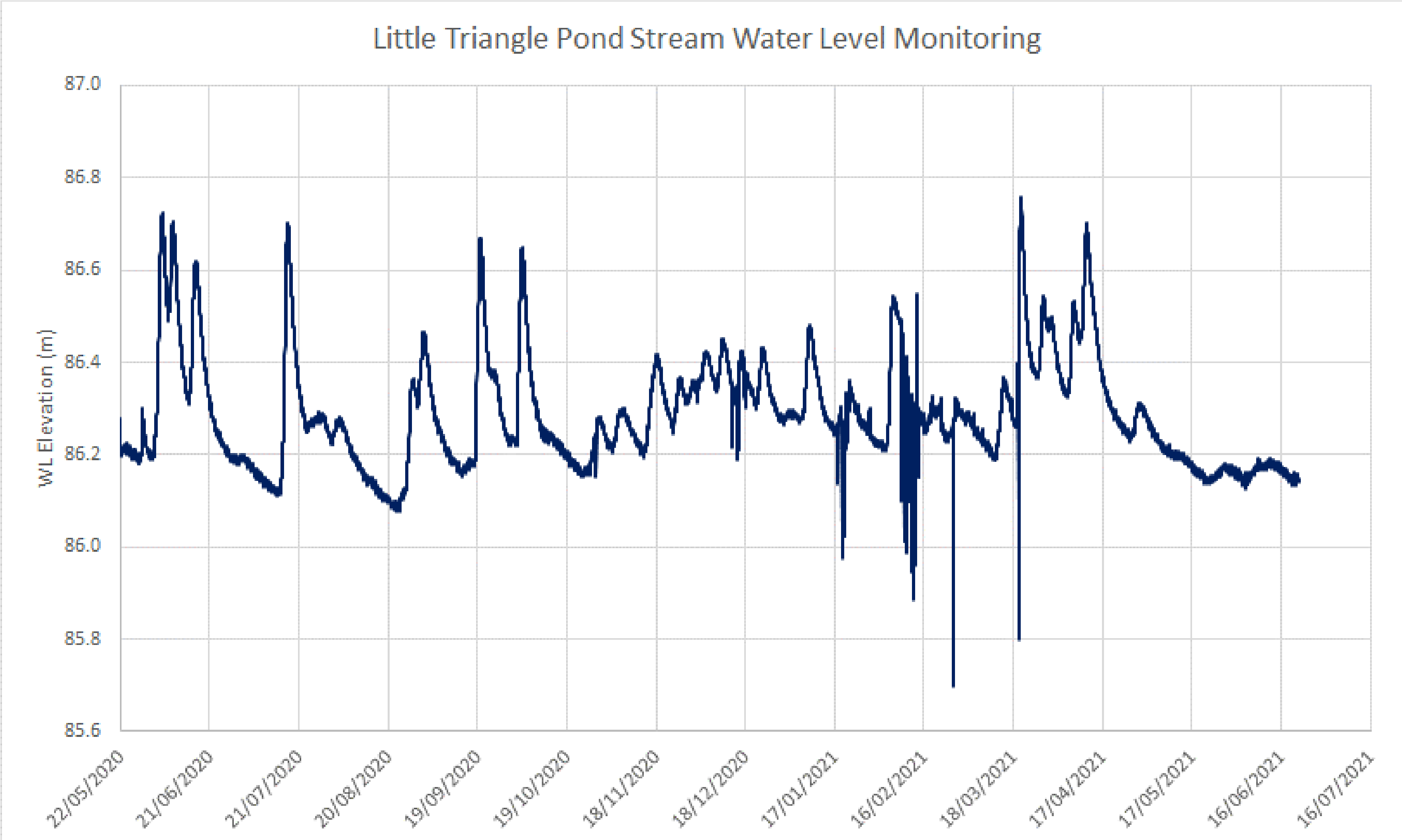


Figure 2.6: Little Triangle Pond Stream Water Level Monitoring

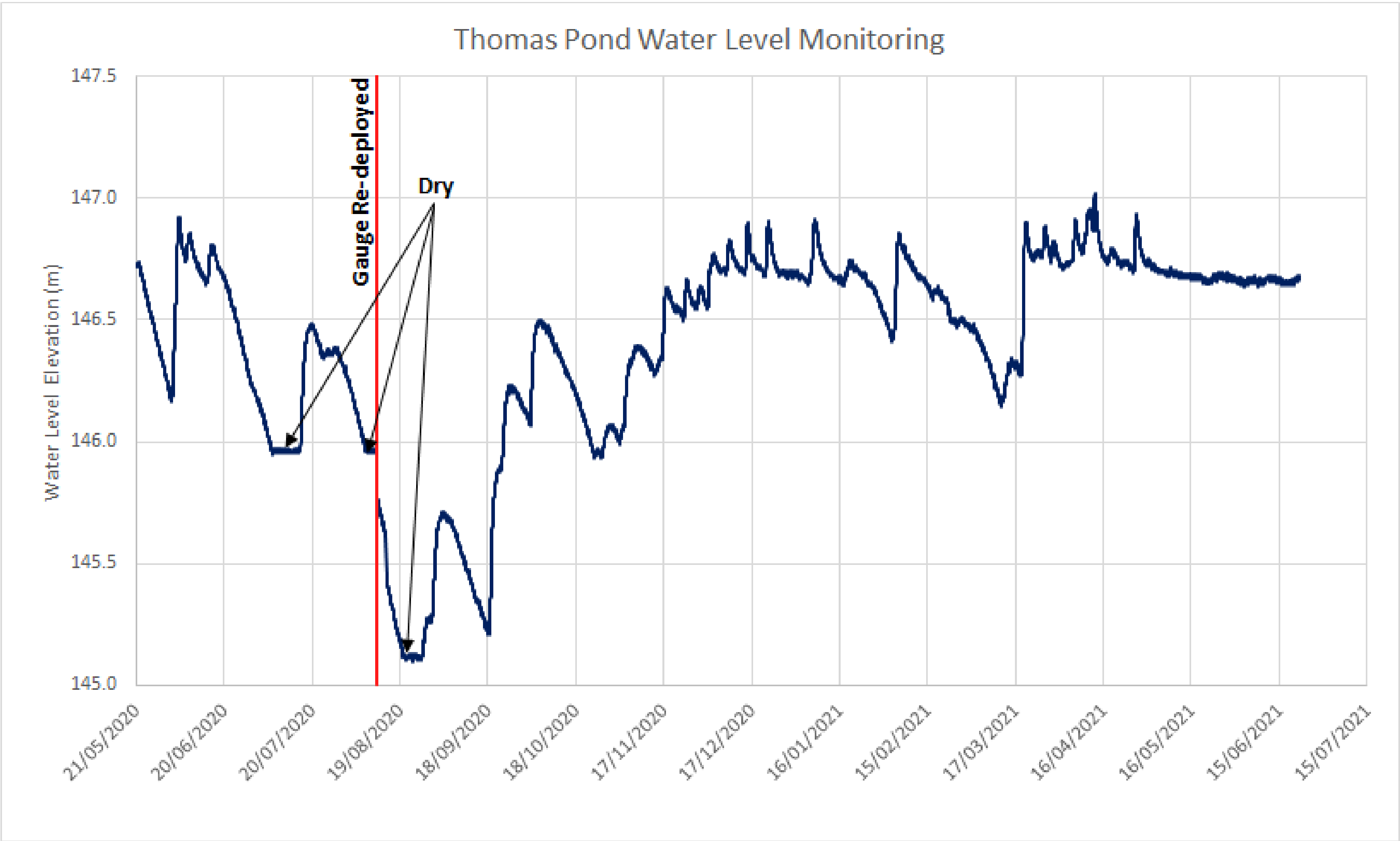


Figure 2.7: Thomas Pond Water Level Monitoring

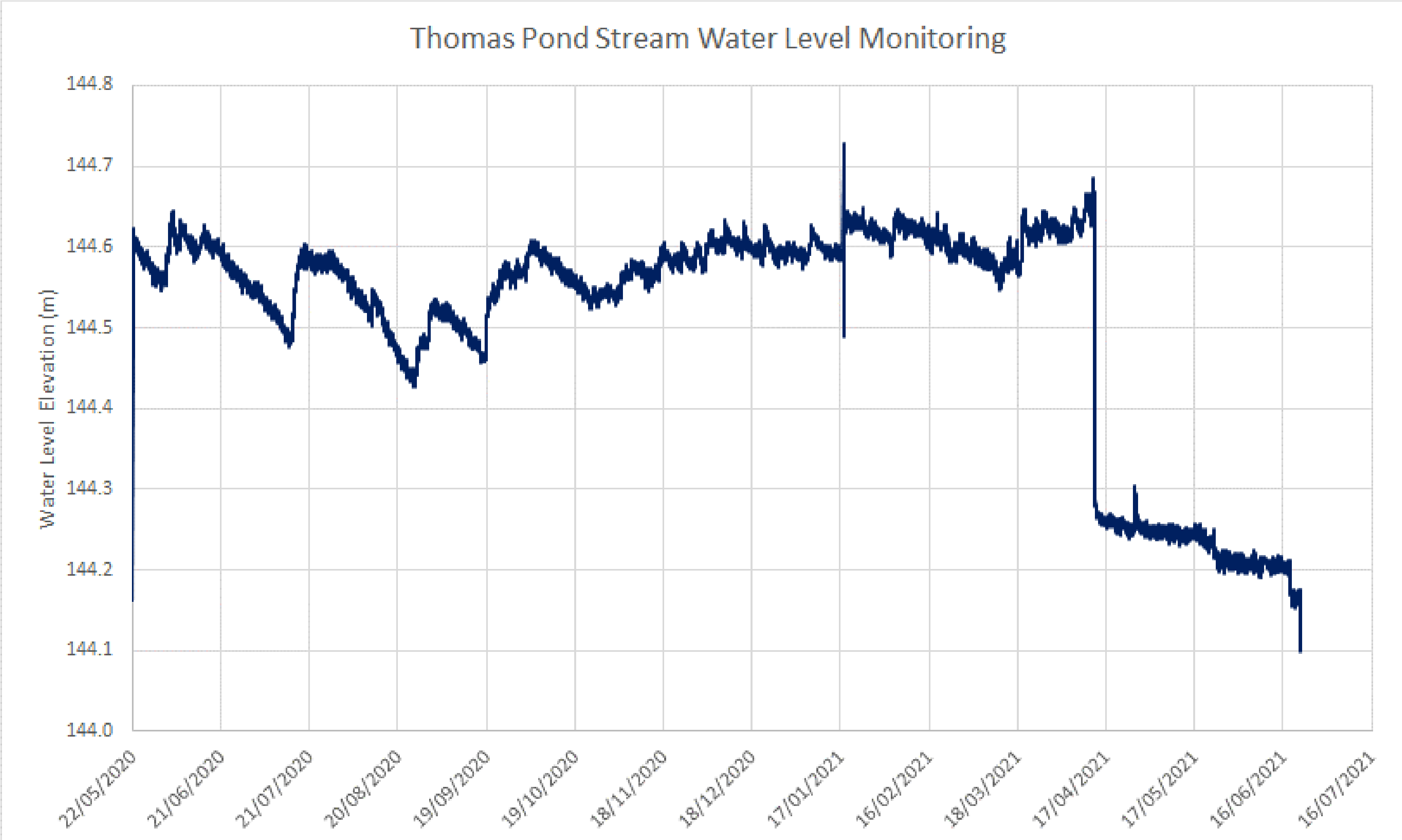


Figure 2.8: Thomas Pond Stream Water Level Monitoring

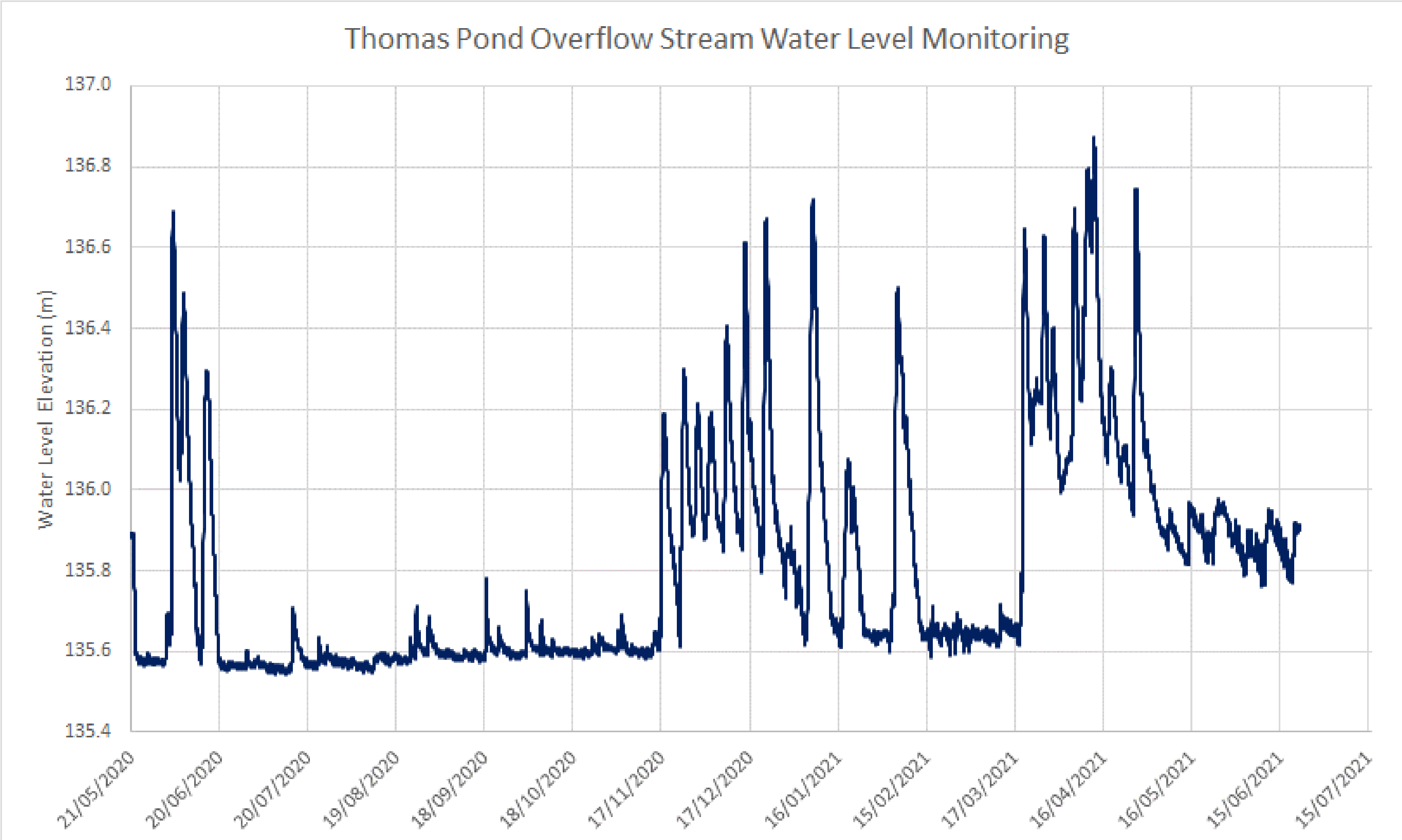


Figure 2.9: Thomas Pond Overflow Stream Water Level Monitoring

2.3.2 Velocity Measurement

Velocity measurements at the locations of the stream divers were collected on the following dates.

Table 2.3: Dates of Velocity Measurement Collection

Location	Date (MM/DD/YY)					
	#1	#2	#3	#4	#5	#6
Little Triangle Pond Outlet Stream	05/21/20	08/11/20	09/22/20	11/05/20		
Thomas Pond Stream (Downstream (D/S) of Sluice Gate)	05/22/20	08/11/20	09/22/20	11/05/20	01/18/21	01/18/21
Thomas Pond Stream (D/S of Overflow Spillway)	05/21/20	12/02/20				

Only two velocity measurements were obtained for the Thomas Pond overflow stream, downstream of the spillway, as the stream was dry for much of the recording period.

Since measurements #2, #3, and #4 for Thomas Pond Stream (D/S of the sluice gate) were collected while the sluice gate was set at an opening of approximately 229 mm, the three measurements yielded similar velocities and, therefore, flows. The lack of flow range limited the number of flow points useful for developing a rating curve in the Thomas Pond Stream. Upon request by CBCL, Newfoundland Power opened the gate to two different heights, such that velocity and cross section data could be collected. On January 18, 2021, operations staff from Newfoundland Power met representatives from SEM Ltd. and CBCL on-site and changed the gate opening from 229 mm to 305 mm and then to 127 mm.

Velocity measurements are converted to flows by collecting corresponding cross-section data at the time of the velocity measurement. Flow is then calculated by multiplying velocity by area of flow. The flow measurements are provided in Table 2.4. Flow measurements were conducted to meet Grade A standard, as described in the *Manual of British Columbia Hydrometric Standards*.

Table 2.4: Flow Measurements

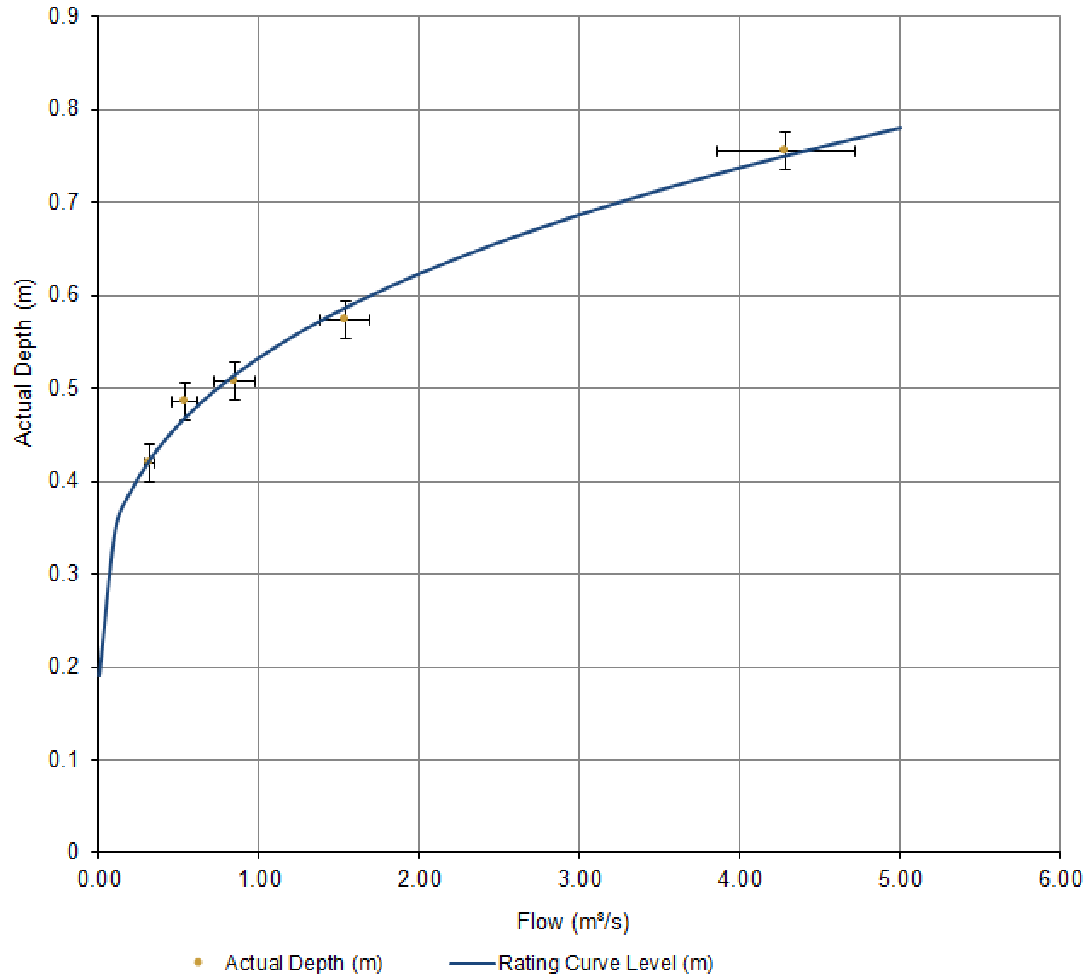
Location	Flow (m^3/s)					
	#1	#2	#3	#4	#5	#6
Little Triangle Pond Outlet Stream	0.85	0.59	4.29	1.53		
Thomas Pond Stream (D/S of Sluice Gate)	0.19	1.11	0.97	1.12	1.62	0.86
Thomas Pond Stream (D/S of Overflow Spillway)	0.69	0.62				

The flow measurements were used to create rating curves for the outlet streams, as described below. The rating curves were used to translate each stream level record to a flow.

2.3.3 Rating Curve Development

The flow and depth measurements were used to create rating curves for the outlet streams. These rating curves are presented in Figure 2.10 to Figure 2.12.

The rating curves were used to translate each stream level record to a flow (i.e., outflow). The outflows were compared to the hydraulic model results (described in Chapter 3) to assess the suitability of using Environment Canada's (EC) nearby hydrometric gauge 02ZM016 – South River near Holyrood station as long-term inflows for establishing reliable yield estimates.



Notes
1.

#N/A 24/Jun/2021

Hydrometric Station Monitoring Report
Little Triangle Pond Stream (LTPS)
Rating Curve

CANADIAN PROJECTS LIMITED

CBCL

Figure 2.10: Little Triangle Pond Stream Rating Curve

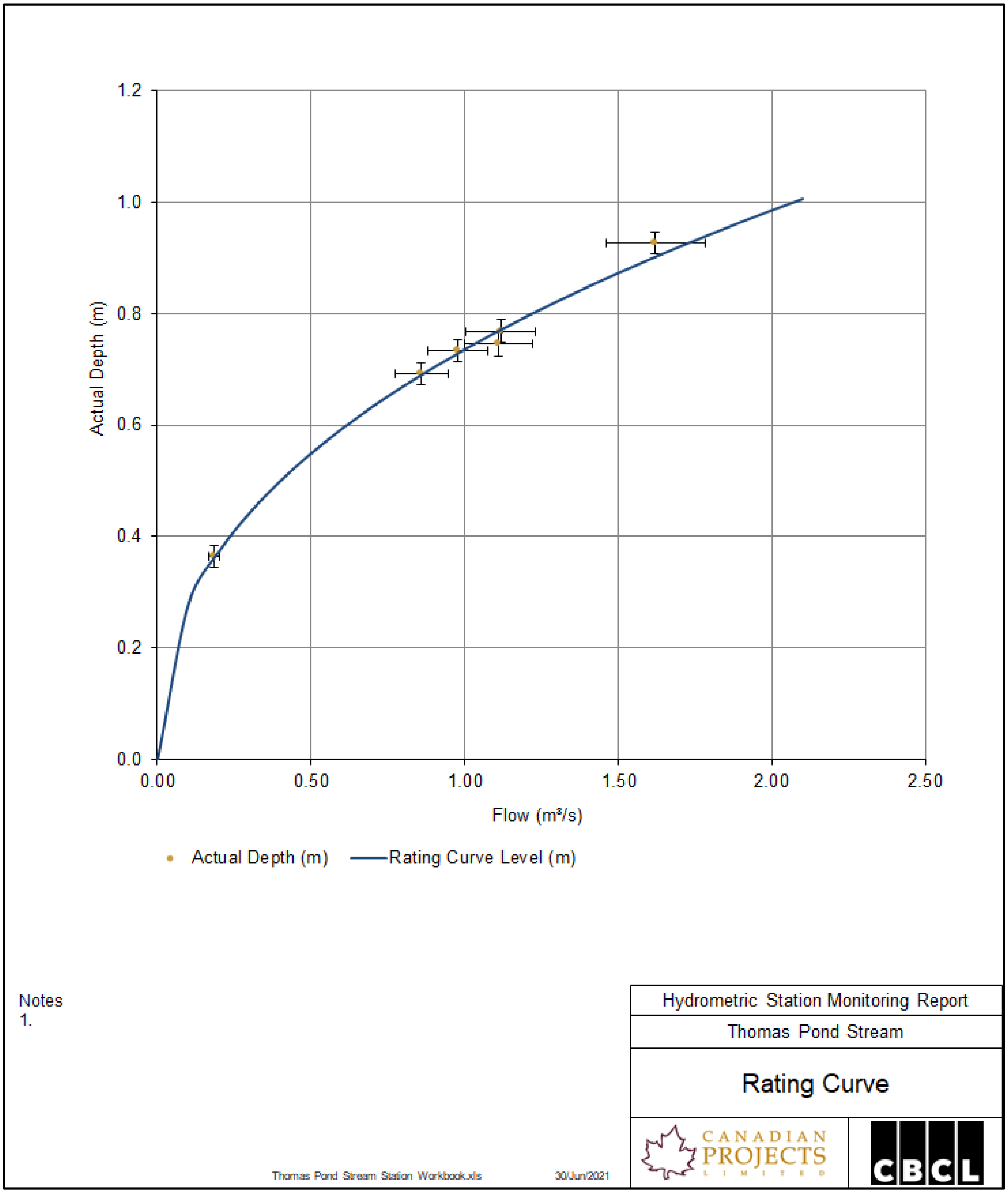


Figure 2.11: Thomas Pond Stream Rating Curve

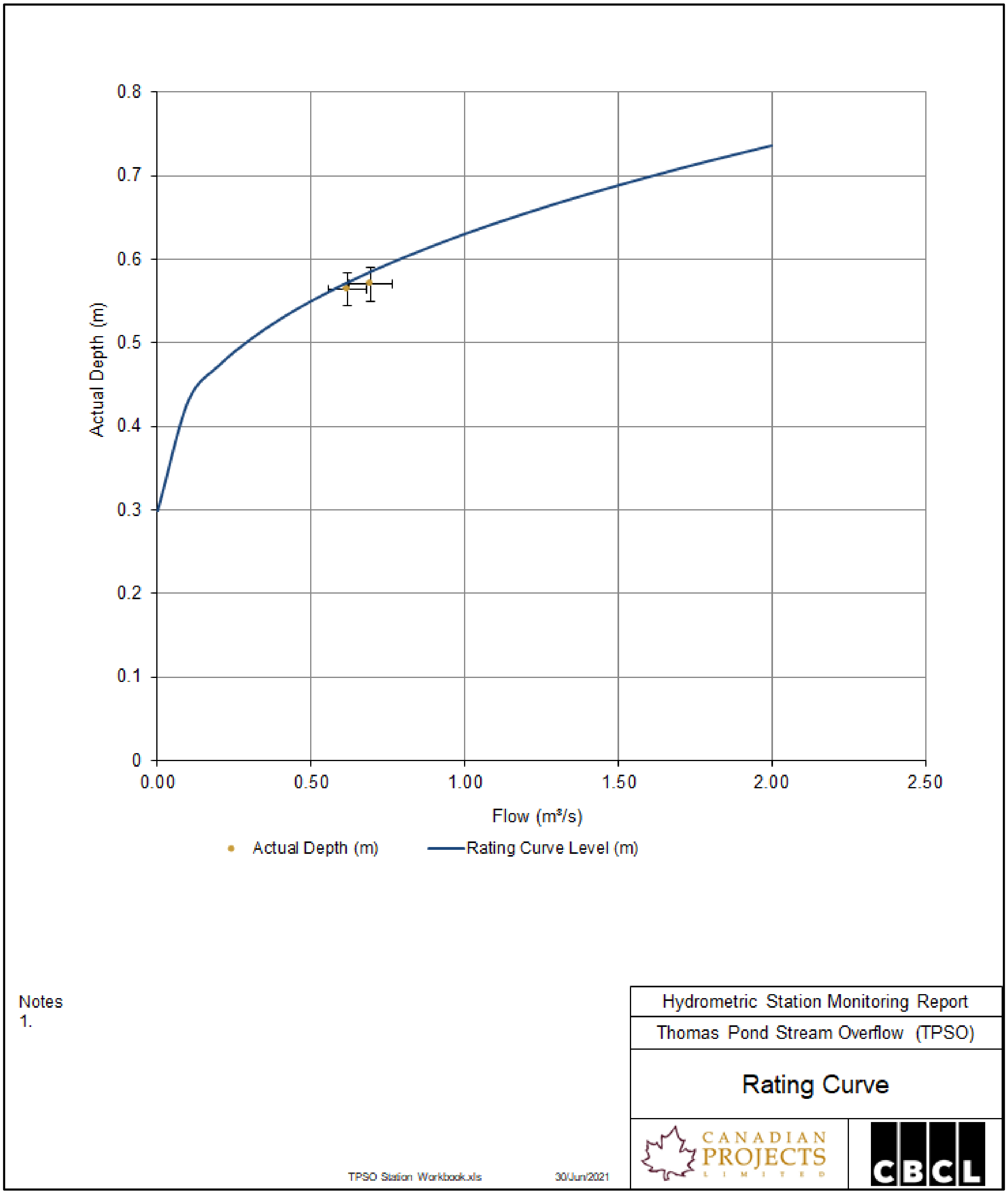


Figure 2.12: Thomas Pond Stream Overflow Rating Curve

2.4 Hydrometric Gauge Data

To estimate reliable yield of the Big Triangle Pond and Thomas Pond sites, long-term flow data is needed. Since there are no hydrometric stations within the Big Triangle Pond and Thomas Pond watersheds, nor downstream of the ponds, several EC gauges were examined to determine if they were appropriate to use for this analysis. The gauge selection was based on the following characteristics:

- Similar climatic conditions (based on the distribution of *Mean Annual Precipitation and the Regional Flood Frequency Analysis for Newfoundland and Labrador 2014 Update*).
- Long period of record.
- Up-to-date data.
- Natural flow (i.e., non-regulated).
- Similar land uses within the compared drainage basin.

Real time hydrometric gauges, operated by EC, were examined. These gauges provide up-to-date data. Their locations, relative to Big Triangle Pond and Thomas Pond, are presented in Figure 2.13 and in Table 2.5.

Several gauges were identified based on the above requirements during the 2016 study, including station 02ZM016, which is the closest spatially to Big Triangle Pond and Thomas Pond. The proximity of 02ZM016 to the two potential sources suggests that the drainage areas experience similar climatic conditions. Additionally, the similar land uses within each drainage basin suggests comparable hydrologic responses are expected, therefore, 02ZM016 was selected as the initial hydrometric gauge to estimate long-term flow data. The appropriateness of this assumption is discussed further in Chapter 3.

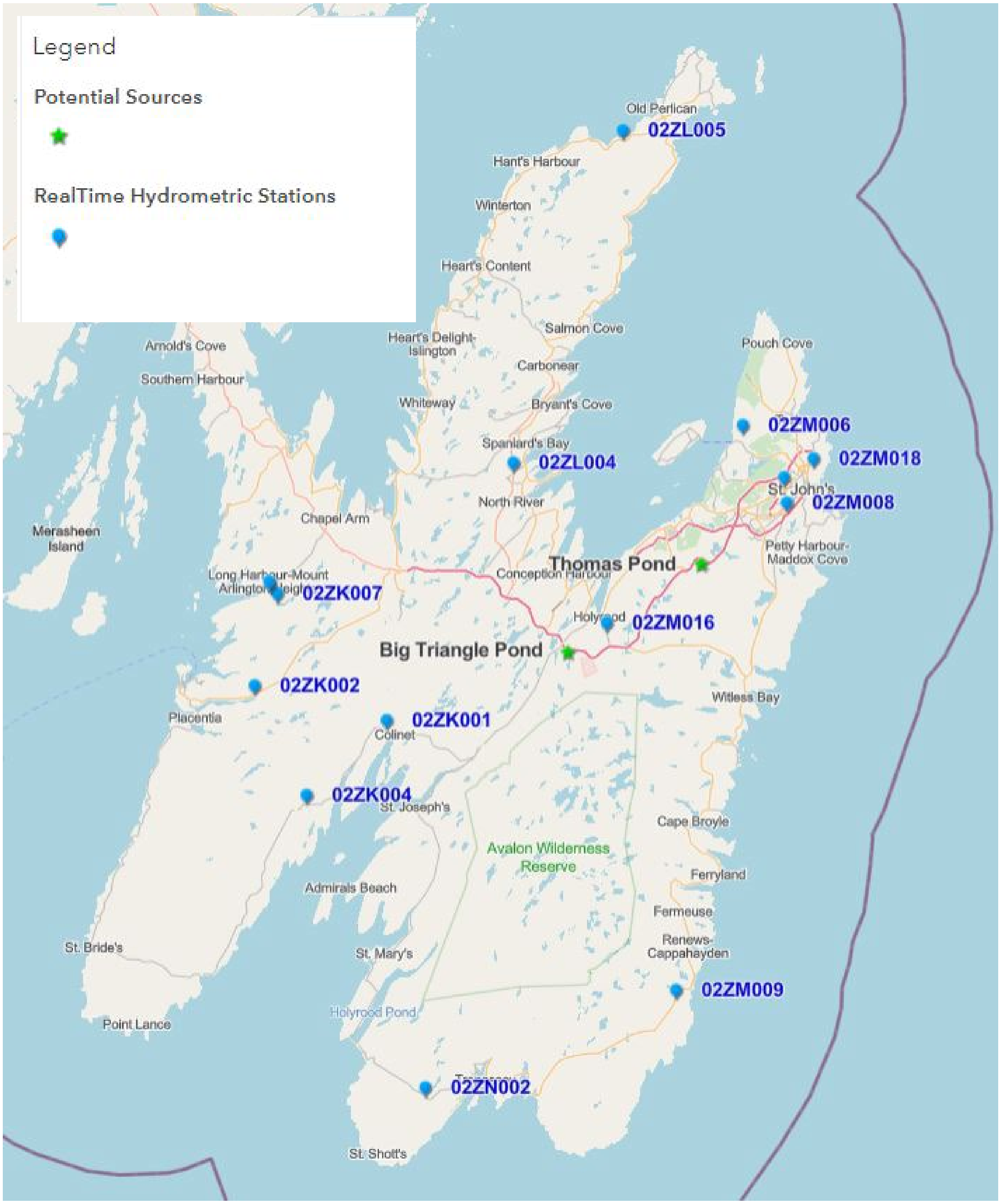


Figure 2.13: Locations of Active Real Time Hydrometric Gauges

Table 2.5: Comparison of Potential Source Watershed Characteristics to Hydrometric Stations

Station ID	Station Name	Start Year	End Year	Monitoring Years	Drainage Area (km^2)	Hydrologic Region
	Big Triangle Pond	2020	2021	1	50.4	SE
	Thomas Pond	2020	2021	1	40.4	SE
02ZM016	South River near Holyrood	1983	2022	39	17.3	SE
02ZK002	Northeast River near Placentia	1979	2022	43	89.6	SW
02ZK004	Little Salmonier River near North Harbour	1983	2022	39	104.0	SW
02ZK001	Rocky River near Colinet	1948	2022	74	301.0	SW
02ZL004	Shearstown Brook at Shearstown	1983	2022	39	28.9	SE
02ZL005	Big Brook at Lead Cove	1985	2022	37	11.2	SE
02ZM006	Northeast Pond River at Northeast Pond	1954	2022	68	3.63	SE
02ZM009	Seal Cove Brook near Cappahayden	1980	2022	42	53.6	SE
02ZN002	St. Shotts River near Trepassey	1985	2022	37	15.5	SE

2.5 Newfoundland Power Operations

Thomas Pond is part of Newfoundland Power's Topsail Pond Hydroelectric Power Generation System. The existing Newfoundland Power infrastructure consists of a dam, spillway, and sluice gate, as illustrated in Figure 2.14. The dam is located approximately 60 m south of the east bound lane of the TCH, and is an earthen dam, approximately 520 m long with a top elevation of roughly 148.5 m. The spillway is a fixed concrete crest overflow, approximately 51.9 m long, with a sill elevation of roughly 146.7 m (Figure 2.15). Spilled water flows under the TCH, through an open bottom concrete box culvert (east bound lane), followed by a concrete bridge (west bound lane), to enter Manuels River.

Figure 2.14: Existing Thomas Pond Infrastructure

Figure 2.15: Thomas Pond Spillway Taken from TCH East Bound Lane

A sluice gate located at the east end of the dam is operated by Newfoundland Power, and releases flow to a man-made rock-cut channel which directs flow to Western Pond and on to Paddy's Pond. The sluice gate is 1.75 m wide and has an invert elevation of approximately 142.1 m. Newfoundland Power provided CBCL with the sluice gate layout and details drawing (dated June 21, 1974), which is included in Appendix A. Figure 2.16 illustrates the sluice gate.

Figure 2.16: Thomas Pond Sluice Gate Taken from TCH East Bound Lane

Operating procedures for Topsail Pond Hydroelectric Power Generation System were provided by Newfoundland Power (Appendix B). Through correspondence with Newfoundland Power, it was found that the efficient operating range of the Thomas Pond reservoir is between 146.56 m and 143.97 m, which maximizes production from the system. The reservoir storage is used to moderate the water supplied to the generating unit, and to allow the unit to operate at or near the most efficient output. In anticipation of inflow peaks, water levels may be reduced marginally to avail of the storage capacity of the reservoir. Such an attempt to minimize spill results is the most efficient use of the natural water resource.

Downstream reservoirs, Paddy's Pond, Three Arm Pond, Three Island Pond, and Topsail Pond also form part of the Topsail Pond Hydroelectric Power Generation System. Discharge from Thomas Pond is monitored to avoid disturbances to residential properties on or near the downstream reservoirs. Additionally, Paddy's Pond water elevation is not to drop below 130.29 m, to accommodate float plane operations.

Presently gate operations are adjusted weekly/monthly or as required to maximize storage without resulting in spill. There is no rule on gate opening vs. pond level. Gate adjustments are performed on an as-needed basis.

While the operating procedures do not state a minimum flow release required for fish, a minimum gate opening of ~25 mm is given. That said, through correspondence with Newfoundland Power it was stated that an ~51 mm gate opening is typically maintained for fish flow.

Sluice gate openings for Thomas Pond were obtained from Newfoundland Power for May 2020 to July 2021, are presented in Table 2.6.

Table 2.6: Thomas Pond Sluice Gate Opening

Date	Gate Opening	Note
May 2020	51 mm	Late May changed to ~229 mm
June 2020 – April 12, 2021	229 mm	
April 13, 2021 – July 2021	51 mm	

In May 2020, Newfoundland Power informed CBCL that the Topsail Pond Hydroelectric Power Generation System, of which Thomas Pond is part of, was in the design stage for a new penstock. Therefore, the plant was out of service during the lake and stream level monitoring period.

2.6 Water Quality Samples

CBCL collected water samples at both Big Triangle Pond and Thomas Pond. Samples were collected on the following dates and were sent to AGAT Laboratories for analysis. The laboratory reports are included in Appendix C.

Table 2.7: Dates of Water Quality Samples

Location	Sample Date and Time (MM/DD/YY HH:MM)			
	#1	#2	#3	#4
Thomas Pond	09/15/20 15:15	12/08/20 11:00	03/22/21 11:00	07/08/22 8:30
Big Triangle Pond	09/15/20 14:45	12/08/20 10:30	03/22/21 10:00	07/08/22 8:00

Chapter 3 Long Term Flow Series

The preliminary reliable yield estimates completed in the 2016 St. John's Regional Drinking Water Study were based on various assumptions concerning flows and storage availability. This study involved collecting additional topographic and bathymetric survey data to refine the storage curves used in the reliable yield assessments. Although water level and flow measurements are also a part of this study, the duration of this data is relatively short. Since the reliable yield assessment is concerned with low flow conditions, it would be ideal to monitor the systems' actual response to low flows. A severe dry period was not experienced during the data collection phase, therefore, it was proposed to extend the flow series by correlating the monitored data to another nearby hydrometric gauge.

A hydraulic model for each of the Big Triangle Pond and Thomas Pond sites was prepared in PCSWMM using the collected bathymetric and topographic survey data. The nearby real-time EC hydrometric gauge 02ZM016 - South River near Holyrood flow series was used as inflow for the hydraulic models. The 02ZM016 5-minute real time data for May 2020 to June 2021 was prorated by ratio of drainage areas to Southern Peak Pond, Big Triangle Pond, Little Triangle Pond, and Thomas Pond. The model results (i.e., water levels in the ponds as well as the downstream channel flows) were compared to the monitored data. If the comparison provided a good fit, then the assumption that inflow series created by drainage area proration is reasonable, and the long-term daily flow series from 02ZM016 can be used to estimate reliable yields.

The following sections describe the development of the long-term flow series.

3.1 Hydraulic Model Development

Hydraulic models of the Thomas Pond and Big Triangle Pond sites were created using the modelling software PCSWMM and the collected bathymetric and survey data.

The models were run with inflow series, as described above. The resulting water levels in the ponds, as well as the downstream channel flows, were compared to the monitored data. A minimum of one complete year of water level and flow data was required for a comprehensive analysis.

3.1.1 Big Triangle Pond

Figure 3.1, Figure 3.2, Figure 3.3, and Figure 3.4 compare water elevations recorded at Southern Peak Pond, Big Triangle Pond, Little Triangle Pond, and flows recorded at the Little Triangle Pond stream station to those from the hydraulic model simulation. As shown, the model simulated water elevations and flows closely matches the monitored data for most of the monitored period. Based on this estimating long-term inflow to the Big Triangle Pond site using the 02ZM016 long-term flow series prorated by ratio of drainage areas is appropriate.

3.1.2 Thomas Pond

Thomas Pond is currently regulated by Newfoundland Power as described in Section 2.5.

The regulating gate opening was reported by Newfoundland Power to be 229 mm for most of the monitoring period. Therefore, the regulating gate was modelled with a 229 mm height opening.

The 02ZM016 real-time flow series was prorated by ratio of drainage areas and entered as inflow series to Thomas Pond, and the results were compared to the measured water levels and flows. Preliminary analysis (comparing data for May to November) revealed that while the modelled water elevation in Thomas Pond compared well to the monitored flow for May, June, and most of July and August, there was a significant difference in the water level comparison for September to November. That said, the general shape of both the modelled and monitored water levels were similar for the remainder of the period of record, suggesting that the 02ZM016 record was still representative of the inflow series to Thomas Pond.

By reducing the prorated inflow by 10%, the modelled and monitored water levels in Thomas Pond produced a better match. Figure 3.5 to Figure 3.7 illustrate the modelled and monitored water levels in Thomas Pond, the channel downstream of the regulating gate, and the flow in the channel downstream of the regulating gate for the entire period of record (June 2020 to June 2021).

Since there were some disagreements with the comparison of modelled and monitored levels and flows using the 02ZM016 gauge, other hydrometric gauges were examined. The result of this analysis is presented in Figure 3.8. The graph shows that the selection of 02ZM016 yields the best match to the monitored water level at Thomas Pond.

Based on this comparison, the 02ZM016 long-term flow series prorated by ratio of drainage areas and reduced by 10% was used as the inflow series to estimate a reliable yield for Thomas Pond.

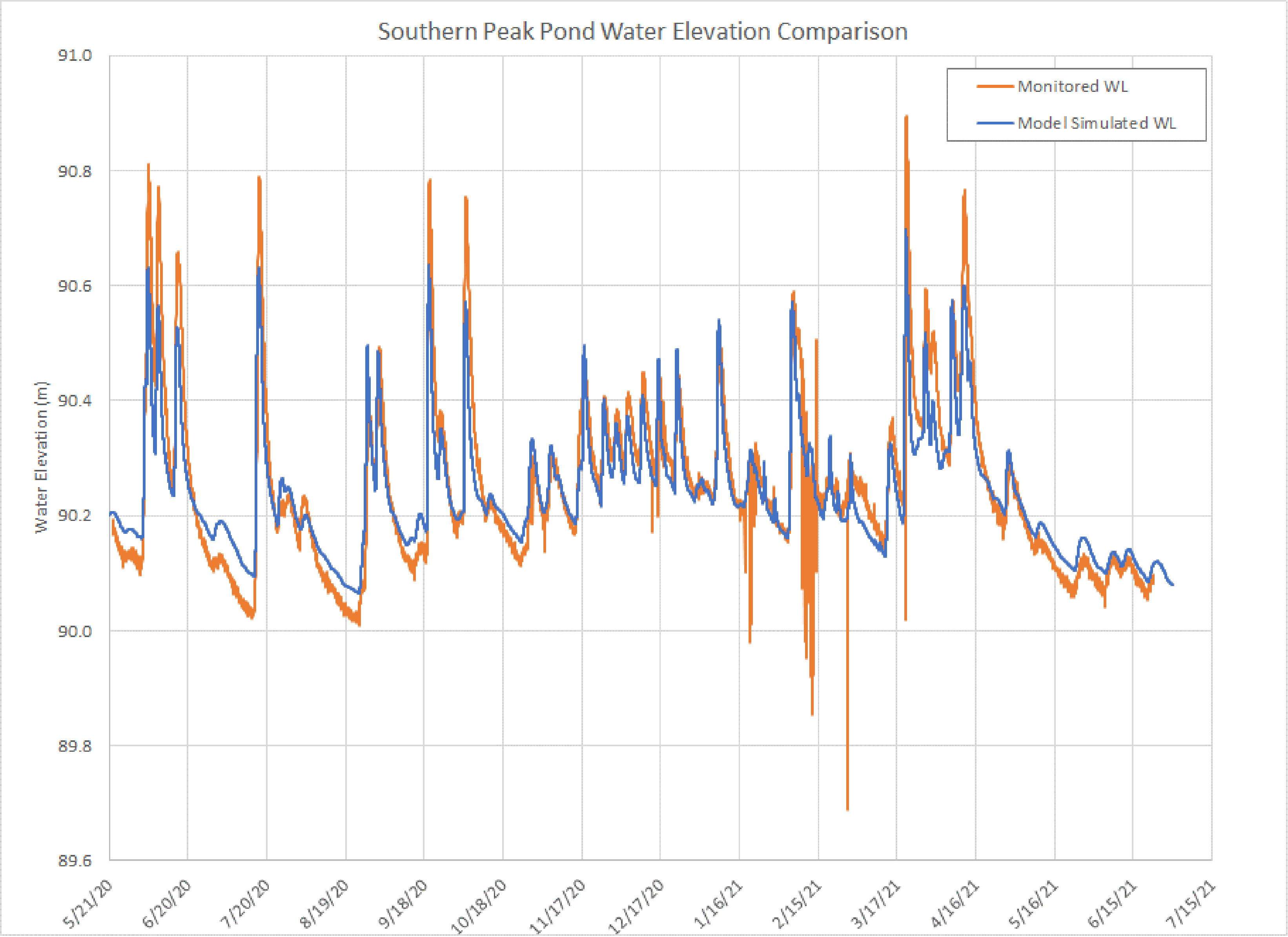


Figure 3.1: Southern Peak Pond Water Elevation Comparison

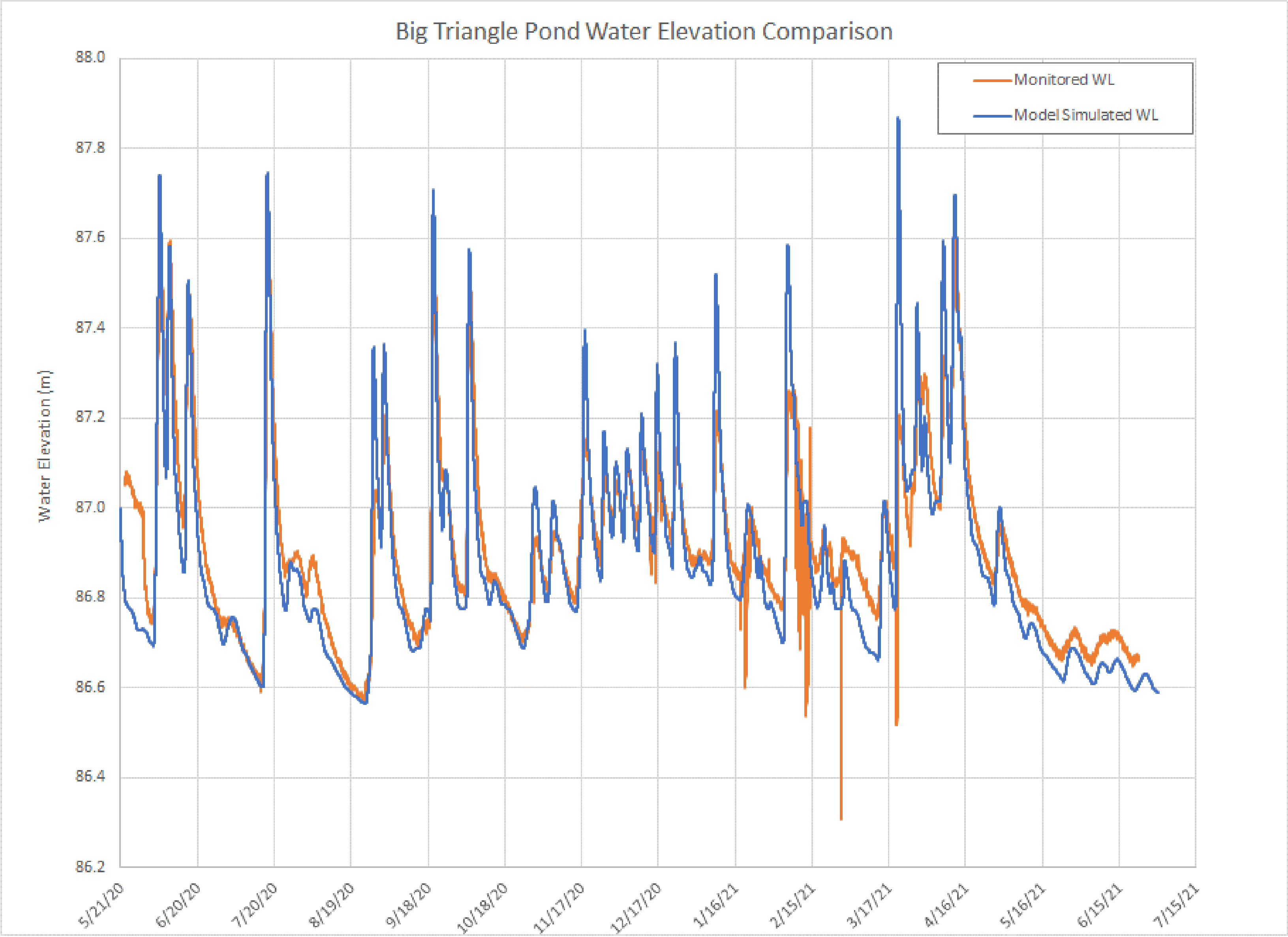


Figure 3.2: Big Triangle Pond Water Elevation Comparison

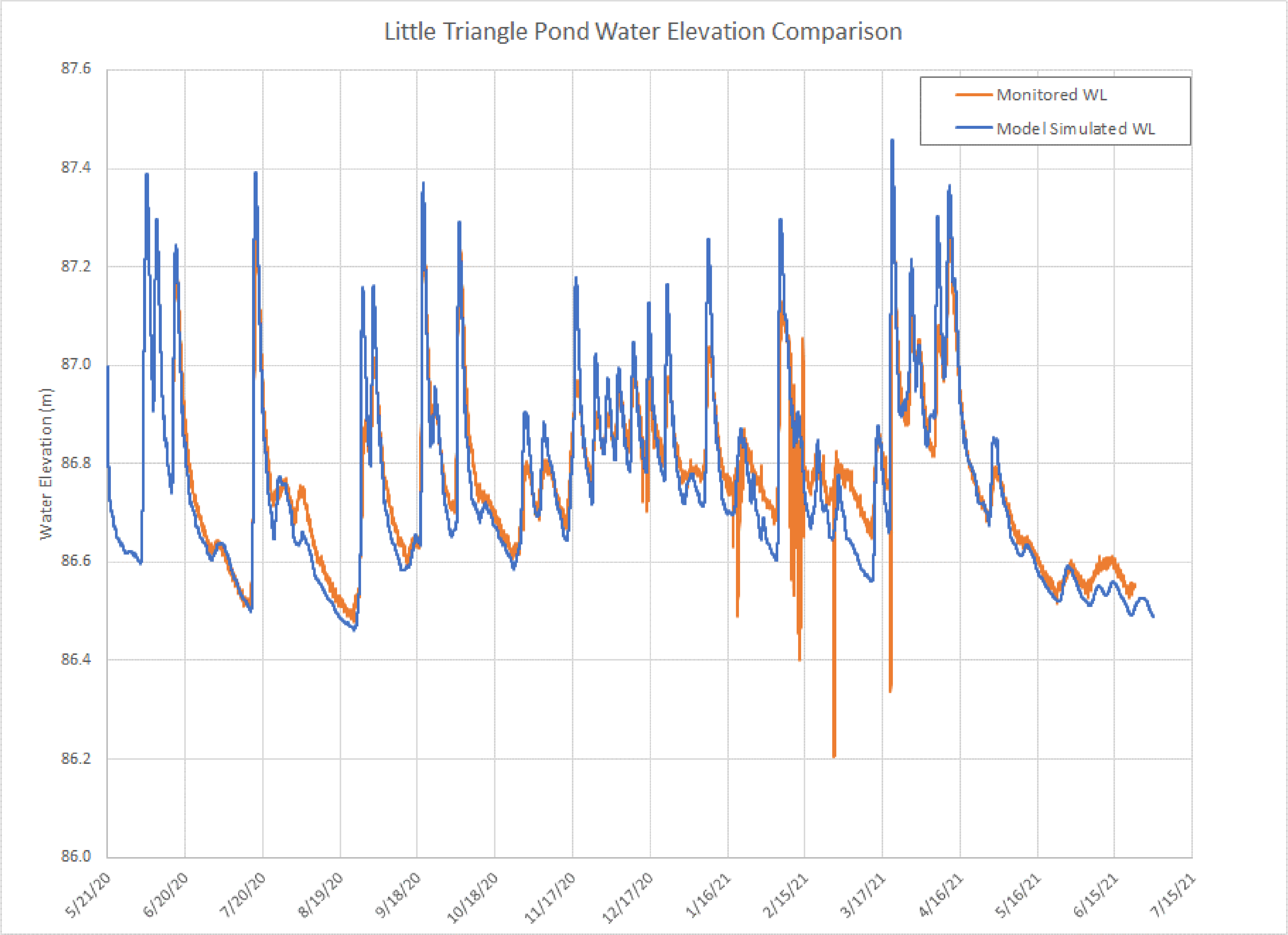


Figure 3.3: Little Triangle Pond Water Elevation Comparison

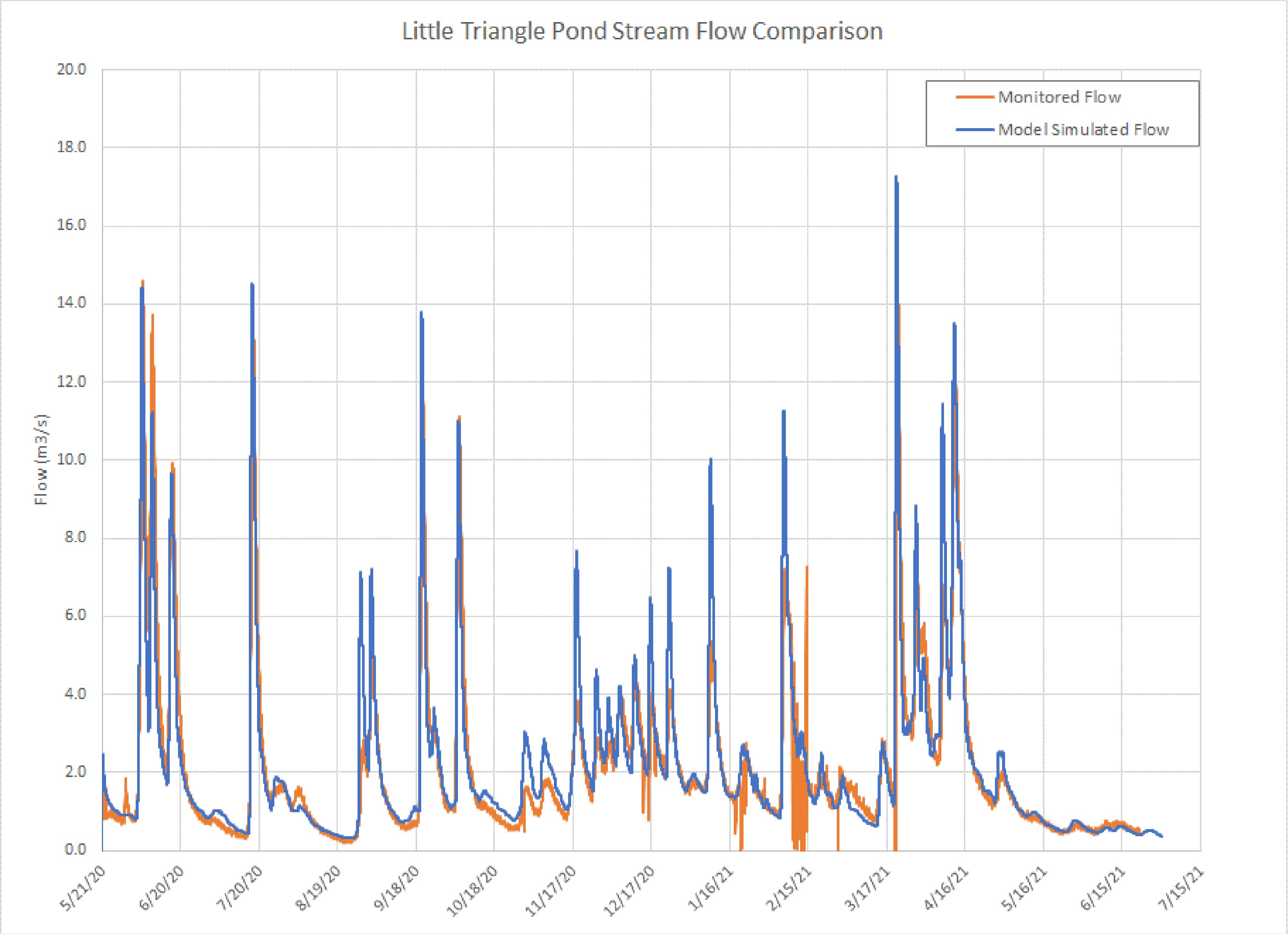


Figure 3.4: Little Triangle Pond Stream Flow Comparison

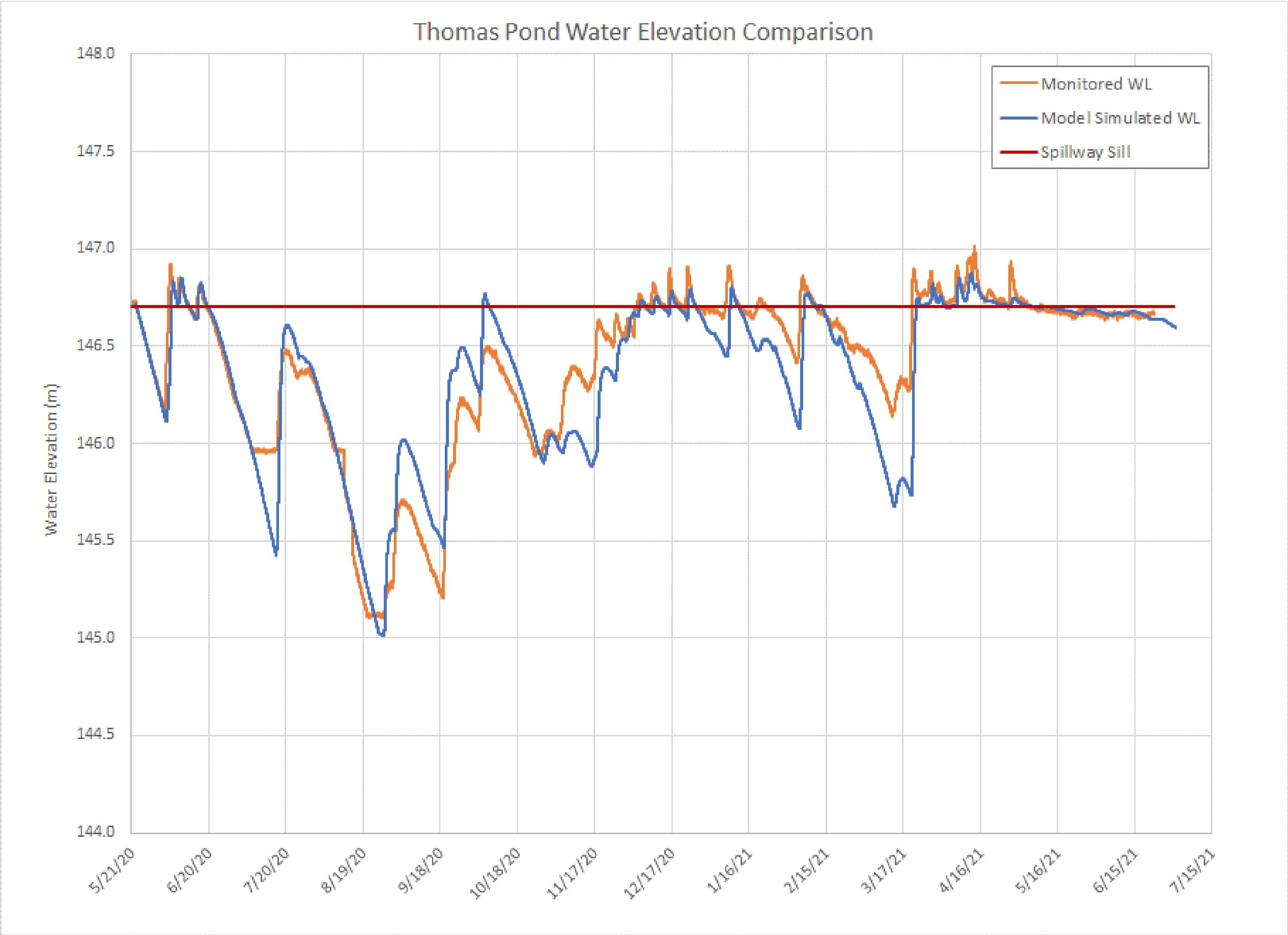


Figure 3.5: Thomas Pond Water Elevation Comparison

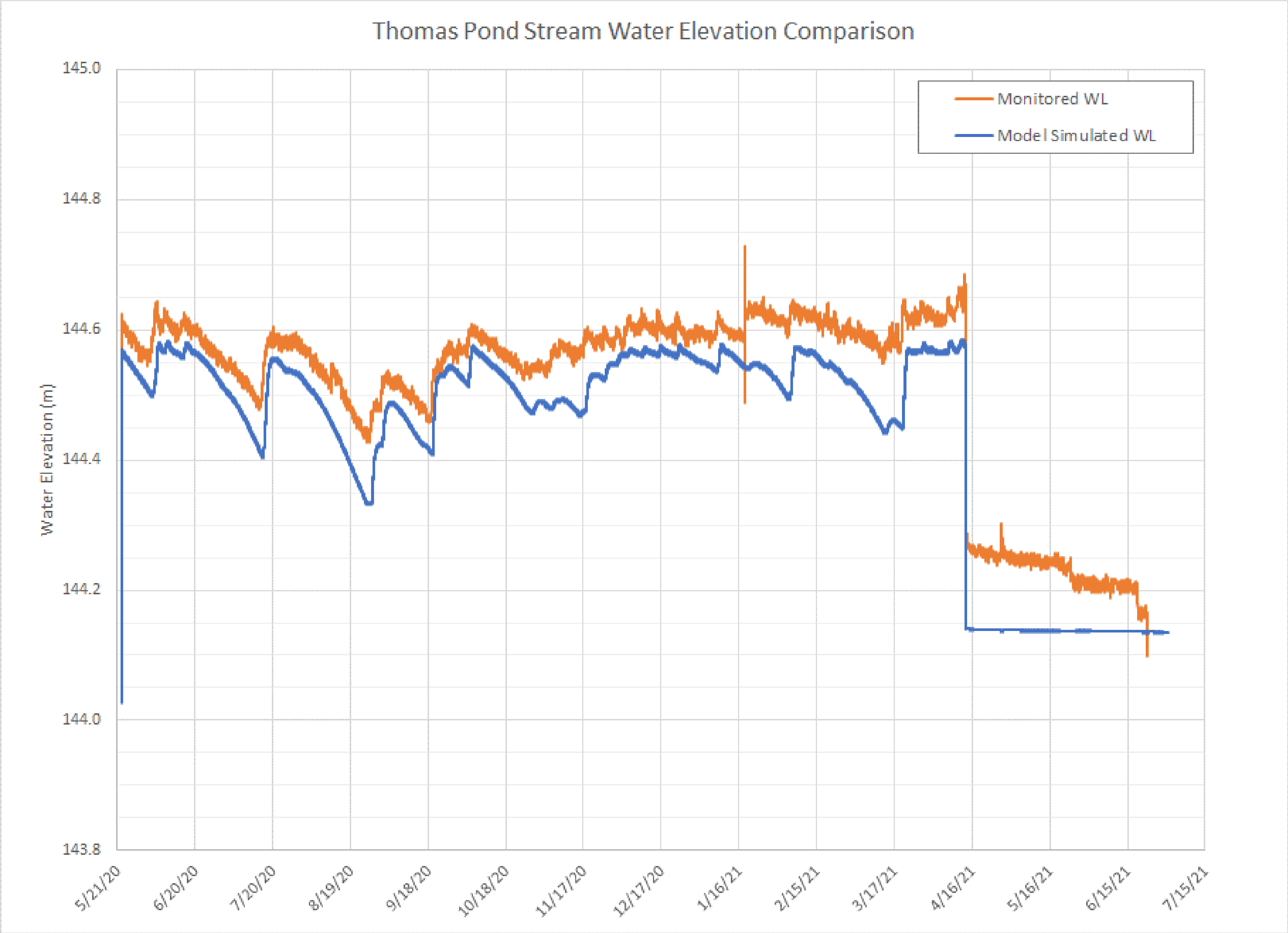


Figure 3.6: Thomas Pond Stream Water Elevation Comparison

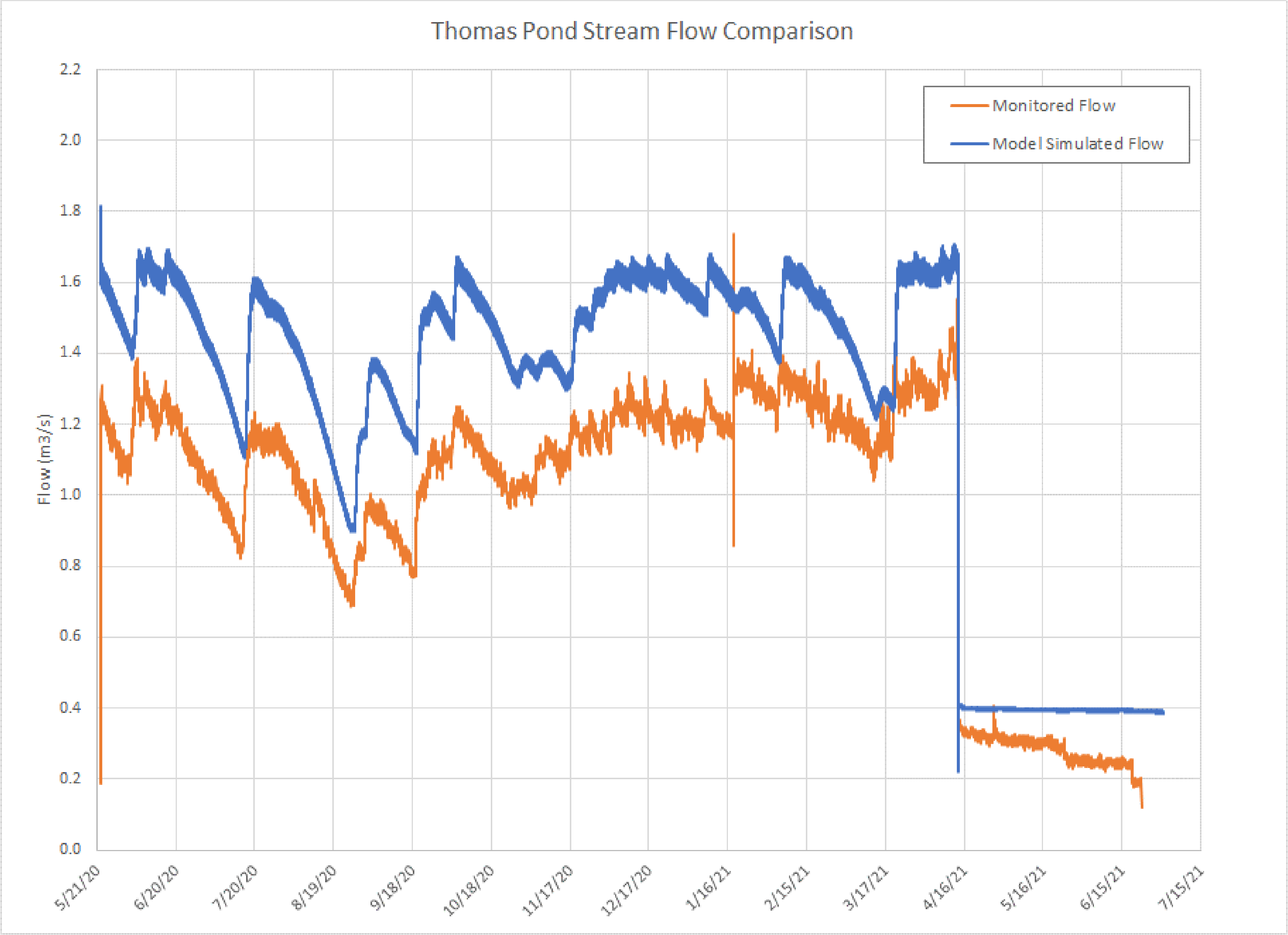


Figure 3.7: Thomas Pond Stream Flow Comparison

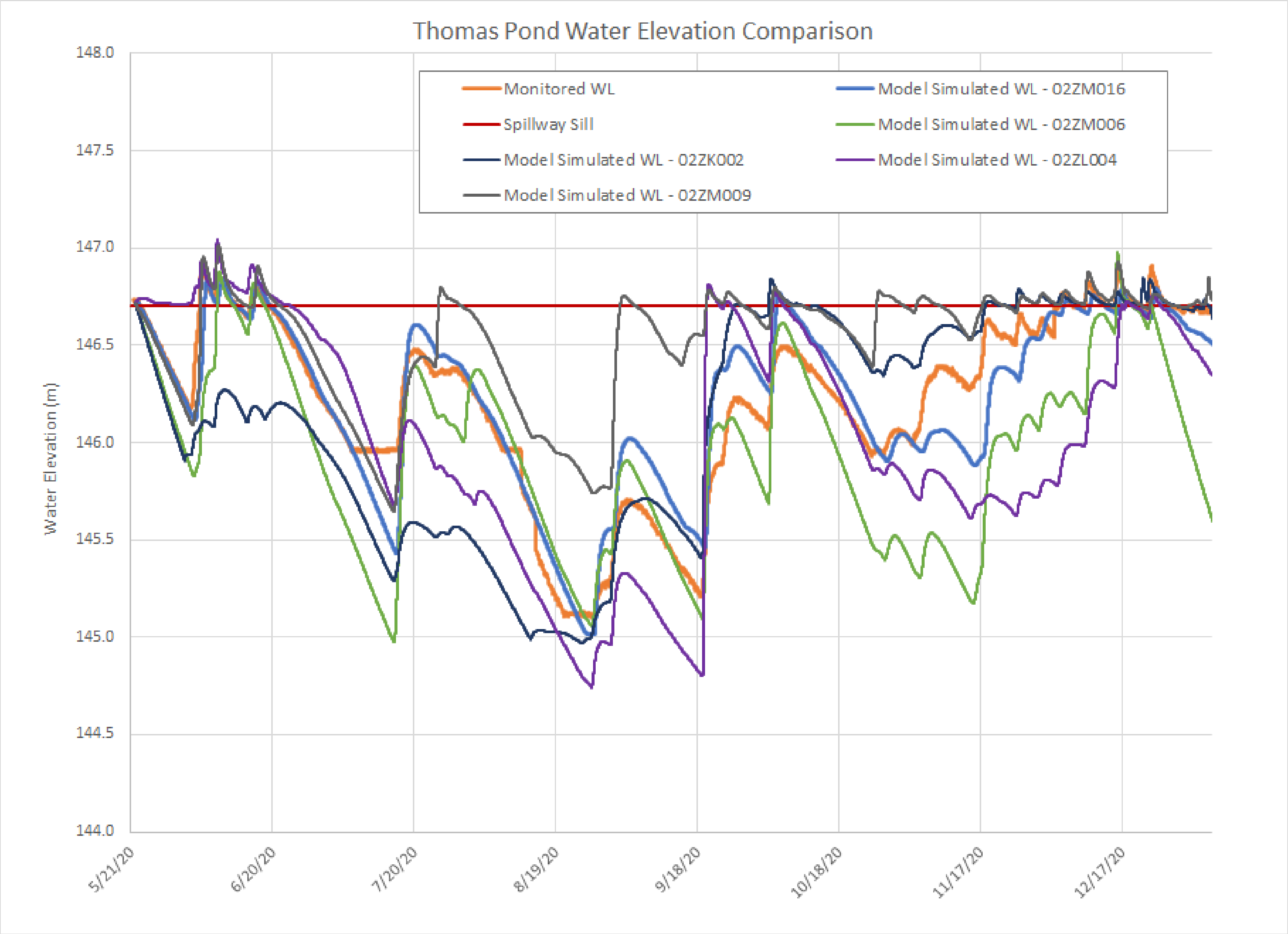


Figure 3.8: Thomas Pond Water Elevation Comparison

Chapter 4 Reliable Yield

The reliable yield (i.e., the flow which can be used for distribution at any time, including dry periods) for each source was estimated by assembling system models, which included routing historical flow through the reservoirs, and extracting potential water demands. Reservoir routing included inflow, storage, and outflow. Inflows were described in Chapter 3. Outflows include flows required for fish (environmental flow), flows over the spillway, and flows that can be extracted for distribution. For this analysis, water extracted for hydroelectric purposes was omitted. Storage curves were used to relate flow and water level.

Several means of estimating environmental flows were examined for the *St. John's Regional Drinking Water Study*, including:

- 85 percentile Flow Duration Curve (FDC) (FDC Q85).
- 95 percentile FDC (FDC Q95).
- Tennant's Method (20 – 40% Mean Annual Flow (MAF)).
- 25% of the MAF.

It was concluded that the Tennant Method provided the best degree of protection for aquatic ecosystems in comparison to the other methods. The Tennant Method was equivalent to the 20% to 40% MAF.

A report by the Department of Fisheries and Oceans Canada (DFO) titled *Review of Approaches and Methods to Assess Environmental Flows Across Canada and Internationally* suggested the use of the low quartile of Mean Monthly Flows (MMFs) method (Q_{25} of MMFs) to estimate environmental flows.

4.1 Big Triangle Pond

The normal water elevation in Big Triangle Pond is approximately 87 m. To increase the amount of storage available, a dam will be required near the outlet of Big Triangle Pond. A spillway to control pond levels during high flows, and a structure to release fish flow and allow for fish passage, will also be required.

Several spillway elevations were examined ranging from 90 to 93 m. By increasing the spillway elevation, the available storage is also increased. It should be noted that the current elevation of the highway is approximately 92 m. A spillway length of 50 m was assumed.

Table 4.1 summarizes the results for each of the methods for Big Triangle Pond.

Table 4.1: Summary of Environmental Flow Estimates

Method	Environmental Flow (m^3/d)
Tennant (20% MAF)	34,560
25% MAF	41,507
Q_{25} MMF	38,880

The additional estimate of environmental flow provided by the Q_{25} MMF falls between the 20% MAF and 25% MAF methods. It was, therefore, used in the update of the reliable yield estimate for the Big Triangle Pond site.

The storage curve, created from LiDAR and bathymetry, was used to relate flow and water level. Survey of the Little Triangle Pond outlet shows the channel bottom is roughly at elevation 86.1 m. To maintain flow in the Little Triangle Pond stream a low operating elevation of 86.5 m in Big Triangle Pond was assumed. Water extraction was increased until the lowest water level in Big Triangle Pond reached 86.5 m. Table 4.2 summarizes the estimates of reliable yield for Big Triangle Pond for the various spillway elevations.

Table 4.2: Summary of Big Triangle Pond Reliable Yield Estimates

Spillway Elevation (m)	Reliable Yield (m^3/d)
90	6,000
91	19,000
92	34,000
93	50,000

As illustrated, the reliable yields are sensitive to the amount of storage provided. Increasing Big Triangle Pond's water elevation beyond 90 m causes the flooded area to extend south and include Southern Peak Pond, as shown in Figure 4.1. The figure (Figure 4.1) also illustrates the extent of land that will require vegetation to be cleared.

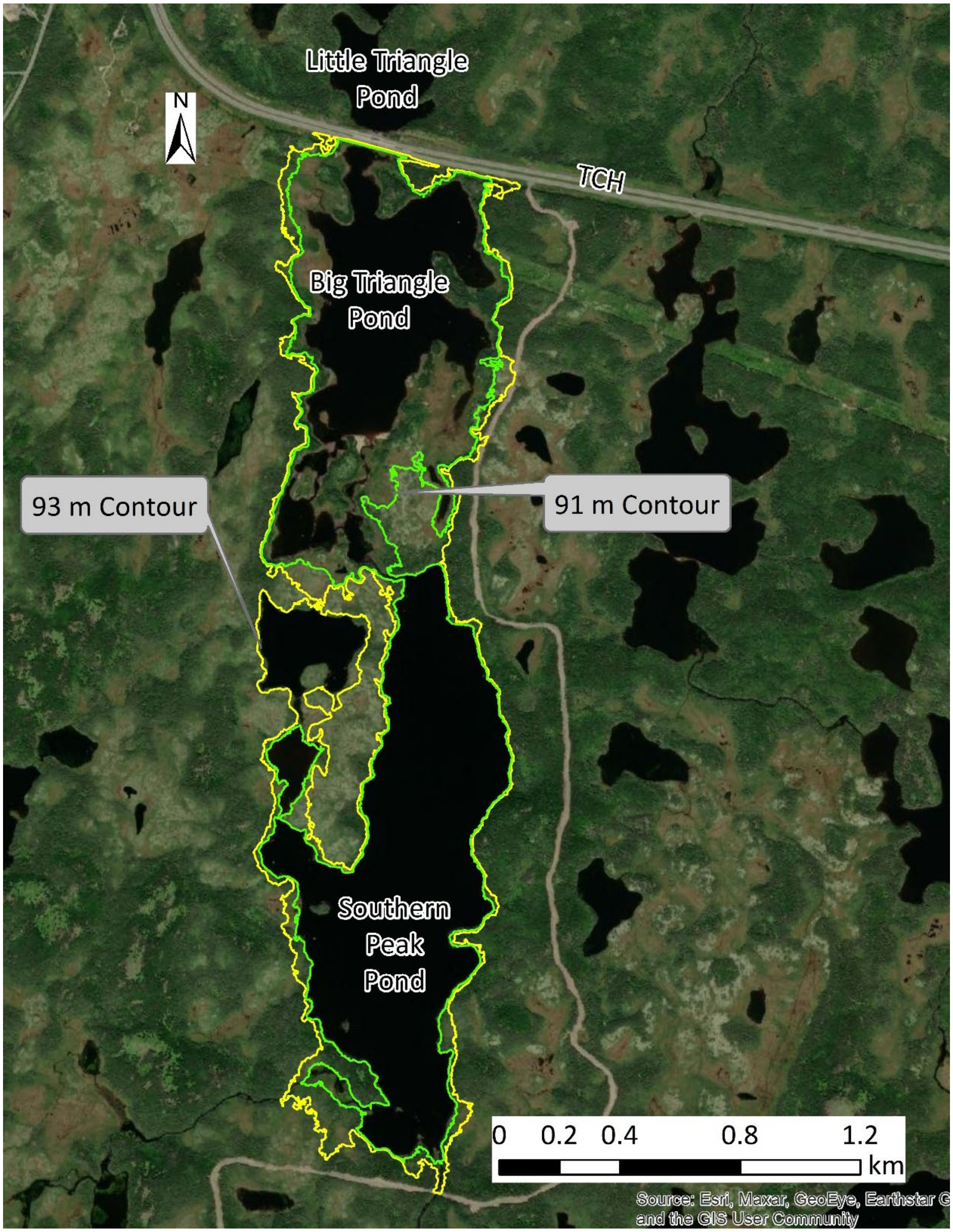


Figure 4.1: Extent of Potential Flooding

4.2 Thomas Pond

It was assumed that the elevations of the existing spillway and dam at Thomas Pond would remain unaltered. Hence, the potential to increase storage availability was not conducted.

Table 4.3 summarizes the results for each of the methods used to estimate environmental flows for Thomas Pond.

Table 4.3: Summary of Environmental Flow Estimates

Method	Environmental Flow (m^3/d)
Tennant (20% MAF)	27,450
25% MAF	36,695
Q_{25} MMF	31,105

Newfoundland Power's Topsail Operating Procedures state all gates must be open a minimum of ~25 mm to maintain flow for fisheries. The operating procedures also gives a low storage elevation limit of 143.971 m for Thomas Pond. This value is very similar to the highest stream bottom in the downstream channel (143.93 m). Therefore, the flow through the regulating gate would be negligible during times when the pond water level was equal to the low storage limit.

Monthly pond levels for 2015 to 2020 were supplied by Newfoundland Power. The lowest level recorded in Thomas Pond during that time was ~144.43 m in August of 2017. Using the orifice equation and assuming a pond level of 144.43 m, downstream channel water level of 144.0 m and a gate opening of ~25 mm equates to 0.08 m^3/s (6,912 m^3/d); well below the other environmental flow estimates presented in Table 4.3.

Newfoundland Power's current operating procedures allow for the release of environmental flows lower than those estimated using the methods listed in Table 4.3. Since the Q_{25} MMF falls between the estimates using the 20% MAF and 25% MAF methods, it was selected for the analysis of reliable yield estimate for the Thomas Pond site.

A low operating level of approximately 144 m was selected, which is similar to Newfoundland Power's low operating level.

Newfoundland Power indicated that there are no set rules for operating the gate with respect to Thomas Pond level. Historically, gate operations at Thomas Pond were operated in accordance with Thomas Pond storage guide curves. Therefore, estimating a potential extraction amount for power generation based on pond water level is not possible.
It was, therefore, assumed that no water would be extracted for power generation purposes. It is recommended that the City contact Newfoundland Power to discuss the use of Thomas Pond as a water supply.

Water extraction was increased until the lowest water level in Thomas Pond reached 144 m. Table 4.4 presents the estimate of reliable yield for Thomas Pond.

Table 4.4: Summary of Thomas Pond Reliable Yield Estimate

Spillway Elevation (m)	Reliable Yield (m^3/d)
146.7 (approx.)	21,000

4.3 Summary

From the analysis it appears that Big Triangle Pond has the potential to provide the largest reliable yield. By increasing the storage through constructing a dam with a spillway at elevation of 93 m, the preliminary reliable yield estimate is approximately 50,000 m^3/d. Without a dam, the reliable yield that can be provided at Big Triangle Pond is negligible.

A reliable yield of 21,000 m^3/d was estimated for Thomas Pond. This estimate does not include water withdrawal for Newfoundland Power's use as there is currently no operating procedure regulating gate opening to Thomas Pond elevation.

4.4 Climate Change

4.4.1 Temperature

4.4.1.1 Averages and Extremes

Daily average temperatures, daytime high temperatures, and nighttime low temperatures are projected to increase, with a steady rate of change through mid- to late century. In general, the coldest temperatures are projected to increase the fastest. Cold extremes are expected to decrease in intensity and frequency, whereas warm extremes will increase in intensity and frequency.

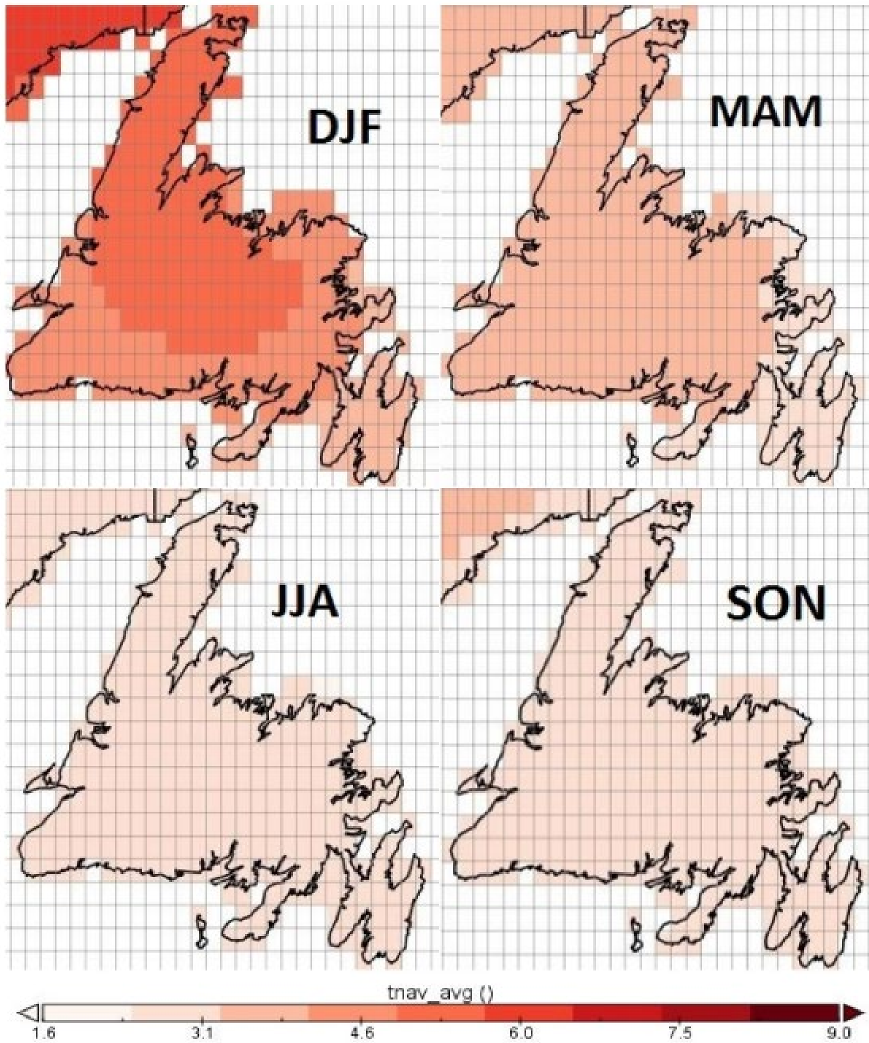


Figure 4.2: Projected Changes in Mean Daily Temperature (˚C) for Mid-Century (from Finnis et al. 2018)

4.4.1.2 Growing Season

As temperatures change, so will average characteristics and the timing of seasons. Newfoundland is expected to undergo a substantial increase in growing degree days during summer, with smaller increases in autumn.

4.4.1.3 Frost and Freeze-Thaw

The number of days with frost is expected to decrease, with the greatest change in regions with daytime temperatures projected to rise above near freezing. Changes in winter thaw events and freeze-thaw cycles are likely to follow a similar pattern.

4.4.2 Precipitation

4.4.2.1 Average Precipitation

Mean daily precipitation is expected to increase throughout the province. On the island, widespread increases are expected by late century. Despite uncertainty in the projections, precipitation is expected to increase in most locations and seasons by mid-century, and larger (nearly universal) changes are expected by the end of the century.

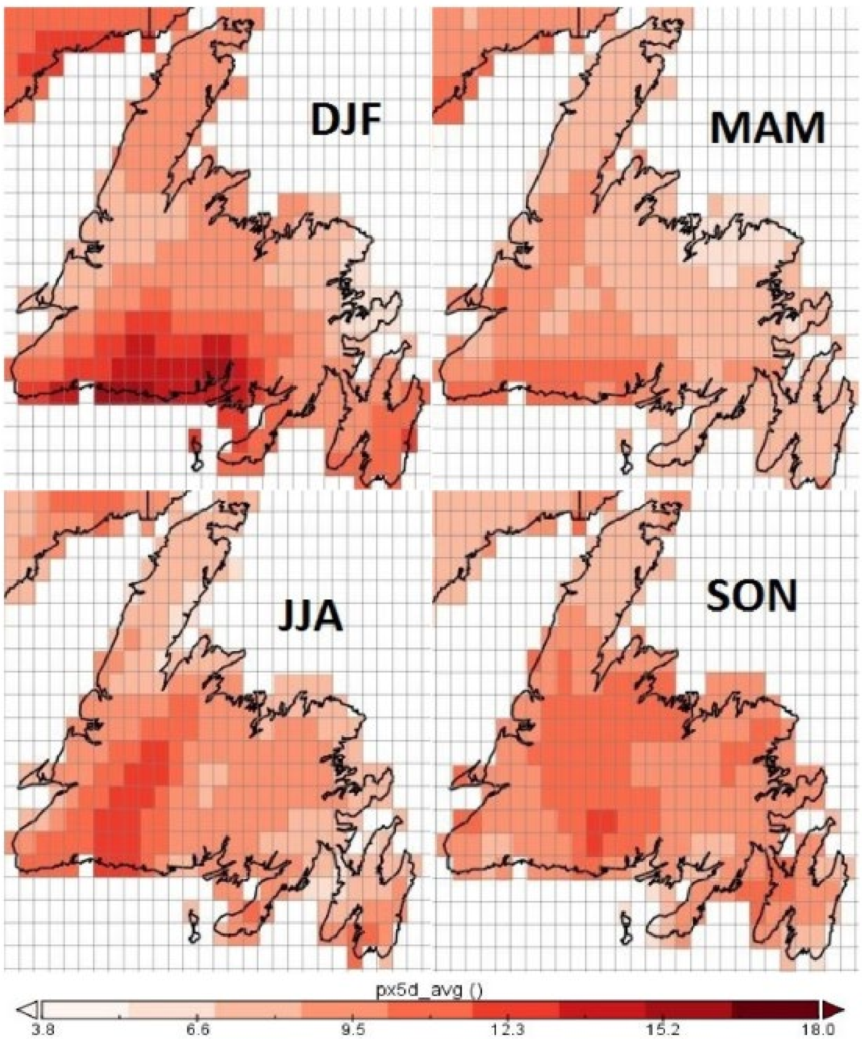


Figure 4.3: Projected Changes in Maximum 5-day Precipitation (mm) for Mid-Century (From Finnis et al. 2018)

4.4.2.2 Precipitation Intensity

Precipitation intensity is expected to increase, as shown by several indices, such as: mean intensity of precipitation events; maximum 3-, 5-, and 10-day precipitation; and number of days with 10 mm or more of precipitation. Models predict intensity increases for all of Newfoundland in all seasons, with the greatest increases in winter. There is notable uncertainty in mid-century projections, but by late century strong increasing trends emerge.

4.4.2.3 Drought

Projections of maximum number of consecutive dry days suggest that droughts are not likely to be a concern for the province (Finnis et al. 2018). The projected change to mean dry spell length (the average number of days between precipitation events) is less than a day. The work by Finnis et al. suggest droughts are not a growing concern for the province.

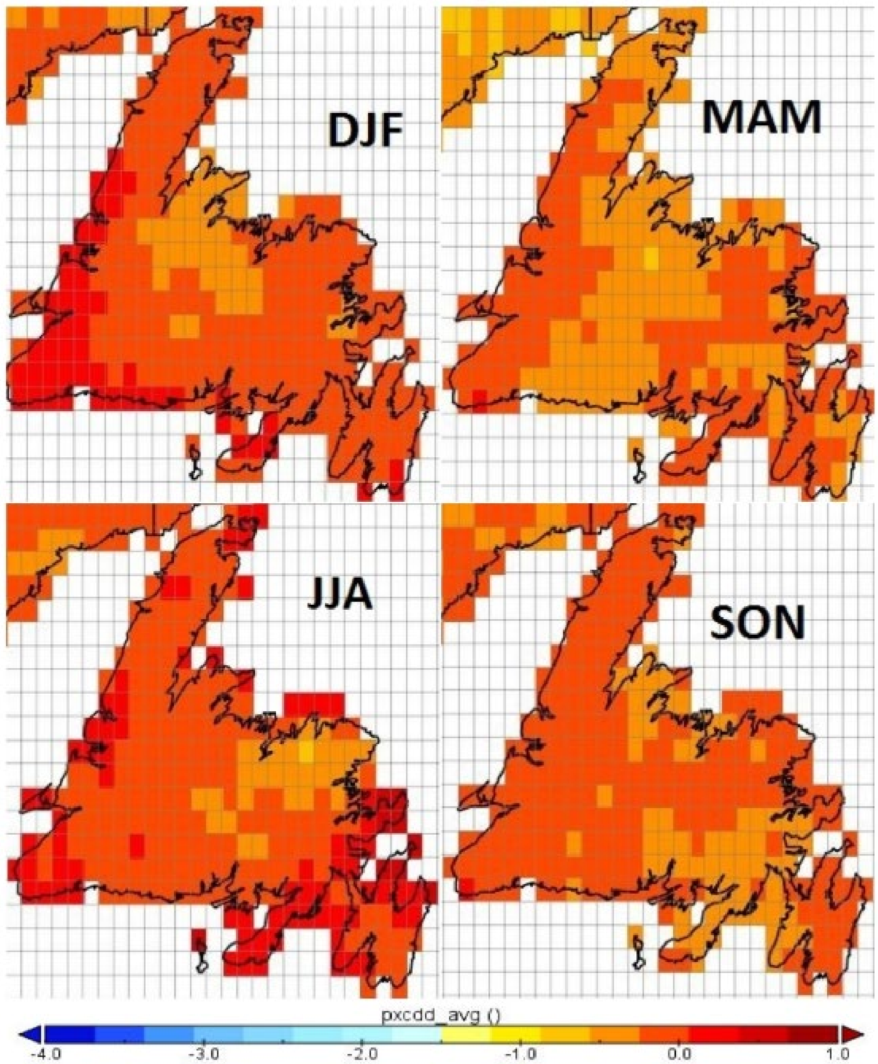


Figure 4.4: Changes in the Maximum Number of Dry Days Projected for Mid-Century (from Finnis et al. 2018)

4.4.2.4 Snow, Winter Rain, & Rain-on-Snow

Combined temperature and precipitation projections suggest regions like the Avalon peninsula will experience fewer, yet heavier, snowstorms, and more frequent and intense rain events during the winter (Finnis et al., 2018; Janoski et al., 2018). These changes also mean more rain falling in winter on frozen ground, as well as rain-on-snow days (Allard and Lemay, 2012; Jeong and Sushama, 2018).

4.4.3 Potential Effects of Climate Change to Study Areas

Climate change can have direct and indirect impacts to the supply, treatment, storage, distribution, design, and operation of drinking water supply systems. The impacts of climate change on water systems may include:

- Structural damage and flood risk to buildings and infrastructure.
- Supply chain disruption.
- Power and communication outages.
- Water quality changes.
- Structural performance and maintenance of dams.
- Operations of residuals management facilities.

Table 4.5: Climate Variables & Impact

Climate Variable	Infrastructure/Activity Impacted
Precipitation: Higher intensity precipitation, more winter rainfall, and changes to snow accumulation and mid-winter thaw events will exacerbate flooding potential.	▸ Structural damage and flood risk to buildings and infrastructure. ▸ Structural performance and maintenance of dams. ▸ Supply chain disruption. ▸ Operations of residuals management facilities.
Ice Jams: Flooding from ice jams has become more frequent and unpredictable in Atlantic Canada (Turcotte et al., 2019). Although increasing air temperatures will decrease river ice cover thicknesses, increased flows during freeze-up could allow for thicker ice and more severe ice-jam flooding (Belatos and Prowse, 200; Turcotte et al. 2019).	▸ Structural performance and maintenance of dams. ▸ Supply chain disruption.
Water Temperature and Quality: Increase in wash-off events from runoff caused by extreme precipitation are likely to negatively impact water quality. Water temperature in streams and rivers is likely to increase (DFO, 2013).	▸ Water quality changes. ▸ Operations of residuals management facilities.

Climate Variable	Infrastructure/Activity Impacted
Hurricanes, Nor'easters, and Winter Storms: A possible increase in the intensities of tropical (e.g., hurricanes) and extra-tropical (e.g., nor'easters) storms is anticipated, resulting primarily in increased precipitation rates (Knutson et al., 2019; Liu et al., 2019; Colle et al., 2015).	- Structural damage to buildings and infrastructure. - Supply chain disruption. - Power and communication outages.
Invasive Species, Pathogens, and Pests: Changing climate conditions will alter suitable habitats and competition dynamics. Among other factors, modified disturbance regimes have been shown to be conducive to invasive species (Dyderski and Jagodzinski 2018), pathogens, and pests (Hellmann et al., 2008).	- Water quality changes. - Operations of residuals management facilities.
Wildfire: Even if dry conditions remain unchanged in Newfoundland, changes to vegetation assemblages and disturbances may affect fire regimes.	- Structural damage to buildings and infrastructure. - Power and communication outages. - Supply chain disruptions. - Operations of residuals management facilities.

That said, there are also opportunities through system improvements to reduce greenhouse gas emissions and build climate resilience in the system. For example, conservation efforts and addressing leaks in the existing system may result in operational cost savings from increased system efficiency, reduced energy demands, and reduced chemicals needed.

4.5 Conflicts with Potential Sources

Thomas Pond:

- Currently part of the Topsail Pond Hydroelectric Power Generation System, water from Thomas Pond supplements Paddy's Pond. There is also a rock quarry located within the Thomas Pond drainage area. Thomas Pond has also been a frequented location for recreation, such as camping and water sport. In April 2015, the City cleaned up the camp sites and dug ditches to deter such illegal camping and dumping.

Big Triangle Pond:

- A subbasin of North Arm Brook, Big Triangle Pond basin also contains part of the Avalon Wilderness Reserve. This potential source drains to North Arm Brook, which is a scheduled Salmon River. DFO confirmed that Big Triangle Pond is scheduled for 90 m upstream of the TCH; where the brook crosses the TCH it is a closed portion with signage posted on both sides of the TCH. Additionally, the North Pines Resort Campground and Cabins lies within the Big Triangle Pond drainage area. Further, it is understood that the Town of Holyrood may use North Arm Brook as a water source which could be affected by the construction of a dam at Big Triangle Pond. There is also mineral exploration activity within the watershed by Eagleridge International Limited.

Chapter 5 Water Quality Analysis

5.1 Raw Water Characterization

Four sets of raw water samples were collected from both source waters over a one-year period. The timing of the samples provides results representative of seasonal water quality changes. The samples were also analyzed for standard water quality parameters (including metals). A summary of the results is provided in Table 5.1 and Table 5.2. The results are compared to the treated water limits in the *Canadian Drinking Water Quality Guidelines* (*CDWQG*). The complete sample results are included in Appendix C.

Table 5.1: Thomas Pond Raw Water Samples (2020-2021)

Parameter	Guideline (*CDWQG*)	15-Sep-20	12-Dec-20	22-Mar-21	08-Jul-21	Average
pH**	7-10.5	6.42	5.80	5.88	6.31	6.10
Alkalinity (mg/L as $CaCO_3$)		<5	<5	<5	<5	<5
Turbidity (NTU)	0.1	1.8	1.5	1.3	1.2	1.0
Colour (TCU)	(15)	107	81.8	45.1	246	120
TOC*** (mg/L)		12	10.2	6.3	6.8	8.8
DOC**** (mg/L)		11	10.2	6.1		9.1
Iron (ug/L)	(300)	1710	592	422	529	813
Manganese (ug/L)	120 (20)	121	23	43	76	66

*Limits reported in () are Aesthetic Objectives (AO) in the *CDWQG*.
** Potential Hydrogen.
*** Total Organic Carbon.
**** Dissolved Organic Carbon.

Table 5.2: Big Triangle Pond Raw Water Samples (2020-2021)

Parameter	Guideline (*CDWQG*)	15-Sep-20	12-Dec-20	22-Mar-21	08-Jul-21	Average
pH	7-10.5	7.03	6.75	6.48	6.62	6.72
Alkalinity (mg/L as $CaCO_3$)		8	6	7	11	8
Turbidity (NTU)	0.1	1.1	1	0.8	1	0.98
Colour (TCU)	(15)	66	62.7	48	6.72	46
TOC (mg/L)		9.3	8.6	5.6	4.1	6.9
DOC (mg/L)		9.7	8.5	5.4		7.9
Iron (ug/L)	(300)	213	218	138	59	157
Manganese (ug/L)	120 (20)	43	11	14	23	23

*Limits reported in () are AO in the *CDWQG*.

As with the results of the *St. John's Regional Drinking Water Study (2016)* by CBCL, both source waters have low alkalinity and pH, low turbidity, and moderate levels of color and organics. This is typical of surface waters in Atlantic Canada and comparable to the surface water supplies currently used by the City. Both ponds show seasonal variability between samples which is likely resulting from factors such as pond turnover, increased organics loading in the fall (from leaves/debris falling from trees), etc.

Surface waters with low alkalinity will have limited capacity to neutralize acids and could see drops in pH throughout a WTP, as various chemicals (such as coagulant or chlorine for disinfection) are added for different treatment processes. Low pH in a source water can affect the performance of treatment processes and may require that a treatment plant includes pH adjustment as a treatment step. Low pH in treated water can also contribute to corrosion in the distribution system.

Moderate levels of organics can lead to coloured water that may not be aesthetically pleasing to drink and can contribute to consumer complaints. In addition to causing aesthetic issues, organic matter can react with chlorine to form Disinfection By-Products (DBPs) such as Trihalomethanes (THM) and Haloacetic Acids (HAAs) which are classified as carcinogenic and have health-based limits in the *CDWQG*.

Iron and manganese were measured in both source waters, with Thomas Pond having consistently elevated iron concentrations above the *CDWQG* AO and both ponds exceeding the manganese AO. Both parameters can contribute to a metallic taste in treated water or can cause staining of fixtures/clothes of the consumer (often contributing to consumer complaints).

A comparison of the average water quality from Thomas Pond and Big Triangle Pond to the existing City water supplies (Petty Harbour Long Pond (PHLP), Windsor Lake (WL), and BBBP) is presented in Table 5.3. Surface water quality results from the most recent available year were retrieved from the NL Water Resources Management Division Water Resource Portal for the comparison and are shown in Table 5.3.

Table 5.3: Comparison of Average Water Quality to Existing Source Waters

Parameter	Thomas Pond	Big Triangle Pond	PHLP*	WL*	BBBP*
pH	6.1	6.7	6.1	6.6	6.6
Alkalinity (mg/L as $CaCO_3$)	<5	8	0	0	3.5
Turbidity (NTU)	1.5	0.98	0.6	0.45	0.5
Colour (TCU)	120	46	11.7	5	17
TOC (mg/L)	8.8	6.9	-	-	-
DOC (mg/L)	9.1	7.9	3.3	2.5	3.8
Iron (ug/L)	813	157	40.0	N/A	70
Manganese (ug/L)	66	23	43.3	N/A	N/A

*Retrieved from NL Water Resources Management Division Water Resource Portal

Generally, Thomas Pond and Big Triangle Pond have higher organics (TOC and DOC) and colour, as well as elevated iron and manganese concentrations, compared to the existing sources. Turbidity in both ponds is slightly higher than the existing sources, except for BBBP. It is anticipated that the organics present could be treated with similar treatment processes currently used by the City. That said, specialized treatment would likely be required to treat the iron and manganese in both potential source waters.

Average water quality results for both ponds were compared to the sampling results collected during the 2016 assessment and are presented in Table 5.4. Both ponds saw an increase in average TOC, iron, manganese, and turbidity from 2016 to 2021. A slight increase in average pH was shown for both ponds and a marginal increase in alkalinity at Big Triangle Pond.

Table 5.4: Comparison of Average Water Quality Results from 2016 Assessment

Parameter	Thomas Pond		Big Triangle Pond	
	2016 Results	2021 Results	2016 Results	2021 Results
	n=5	n=4	n=5	n=4
pH	6	6.10	6.7	6.72
Alkalinity (mg/L as $CaCO_3$)	5.2	<5	7.8	8.0
Turbidity (NTU)	1.26	1.45	0.42	0.98
Colour (TCU)	66	120	50	46
TOC (mg/L)	6.9	8.8	4.5	6.9
DOC (mg/L)	-	9.1	-	7.9
Iron (ug/L)	682	813	125	157
Manganese (ug/L)	53	66	16	23

5.1.1 Evolving Water Quality

The increase in organics in both ponds could be the result of lake recovery from acidification. In the 20th century, many lakes in Atlantic Canada were negatively impacted by acid rain related to industrial emissions. As a result, the lakes became more acidic (lower pH). Changes in environmental regulations in the 20th century saw a decrease in the occurrence of acid rain. Studies in the region have shown that with the decrease in sulfate depositions associated with acid rain, there has been a change in source water quality. Increases in organic concentrations have been noted throughout the region, as shown in Figure 5.1 and would match water quality results collected through this current assessment. Increases in pH and alkalinity are also often seen with lake recovery. That said, they have not been as prominent in the current data set for the two ponds.

Increases in organics over time, or changes in the type of organics present, can contribute to color, taste, and odour concerns, along with increased DBPs in the treated water. Operationally, it could result in increased chemical doses and could affect treatment process performance. As lake recovery is an emerging area of study in the region, it is difficult to predict how long increases in organics would continue, or what concentration of organics can be expected in the future. That said, it should be taken into consideration when assessing the treatability of a source water and selecting appropriate treatment processes.

With lake recovery and changes in source water quality, there is the potential that there will be a change in the species found in the water, including algal and cyanobacteria species. As the pH increases, and water quality changes during lake recovery, studies have shown that the presence and species of cyanobacteria can increase in the source water. Cyanobacteria, also referred to as blue-green algae, are photosynthetic bacteria that can be found in many aquatic ecosystems. Some cyanobacteria, if they experience excessive growth or bloom conditions, can produce cyanotoxins and/or taste and odour compounds. That said, the presence of cyanobacteria does not mean that cyanotoxins and/or taste and odour compounds will be present. Cyanotoxins, if produced, are chemical compounds with toxicological properties and can have health-based effects if consumed through drinking water. Geosmin and 2-Methyl-Isoborneol (MIB) are two volatile taste and odour compounds that can be produced by cyanobacteria and can be detected by humans at very low concentrations. They do not have health-based water quality concerns but can contribute to taste and odour complaints as they produce a musty, earthy odour. The potential occurrence of lake recovery in both ponds increases the likelihood of cyanobacteria being present in the lake but does not confirm that conditions would occur where cyanotoxins or taste and odour compounds are produced.

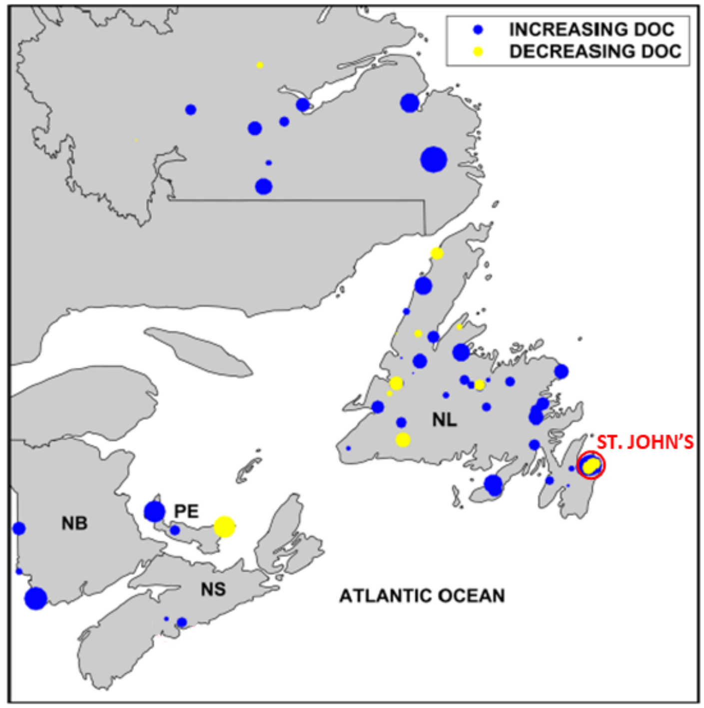


Figure 5.1: Change in Dissolved Organic Matter Concentrations for Atlantic Canadian Surface Water Bodies

(from Anderson et al 2016, Lake Recovery Through Reduced Sulfate Deposition: A New Paradigm for Drinking Water Treatment)

To gather baseline conditions for the two ponds, samples for microcystin (a cyanotoxin that has a maximum allowable concentration limit in the *CDWQG*), geosmin, and MIB were collected during three of the sampling events (September, March, and July). Conditions when these parameters are likely to occur typically happen in the late summer to early fall. The results are provided in Table 5.5. It should be noted that with the seasonal sampling approach used for this assessment, there is the potential that water quality events that occur on a shorter time scale, such as a cyanobacteria bloom, are not captured.

Table 5.5: Microcystin, Geosmin, & MIB Sample Results

Parameter	Thomas Pond			Big Triangle Pond		
	15-Sep-20	22-Mar-21	08-Jul-21	15-Sep-20	22-Mar-21	08-Jul-21
Geosmin (ng/L)	<3	<3	16	<3	<3	<3
MIB (ng/L)	<3	<3	<3	<3	<3	<3
Microcystin (ug/L)	<0.1	<0.1	<0.15	<0.1	<0.1	<0.15

Most sample results were reported below the detection limit of the analysis completed (reported as <). The exception was the geosmin result for Thomas Pond in July 2021. For humans, the detectable level of geosmin is between 5-10 ng/L and the sample result from Thomas Pond was reported at a concentration of 16 ng/L. This indicates that cyanobacteria were present in the lake at the time of sampling to produce geosmin and that conditions occurred where geosmin was at concentrations that could result in consumer complaints.

Testing was also completed for pesticides and Polychlorinated Biphenyls (PCBs) on both ponds during the September 2020 sampling event. All test results were reported below the analysis detection limit.

5.2 Treatability Study

Reduction of organic matter along with the removal of pathogens will be the primary goal of a treatment plant for either pond, if selected as a source water for the City. Treatment processes considered should meet industry standards and best practices. For municipal water treatment, industry standard processes can be broken down into conventional treatment trains and membrane-based treatment processes. Conventional treatment processes can be further divided into sedimentation and Dissolved Air Flotation (DAF) processes.

Conventional processes use coagulation and flocculation to precipitate the colour from the water and condition it for removal. Coagulation is the most well-established method of removing Natural Organic Matter (NOM). Coagulants, which may be aluminum or iron based, are chemicals that can be added to water to promote dissolved and colloidal species to agglomerate into larger particles known as flocs. These flocs are often removed in a clarification step, which may be based on gravity or buoyancy. The clarified water is then filtered through media to remove any remaining flocs. Some coagulation processes do not include a clarification step, relying instead on filtration for all floc removal, this is referred to as direct filtration.

Historically in North America, the floc has been removed by settling in sedimentation basins. The settling process uses gravity to settle flocculated particles to the bottom of the settling tank. An alternative to conventional sedimentation is the use of DAF process, which injects fine bubbles into the water that attaches to the flocculated particles and cause them to float to the water surface where they are collected and removed. DAF clarification is a popular treatment option in Atlantic Canada as it is suitable for water with low turbidity levels and high concentrations of dissolved NOM as shown in Figure 5.2. DAF is currently used at both the BBBP and PHLP water treatment facilities.

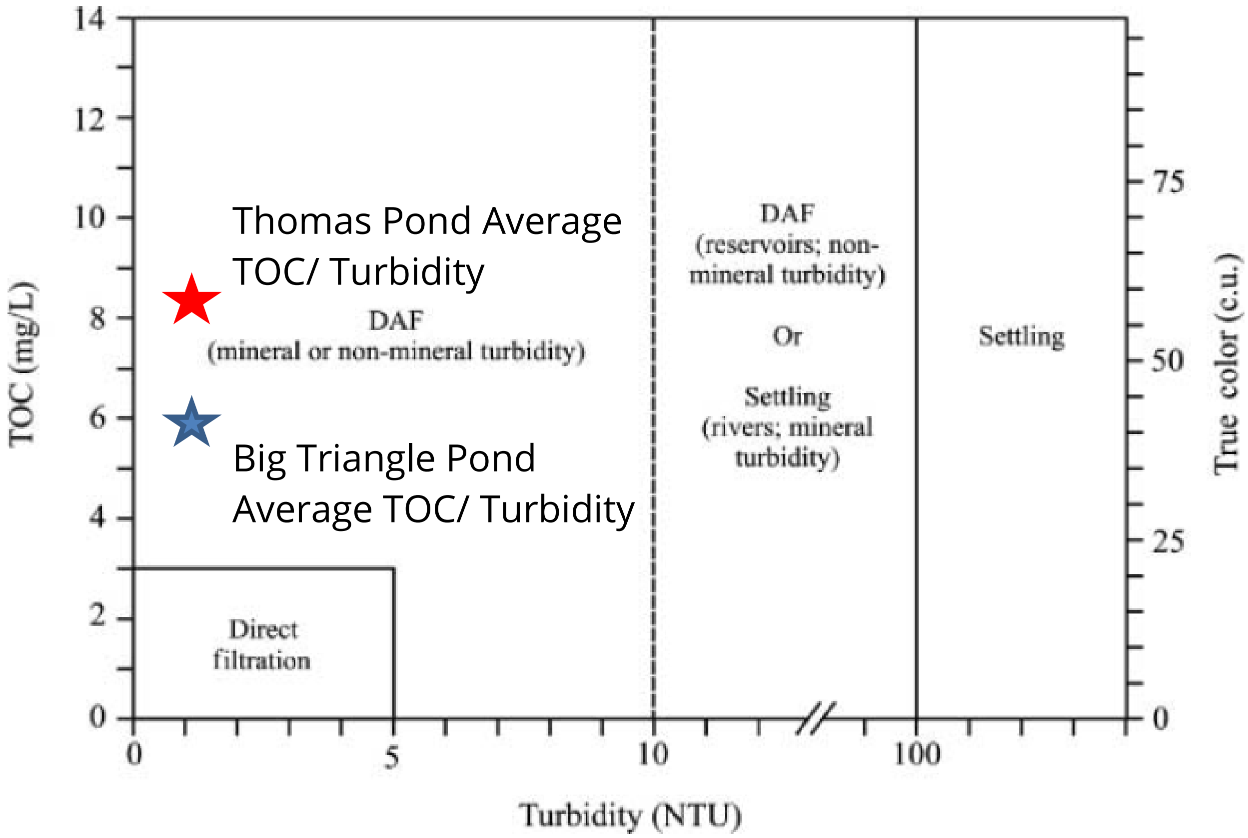


Figure 5.2: Clarification Process Selection Based on Average Water Quality. Adopted from Valade et al, Treatment Selection Guidelines for Particle and NOM Removal

Membrane systems are available in a wide variety of types and configurations. Most notable are Microfiltration (MF), Ultrafiltration (UF), and Nanofiltration (NF). Membrane processes are pressure-driven sieve processes that separate particulates by moving water through pores in the membrane and collecting the particulates on the membrane surface. All three of MF, UF, and NF provide an effective barrier to bacteriological contaminants, including *Cryptosporidium* and *Giardia*. UF and NF also provide 3-4 log removal of viruses. The configuration determines if coagulation, flocculation, and/or pre-membrane filters are necessary to meet desired water quality targets. The WL WTP uses MF membranes filtration as a key treatment process.

Sedimentation, DAF, and membrane systems are all valid treatment processes that could be carried forward for consideration for the pre-design phase if one or both ponds are selected as a source water for the City. Using the raw water characteristics described above, along with experience at similar surface water plants in the region, and treatment plants currently used by the City, DAF was selected to be used at bench-scale to complete the treatability study on both ponds. Aluminum Sulphate (alum) and Polyaluminum Chloride (PACl) were selected as coagulants to evaluate.

The experimental design for the bench-scale jar testing is shown in Table 5.6. The methodology was followed for both source waters. Duplicate jar tests were completed for each trial condition and sample analysis were completed in duplicate.

Table 5.6: Jar Testing Experimental Design

Parameter	Jar 1	Jar 2	Jar 3	Jar 4
Alum Dose (mg/L)	20	30	40	50
PACl Dose (mg/L)	10	20	30	40
Target pH	pH of minimum solubility for coagulant (pH 6 for alum, pH 6.5 for PACl) and pH 7			
Rapid Mix	1 minute at 200 rpm			
1st stage flocculation	10 minutes at 40 rpm			
2nd stage flocculation	10 minutes at 20 rpm			
DAF	10 minutes			
Filtration	Samples filtered with 0.45 um filter paper (rinsed with deionized)			
Analysis	pH Turbidity (not filtered) UV254 DOC			

Turbidity results for each combination of coagulation and target pH are provided in Figure 5.3 and Figure 5.4. For both source waters, PACl outperformed alum, with large increases in DAF turbidity experienced using alum at varying pH. The alum results for Big Triangle Pond did not follow the trend that would be anticipated and could be the result of unintended overdosing of coagulant which contributed to increased turbidity. Optimal DAF effluent turbidity was achieved at a PACl dose of 30 mg/L and at a pH of 7 for both source waters.

It should be noted that the turbidity results represent DAF effluent turbidity and are not representative of filtered effluent turbidity (which was not simulated at bench-scale). It can be used as a performance indicator for the coagulant and DAF clarification step. That said, it would be expected that filtration would be designed to follow the DAF clarifier to meet the drinking water treatment standards (<0.3 NTU). Higher DAF effluent turbidity may not affect the final filtered water turbidity but could affect the operation of the filters resulting in shorter filter run times, more frequent backwashes or increased operational labour to maintain.

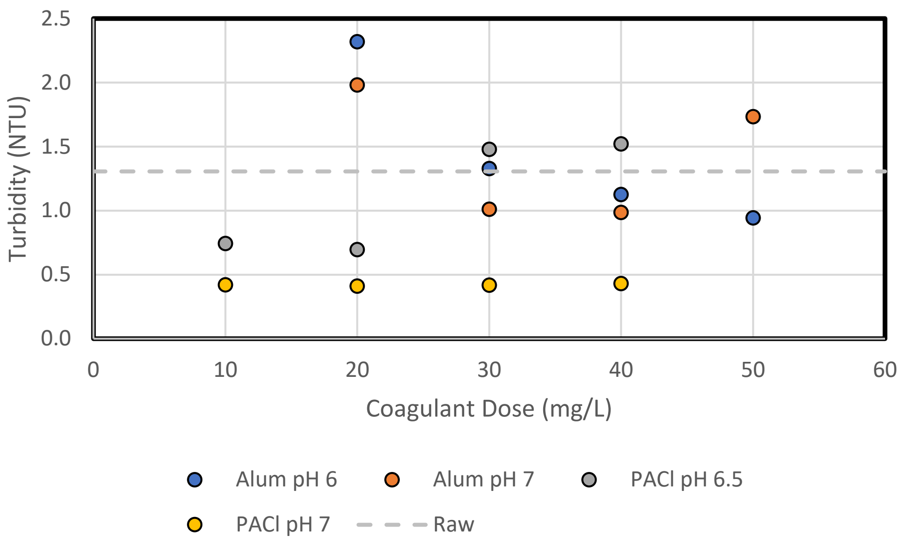


Figure 5.3: Thomas Pond DAF Effluent Turbidity

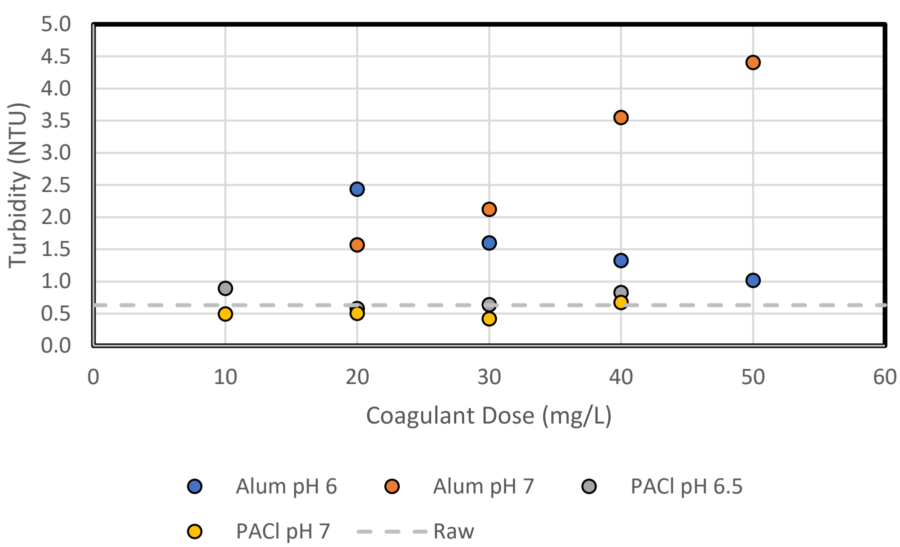


Figure 5.4: Big Triangle Pond DAF Effluent Turbidity

Figure 5.5 and Figure 5.6 show the UV254 results for both source waters. The samples were filtered to represent filter effluent UV254. Raw water UV254 is plotted on the secondary axis. Approximately 90% reduction in UV254 was achieved at the optimal coagulant dose, which corresponded to a PACl dose of 30 mg/L at a pH of 6.5 for both source waters.

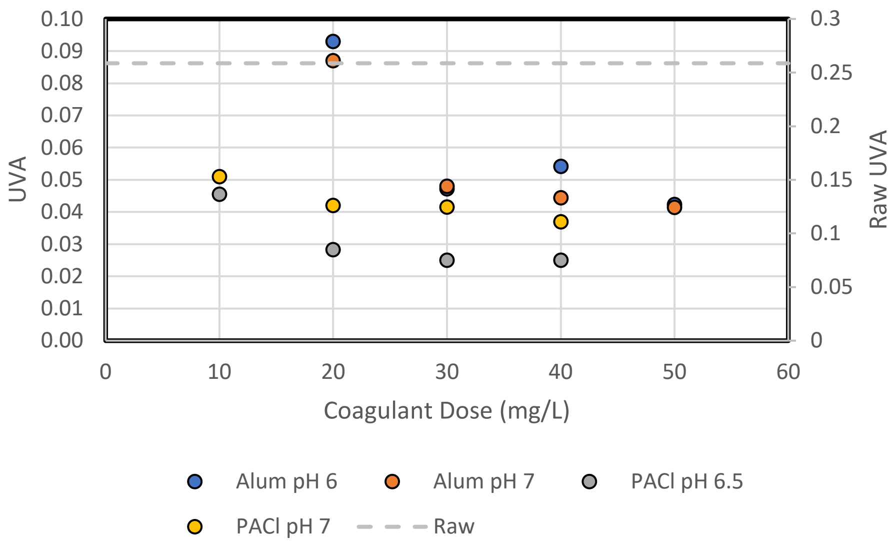


Figure 5.5: Thomas Pond UVA (Filtered)

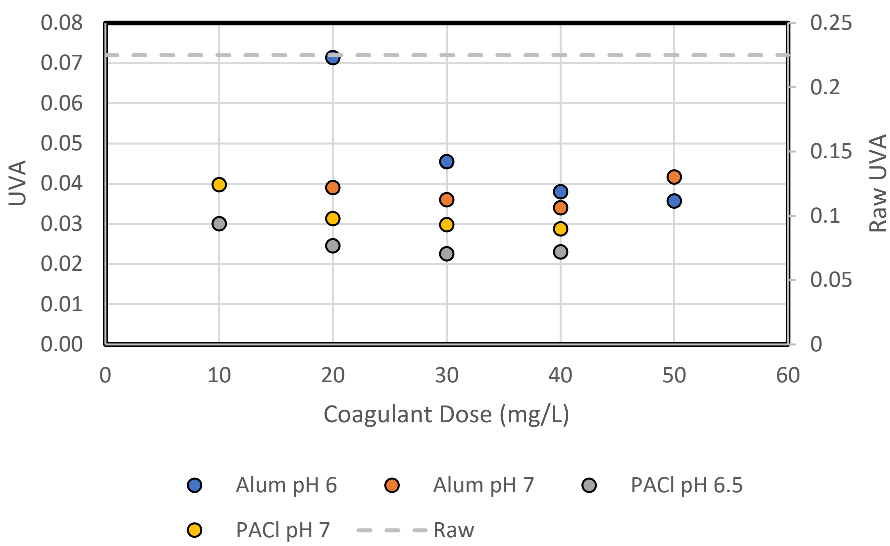


Figure 5.6: Big Triangle Pond UVA (Filtered)

Figure 5.7 and Figure 5.8 show the results for DOC for both source waters. For both source waters, the optimal conditions for DOC removal were achieved at a 30 mg/L PACl dose at a pH of 6.5. For Thomas Pond, the optimal conditions saw a 73% reduction in DOC and for Big Triangle Pond the reduction was 75%.

In the *Drinking Water Treatment Standards for Newfoundland & Labrador*, a performance standard for DOC is provided. For average source waters with DOC greater than 5 mg/L and less than 8 mg/L, the maximum treated water DOC is 2.5 mg/L. For the conditions trialed, all conditions, except for alum at pH 6 for both ponds, was able to meet this standard.

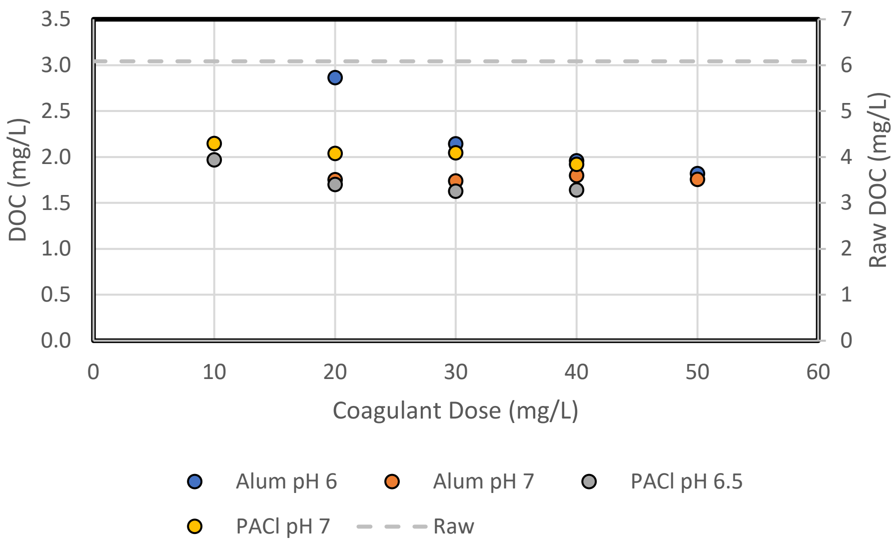


Figure 5.7: Thomas Pond DOC (Filtered)

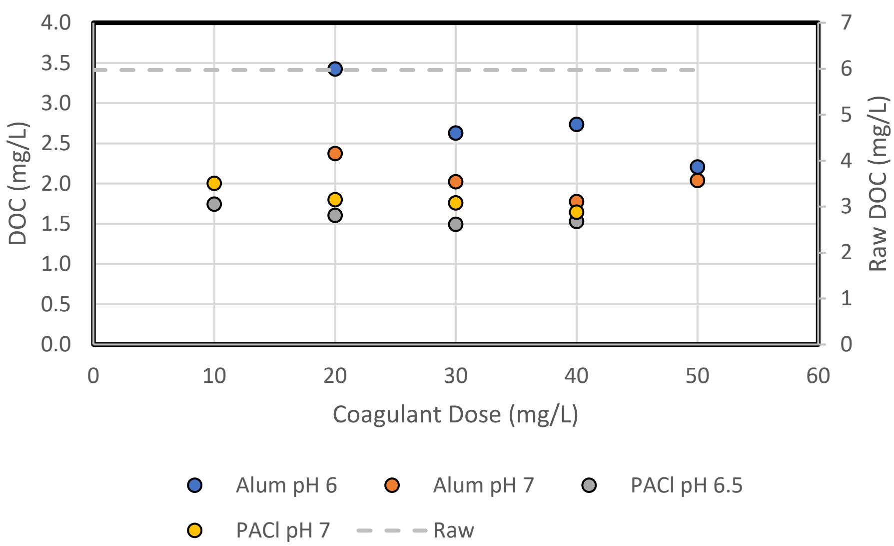


Figure 5.8: Big Triangle Pond DOC (Filtered)

Results of the bench-scale treatability study show that both ponds have source water that can be treated to meet organics removal standards outlined by the province and that DAF would be a viable treatment option to carry forward to pre-design.

Chapter 6 Capital Works Requirements

6.1 Water Treatment Plant

6.1.1 Treatment Plant Capacity

An analysis of the future MDDs for the RWS for 2046 was completed in the 2016 Assessment. This included projected demands for BBBP, WL, and PHLP service areas, along with the projected demands for new service areas. The new service areas included Paradise, Portugal Cove- St. Phillip's, CBS, Torbay, and Holyrood. Table 6.1 is a reproduction of Table 5.5 from the 2016 report. The projections were developed based on moderate growth scenario for the region and determined that approximately 40,000-50,000 m^3/d of additional treated water would be required to service the existing municipalities and the municipalities of Torbay and Holyrood over the planning period.

A high-level comparison was made between the projections made in 2016 and the demands currently experienced by the RWS WTPs five years later. It was found that the projections are valid to continue to carry forward for this study. For planning, a design life between 20-30 years is a generally accepted range for upgrades and construction of new water treatment and supply infrastructure. This allows for a full operating lifecycle of most operating components within a facility. The 2016 projections were carried out until 2046. Using a base year of 2021, this would result in a design period of 25 years and lines up with general practice for planning.

From the reliable yield assessment, a reliable yield of 50,000 m^3/d at Big Triangle Pond could be achieved with a dam and 21,000 m^3/d could be provided at Thomas Pond. While the treatment processes would be the same, the size and cost of a WTP to treat 21,000 m^3/d would be significantly different than the cost of a 50,000 m^3/d facility. This would be in addition to the cost to design and build a dam at Big Triangle Pond. For comparison purposes in this study, the design capacity for a treatment plant will be 21,000 m^3/d at both ponds, based on the maximum reliable yield from Thomas Pond.

With the selection of 21,000 m^3/d as the maximum day capacity for a treatment plant, there would continue to be a deficit of approximately 25,000-30,000 m^3/d for the RWS by 2046 with a treatment plant built. To address the anticipated water deficit, infrastructure upgrades in the existing distribution system along with water conservation efforts may be required over the operating period as identified in the 2016 report.

Table 6.1: Future System Configuration, Service Area MDDs, & Existing Treatment Plant Capacities

Water System		Total MDD 2014	2026	2036	2046	Watershed Reliable Yield	WTP Capacity
		(m³/D)				m³/D)	
BBBP Service Area	St. John's - BBBP	30,105	31,150	32,022	32,710		
	Mount Pearl	27,492	28,983	30,225	30,414		
	Paradise	12,243					
	Portugal Cove - St. Philip's	3,586					
	CBS	18,337					
	BBBP (diverted from WL service area)		15,000	15,000	15,000		
	Total - BBBP	**91,763**	**75,133**	**77,247**	**78,124**	**90,700**	**85,000**
WL Service Area	St. John's - WL	64,606	69,099	72,843	74,150		
	(Demand diverted to BBBP service area)		-15,000	-15,000	-15,000		
	Total - WL	**64,606**	**54,099**	**57,843**	**59,150**	**54,500**	**70,000***
PHLP Service Area	***Total - PHLP***	**15,000**	**17,232**	**19,092**	**19,360**	**15,900**	**14,500**
New Service Area	Paradise		14,165	15,767	16,524		
	Portugal Cove - St. Philip's		4,364	5,013	5,163		
	CBS		20,937	23,103	23,596		
	Torbay		3,000***	3,000***	3,000***		
	Holyrood		1,500***	1,500***	1,500***		
	Total - New WTP		43,966	48,383	49,783	50,000**	
	Total – All Serviced Areas	***171,369***	***185,931***	***202,565***	***206,417***	***211,100***	

*Summer-time normal capacity.

**Required.

*** Estimated.

6.1.2 Source Water Quality

As described in Chapter 5, the source water for both ponds are typical of surface water supplies in Atlantic Canada, having low alkalinity and pH, low turbidity, and moderate levels of organics. Reduction of organic matter, along with removal of pathogens is the primary goal of a treatment plant for either pond. That said, in comparison to the other source waters that supply the City, iron and manganese have been measured in both ponds at levels that warrant treatment for removal to meet water quality guidelines. Geosmin was detected during the summer sampling event at Thomas Pond, and it is anticipated that Big Triangle Pond could also be susceptible to taste and odour events now or in the future. Based on these results, taste and odour treatment has been included in the WTP concept, along with consideration for cyanotoxin removal as it has been identified as an emerging parameter of concern.

6.1.3 Treatment Objectives

As with the existing WTPs operated by the City, a new treatment plant would be designed to meet the provincial "*Standards for Bacteriological Quality of Drinking Water*" as provided by the Department of Environment and Climate Change, along with the Health Canada "*Guidelines for Canadian Drinking Water Quality*".

In recent years, Health Canada has enacted several new or amended guidance documents and water quality parameters, including pathogen guidance (e.g., *E. coli*), organic parameters (e.g., NOM), and inorganic parameters (e.g., manganese and aluminum). The guidance on some subjects, such as corrosion control, continues to evolve at both the federal and provincial levels. DBPs including THMs and HAAs, may eventually be decreased from current limits to coincide with limits elsewhere. With evolving guidance and research, it is difficult to predict the direction of water quality regulation at either a provincial or national guidance level over the operating period of a WTP. Some trends and recent regulatory events that are relevant for design include:

- Development of parameters governing HAB events (treatment, parameters, and analytics).
- Re-affirming pathogen requirements and efficacy of clarification and filtration processes.
- Increasingly stringent corrosion control and assessment methods.
- Process residuals management and source water discharge restrictions (i.e., aluminum concentrations in liquid stream discharge).

The above points coupled with potential changes to source water quality do not specifically identify a parameter or new target regulation that the project must meet. Instead, these topics act as points of consideration for a treatment plant.

6.1.4 Treatment Process Options

Through the treatability bench scale testing, coagulation and flocculation followed by DAF and multi-media filtration has been shown to be effective for organics removal for both source waters. In addition, the City is familiar with the technology as it is used at the other WTPs operated by the City. It has also been shown to be a reliable treatment technology for the source water in the region and for increased biomass/algae loadings in the event of a HAB. As such, DAF has been chosen as the main treatment process to move forward with for this assessment. That said, it should be noted that there are other treatment processes including sedimentation and membrane filtration (that are proven treatment technologies) that can also meet the water quality standards and could be re-evaluated at the pre-design phase.

As mentioned, standalone DAF and filtration would require enhancement to provide removal for iron/manganese. Pre-oxidation and filtration are commonly used for combined iron and manganese removal. Pre-oxidation involves addition of a chemical oxidant, which reacts with the dissolved iron or manganese, resulting in the formation of iron and manganese precipitates which can then be removed by filtration. Common oxidants include oxygen (aeration), chlorine, and potassium permanganate. Aeration tends to be less effective compared to the other two oxidants as the reaction between dissolved oxygen and dissolved manganese is too slow at typical pH levels found in drinking water to be practical in most applications. Pre-oxidation with potassium permanganate is more commonly used in the region as pre-oxidation with chlorine can result in higher DBP formation.

Conventional treatment processes such as coagulation, flocculation, DAF, and multimedia filters are largely ineffective at removing cyanotoxins, geosmin, or MIB. DAF treatment will greatly enhance the removal of algae and associated intracellular toxins and taste and odour compounds, but not extracellular (dissolved) cyanotoxins or geosmin and MIB. More advanced treatment technologies such as Granular Activated Carbon (GAC), Powdered Activated Carbon (PAC), biological filtration, ozonation, or advanced oxidation is often required. These processes represent major installation and maintenance expenditures and require careful selection and process design. Most treatment plants in the region do not have the advanced treatment technologies (except for BBBP’s WTP that has ozonation), however, several larger municipalities in Atlantic Canada are currently studying implementing advanced treatments for toxin and taste and odour control.

Table 6.2 summarizes treatment efficacy of oxidation processes and activated carbon treatments for removal of various algal toxins, MIB, and geosmin. As noted, ozone and Advanced Oxidation Processes (AOPs) are the most effective oxidants for control of taste and odors and most algal toxins. Free chlorine and permanganate are effective for some algal toxins but are not effective for removal of algal toxins or MIB and geosmin. Generally activated carbon is effective for toxins and taste and odour removal, but performance may vary depending on the target parameter present and the base material of the activated carbon (i.e., coal vs. coconut carbons).

Table 6.2: Effectiveness of Toxin & Taste & Odor Treatment Options

	Free Chlorine[1]	Monochloramine	Chlorine Dioxide	Permanganate	Ozone	AOP	Ultraviolet (UV)	GAC[2]	PAC[2,3]
Microcystin	M	I	I	E	E	E	I	E	E
Cylindrospermopsin	E	I	I	I	E	E	I	E	E
Anatoxin A	I	I	I	M	E	E	I	E	E
Saxitoxin	E	I	I	I	I	I	I	E	E
MIB and Geosmin	I	I	I	I	E	E	I	E	E
Cost	$	$	$$	$	$$$	$$$	$$	$$$	$$
E = Effective, M = Moderate, I = Ineffective									

[1]It is important to note that the effectiveness of chlorine is highly dependent upon contact time and pH.

[2] Parameters of concern may have varying affinity to different base materials for activated carbon.

[3] PAC performance can be affected by contact time and pH.

While ozonation and AOP processes would provide robust treatment in the event of a HAB, they represent a large capital and operational investment to build and maintain for an event that may or may not occur during the operational period of the plant. It is anticipated that any treatment selected would be used on an as-needed basis if a HAB occurred rather than being included in regular operations during normal water quality conditions. PAC, while considered a less robust option for treatment, would still provide adequate removal at a relatively moderate capital and operation investment and has been carried forward in concept at this time. Further review of treatment options for HAB events would be completed during the pre-design phase.

Following treatment, disinfection would be required to meet water quality standards. UV disinfection for primary and chlorination for secondary disinfection is currently used at PHLP WTP and has been selected to be carried forward based on operator familiarity with the disinfection system.

6.1.5 Design Considerations

6.1.5.1 Plant Siting

Many factors should be considered when evaluating the location of a WTP, including hydraulics, expected site preparation costs, and complexity of integrating the plant into the existing distribution system.

Identified in the 2016 report, a WTP located at Thomas Pond would connect to the existing distribution system at the Fowlers Road Reservoir via new transmission main. The proposed location of the WTP was identified as near the spillway and located near the TCH. A low lift pump station would be included on the site to supply raw water to the WTP.

For Big Triangle Pond, a location near the proposed dam/spillway does not appear feasible for a WTP due to the elevation and anticipated flooding extents due to the proposed dam. A proposed location has been identified along Salmonier Line. A low lift pump station, located near the proposed dam would be used to pump raw water to the proposed WTP location. The proposed transmission main from the treatment plant would connect to the system in Holyrood.

The proposed locations for plant siting at both ponds are shown in Figure 6.1 and Figure 6.2.

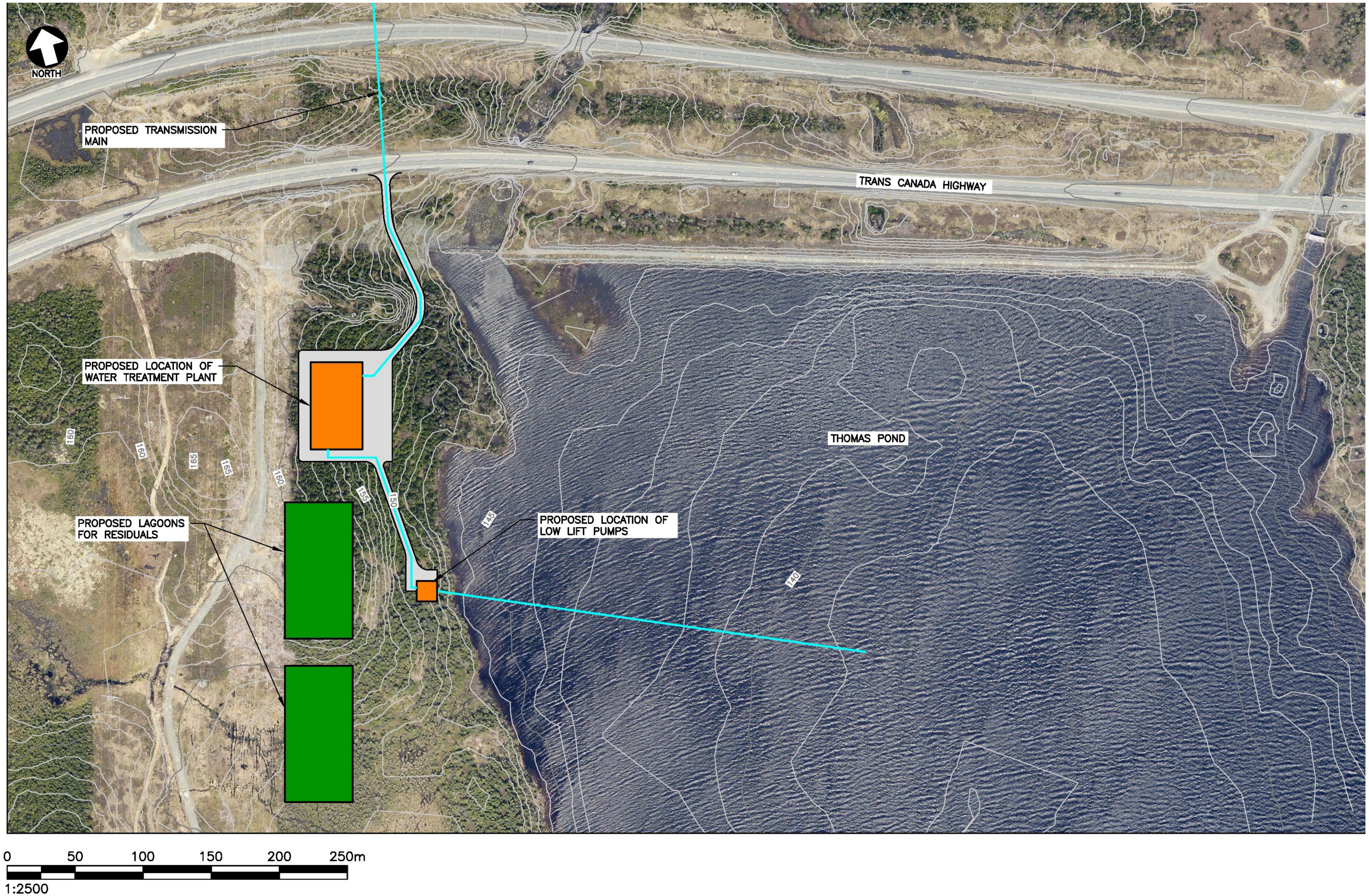


Figure 6.1: Thomas Pond Site Plan

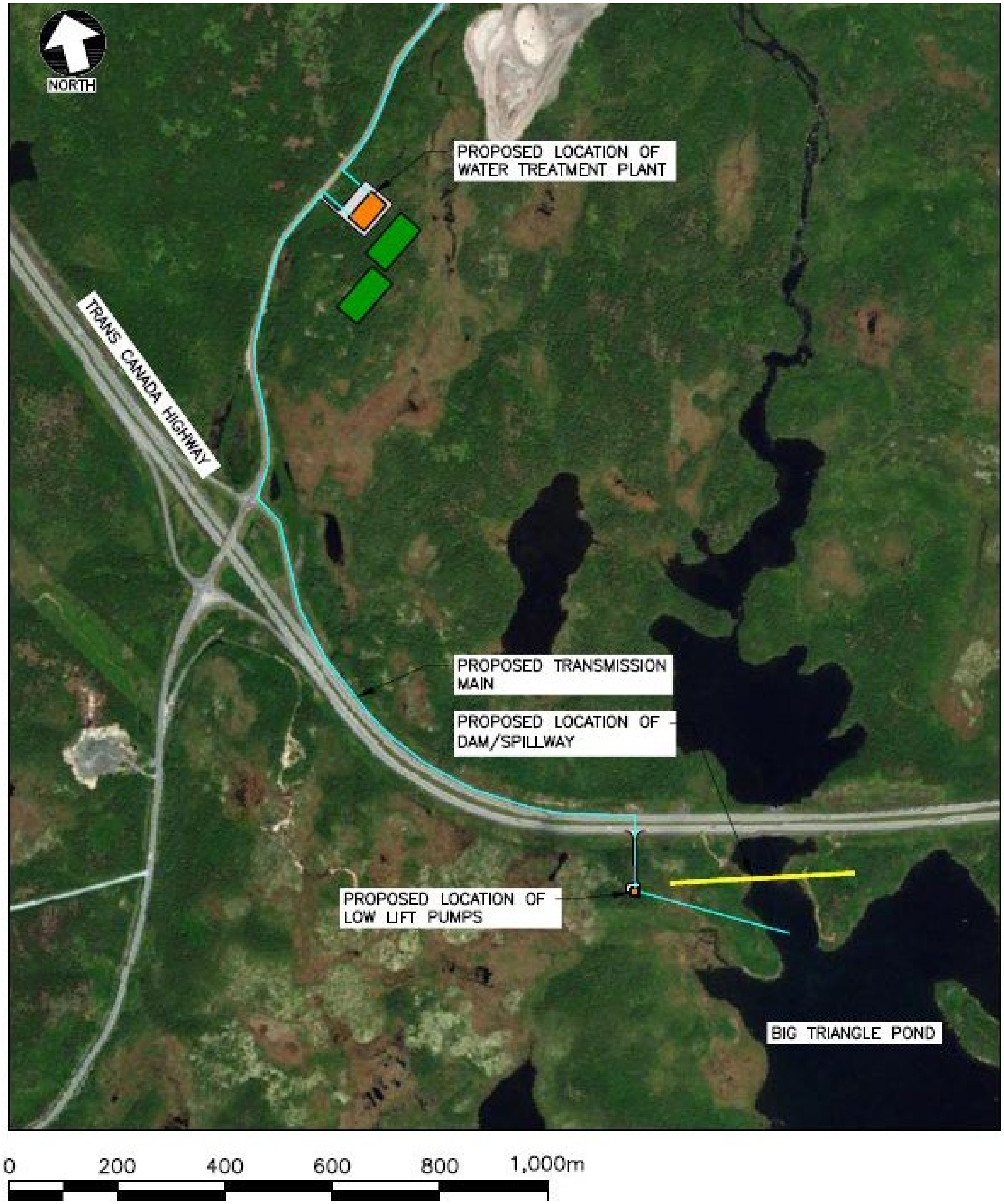


Figure 6.2: Big Triangle Pond Site Plan

6.1.5.2 Raw Water Pumping

At either pond, a new intake and low lift pump station would be required to pump raw water to the proposed treatment plant site. The style and location of the pump station would be selected during the pre-design phase and would take into consideration hydraulics and climate resiliency. For this assessment, allowance has been provided for a forebay style intake with low lift pumps and building structure.

6.1.5.3 Intake Piping

For both Thomas Pond and Big Triangle Pond, intake infrastructure consists of a large diameter pipe from the water source to a low lift pump station. The intake line is likely to consist of HDPE pipe with concrete anchors; excavation close to shore is also required. It is proposed to locate screens in the pump station before a wet well. Water is pumped from the low lift pump station to the WTP by vertical turbine pumps.

6.1.5.4 Proposed Treatment Train

Generally, raw water would be pumped from the low lift pump stations to the entrance of the WTP. Potassium permanganate ($KMnO_4$) and lime would be added into the first chemical mixing tanks for manganese removal. Carbon dioxide (CO_2) would then be added to increase alkalinity and to reach the coagulation pH prior to coagulant addition. Two sets of concrete flocculation tanks, with three cells each, would be used for tapered flocculation prior to clarification. A PAC system, for taste and odour control along with cyanotoxin removal, would be included in the pre-treatment area and allowance would be provided for dosing into the final chemical tank.

Two DAF clarifiers have been included in the conceptual layout for capital costing. The DAF clarifiers would be sized to be able to treat the design flow and to allow for one clarifier to be offline for maintenance or repairs. The DAF system would consist of the necessary skimmers, saturators, recycle pumps, and solids removal.

Following DAF clarification, three multimedia filters consisting of anthracite and sand would be included for filtration. The filters would be sized for two filters to be capable of treating the treatment plant design flow with one filter offline. The filters would include the underdrains and filter internals along with the necessary backwash pumps and pipe work.

From the filters, the treated water would flow to UV disinfection units for primary disinfection. The UV units would be sized to treat the design flow with one unit offline for maintenance or cleaning. Following UV disinfection, the water would be dosed with chlorine for secondary disinfection. The water would flow through a chlorine contact tank to provide the required contact time prior to leaving the facility. High lift pumps would be used to pump the water to the transmission main and distribution system. The finished water will be pH adjusted and have corrosion inhibitor addition.

6.1.5.5 Treated Water Storage

For both ponds it is assumed that the majority of storage required would be provided throughout the existing distribution system. That said, high lift pumps would be required to get the treated water to the distribution system and a clearwell/storage would be required for this. Treated water would also be required for filter backwashing. An in-ground clearwell tank would be sufficient for treated water storage.

6.1.5.6 Water Treatment Plant Residuals

Wastewater from the treatment plant would include intermittent generation of relatively large flow from filter backwashes and filter to waste operations as well as continuous production of low solids sludge from the DAF clarifiers. These waste streams would require treatment on site, or collection and discharge to the nearest wastewater collection system. Lagoons and drying beds have been included at this time for residuals treatment and would be located near the treatment plant at both pond locations. The lagoons would require dredging on a 5 to 10 year basis to remove accumulated solids. Proposed locations are shown on Figure 6.1 and Figure 6.3.

Figure 6.3: Big Triangle Pond WTP & Lagoon Location

6.1.5.7 Building Design

The treatment plant building would be designed to be similar to the existing treatment plants, with a focus on PHLP as a recently constructed facility of similar capacity and treatment process. The treatment plant building would consist of concrete tank foundations and slab on grade. Walls would be concrete block with split-face masonry block siding. Interior walls would be constructed of masonry block with gypsum board finish. The roof would be constructed of timber trusses with metal finish.

6.1.5.8 Building Layout

The building layout will include dedicated process areas for each treatment process. Separate chemical rooms would be included for the lime, PAC systems, and chlorine systems, while the remaining chemicals would be stored in a general chemical room. The WTP building would have a workshop area, administrative areas, laboratory space, and washrooms. A separate electrical room and a control room would also be included.

6.1.5.9 Electrical

600V three phase power would be required for a treatment plant at either location and would need to be extended to the site by Newfoundland Hydro. Single phase power appears to be located close by the proposed location at Big Triangle Pond and currently there is no power near the Thomas Pond proposed site. An emergency backup power generator would also be included in the design of the plant to provide sufficient power to operate the WTP during power outages.

A new overhead telecommunication service connection would also be required at both locations for telephone and high-speed internet service.

6.2 Source Development

To provide a reliable yield of 21,000 m^3/d at Big Triangle Pond, the pond elevation must be raised. For this study, it is assumed that a concrete dam with a spillway elevation of 91 m is required. The flooding extents around Big Triangle Pond are shown on Figure 4.1.

6.3 Transmission Infrastructure

For Thomas Pond, transmission infrastructure includes pumps at the WTP and a transmission main from the WTP to the Fowler's Road reservoirs as shown on Figure 6.4. A connection would be made at the existing control valve chamber. The Hydraulic Grade Line (HGL) for this configuration is provided in Figure 6.5.

The transmission infrastructure for Big Triangle Pond consists of pumps at the WTP, a transmission main, and an intermediate pump station located next to CBS's South reservoir. The transmission main would be connected to the existing 600 mm transmission main located on Route 2 as shown on Figure 6.6. The HGL for this configuration is provided in Figure 6.7.

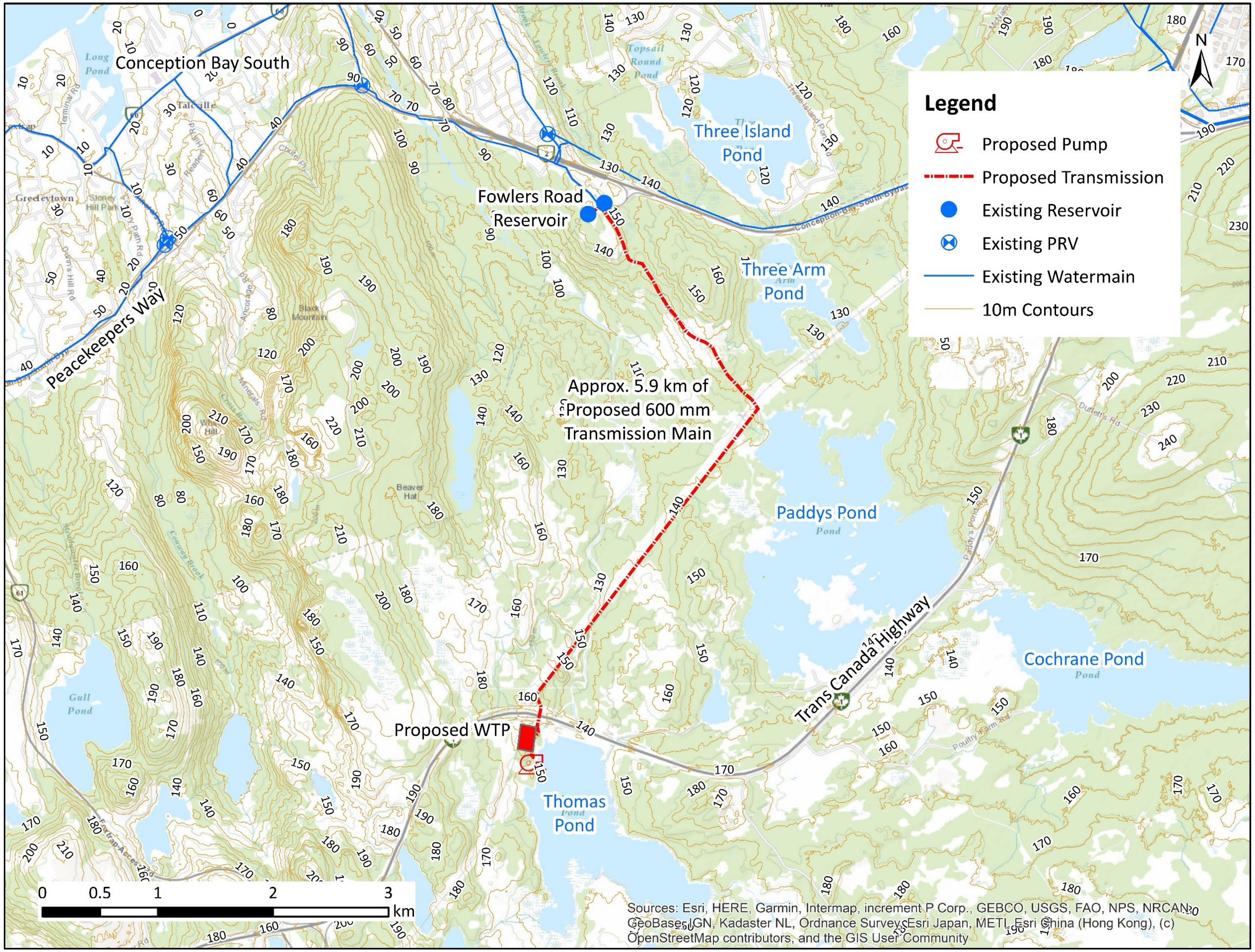


Figure 6.4: Thomas Pond Proposed Transmission Infrastructure

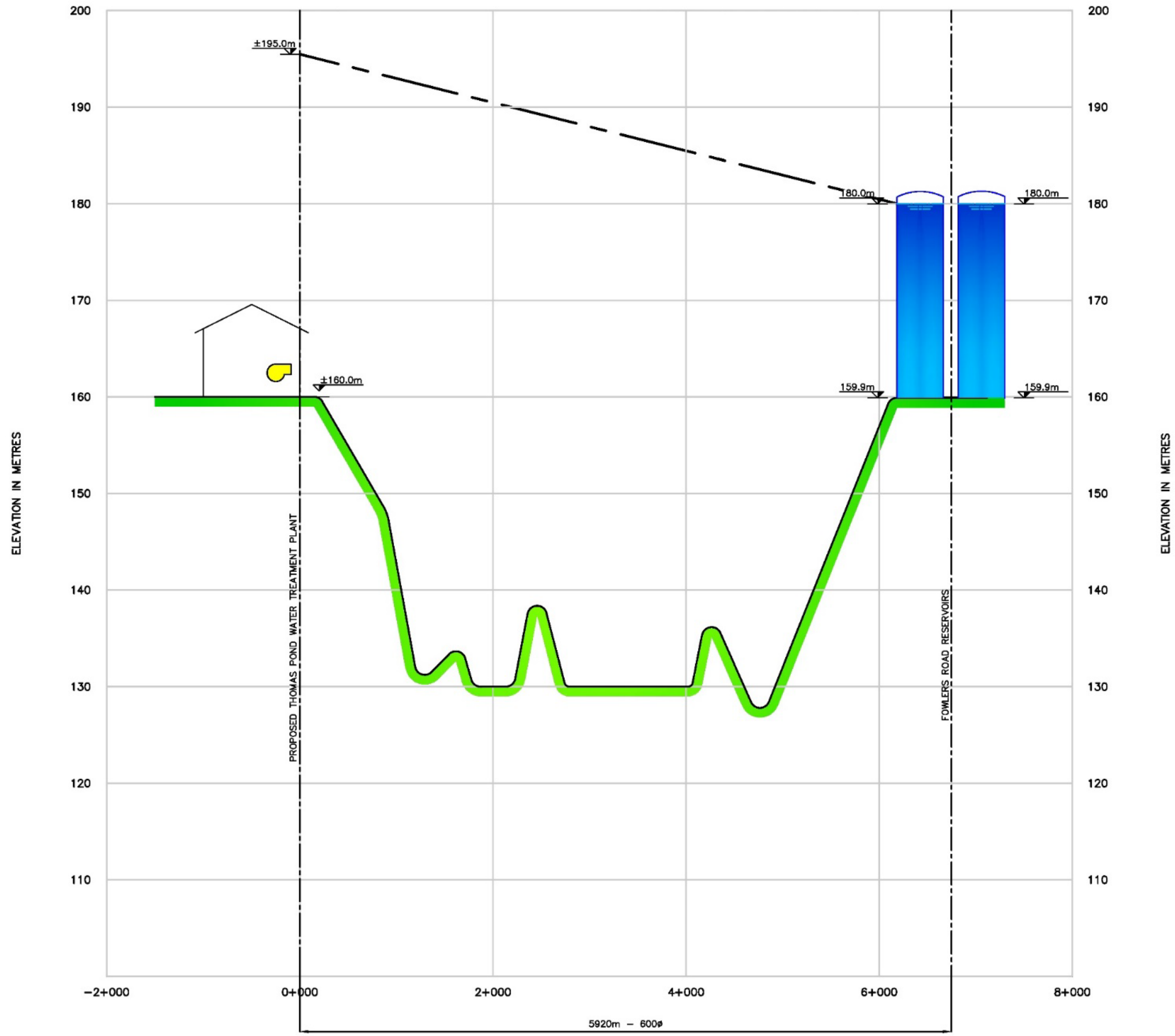


Figure 6.5: Thomas Pond Hydraulic Grade Line

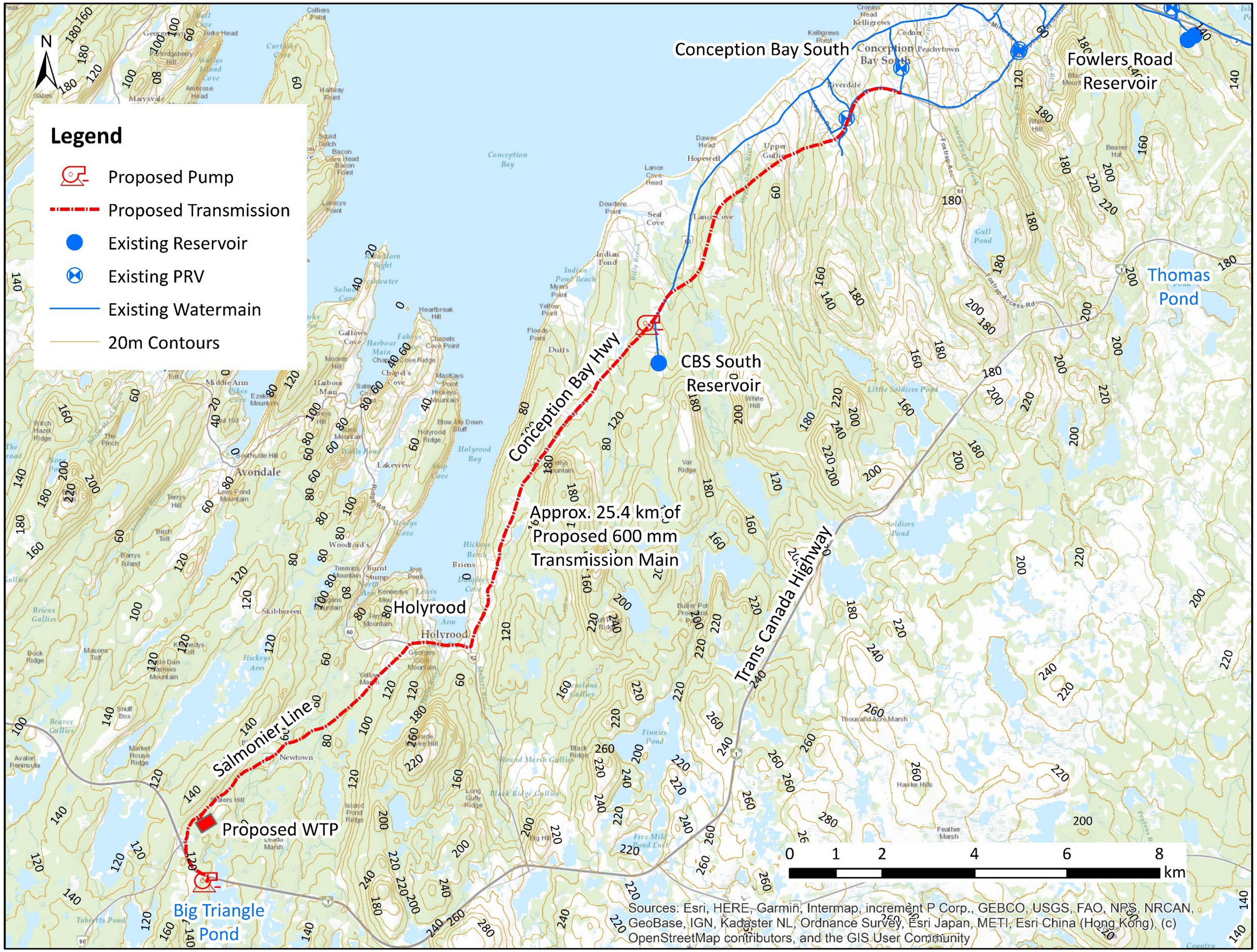


Figure 6.6: Big Triangle Pond Proposed Transmission Infrastructure

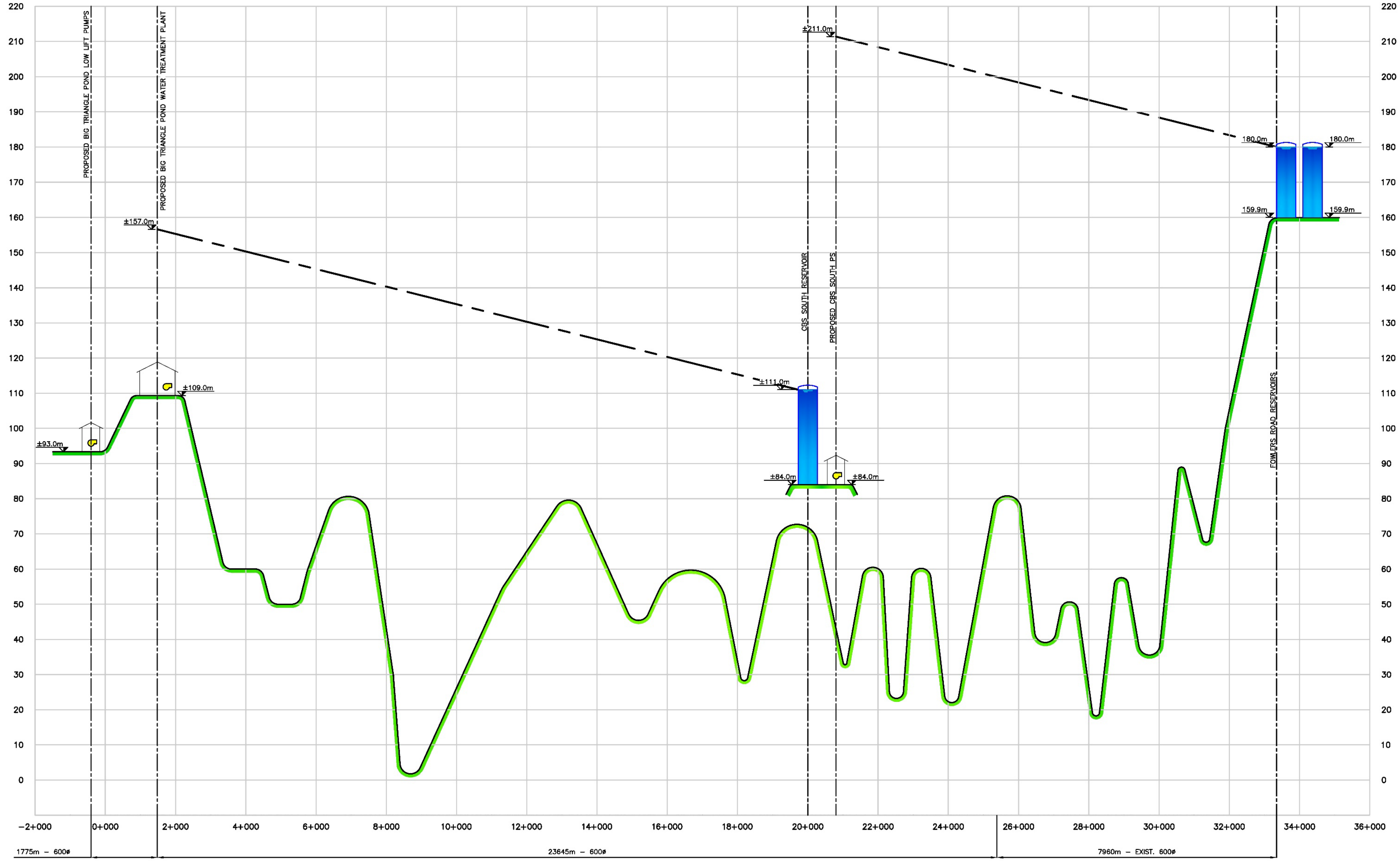


Figure 6.7: Big Triangle Pond Hydraulic Grade Line

Chapter 7 Cost Opinions

Appendix D contains Class 'D' cost opinions. In summary, the estimated capital costs are:

- Thomas Pond: $101,181,000.
- Big Triangle Pond: $199,862,000.

The estimated WTP annual operations and maintenance cost for both options is $3,143,000. Assuming a 20-year operating life and a 6% discount rate, the net present value of the estimated operations and maintenance cost is $36,050,000. Therefore, the total net present values are:

- Thomas Pond: $137,231,000.
- Big Triangle Pond: $235,912,000.

Chapter 8 Conclusions & Recommendations

Key conclusions and recommendations are presented in the following sections.

8.1 Conclusions

The two potential source ponds examined are Big Triangle Pond and Thomas Pond. First, the reliable yield of each source was estimated. Then a treatability assessment, water transmission infrastructure evaluations, and cost estimating was completed for each of the sources.

Without the construction of a dam and spillway at Big Triangle Pond, the site is not a viable source, as the reliable yield is negligible. Reliable yields were estimated for various spillway sill elevations and are presented in Table 8.1. A spillway sill elevation of 90 m is approximately 4 m high.

Table 8.1: Summary of Big Triangle Pond Reliable Yield Estimates

Spillway Elevation (m)	Reliable Yield (m^3/d)
None	Negligible
90	6,000
91	19,000
92	34,000
93	50,000

Assuming an agreement can be reached with Newfoundland Power, it is estimated that the reliable yield of Thomas Pond is 21,000 m^3/d, without making changes to the existing dam and spillway.

Water quality samples were collected seasonally from both ponds over the course of one year. The ponds have similar water quality to surfaces waters in Atlantic Canada, however, they have higher organics concentrations compared to the existing source waters used by the City. Thomas Pond also showed higher concentrations of iron which exceed the *CDWQG* and had a detection of geosmin during summer sampling. Results of the bench-scale treatability study show that both ponds have source water that can be treated to meet organics removal standards outlined by the province and that DAF would be a viable treatment option to carry forward to pre-design. Following DAF clarification, three multimedia filters consisting of anthracite and sand would be included for filtration. From the filters, the treated water would flow to UV disinfection units for primary disinfection. Following UV disinfection, the water would be dosed with chlorine for secondary disinfection. High lift pumps would be used to pump the water to the transmission main and distribution system.

For both Thomas Pond and Big Triangle Pond, intake infrastructure consists of a large diameter pipe from the water source to a low lift pump station. The intake line is likely to consist of HDPE pipe with concrete anchors; excavation close to shore is also required. For Thomas Pond, transmission infrastructure includes pumps at the WTP and a transmission main from the WTP to the Fowler's Road reservoirs. The transmission infrastructure for Big Triangle Pond consists of pumps at the WTP, a transmission main, and an intermediate pump station located next to CBS's South reservoir. The transmission main would be connected to the existing 600 mm transmission main located on Route 2.

The two sources were evaluated using the following criteria:

- Life cycle cost.
- Reliable yield.
- Water quality.
- Environmental impacts.
- Water rights.
- Watershed usage.
- Watershed land use zoning.
- Municipal authority.
- Stakeholder acceptance.
- Source proximity.

Each criterion was assigned a weighting. Through consultations with City staff, weightings were allocated to each criterion based on level of importance. Critical items such as life cycle costs and reliable yield have been assigned high weightings, while lower weightings were assigned to items that may more readily addressed, such as watershed usage, and land use zoning.

While a larger reliable yield can be achieved through the construction of a higher dam at Big Triangle Pond, the size and cost of a WTP to treat 21,000 m^3/d would be significantly different than the cost of a 50,000 m^3/d facility. Therefore, to make a meaningful comparison of the sources, it was assumed that the reliable yield for each source is the same: 21,000 m^3/d. The evaluation is presented in Table 8.2.

Table 8.2: Source Evaluation Matrix

Criterion	Description	Unit of Measure	Weighting (%)	Thomas Pond		Big Triangle Pond		Notes
				Score	Points	Score	Points	
Life Cycle Cost (LCC)	Present value of capital and O&M costs over a selected timespan with a given interest rate.	Lowest life cycle cost receives a score of 5. The other project score is calculated as: Score = 5 * (Lowest LCC/Highest LCC).	30%	5	1.5	2.9	0.87	Lower costs are more favorable.
Reliable Yield	Reliable yield of each source which, for evaluation purposes, is the same.	Both sources score 5.	15%	5	0.75	5	0.75	Assuming equivalent reliable yield of 21,000m^3/d.
Water Quality	Water quality of each source which, for evaluation purposes, is the same.	Both sources score 5.	10%	5	0.5	5	0.5	
Environmental Impacts	Extent to which project could impact the natural environment.	Qualitative judgement on a scale of 1 to 5 where a project with higher environmental impacts receives a lower score.	10%	4	0.4	1	0.1	Dam, land flooding at Big Triangle Pond.
Watershed Usage	Extent to which existing watershed usage could impact watershed protection requirements.	Qualitative judgement on a scale of 1 to 5 where a watershed with more existing uses or developed areas receives a lower score.	5%	3	0.15	3	0.15	Forest management activities and agriculture within the Thomas Pond Watershed. Mining and Holyrood water supply study in Big Triangle Pond.
Watershed Land Use Zoning	Extent to which municipal or provincial regulations could allow for uses that are not in conformance with using the watershed to support a drinking water source.	Qualitative judgement on a scale of 1 to 5 where a watershed with permitted uses that are not in conformance with using the watershed to support a drinking water source receives a lower score.	5%	3	0.15	3	0.15	Both sources are zoned as "watershed".
Municipal Authority	Municipal jurisdiction having authority over the location of the source and watershed.	Source inside City limits scores 5.	5%	5	0.25	3	0.15	Thomas Pond is in City limits.
Stakeholder Acceptance	Ease with which project is expected to be accepted by the City, customers, regulatory agencies, and general public.	Qualitative judgement on a scale of 1 to 5 where a project that is expected to be less acceptable receives a lower score.	5%	4	0.2	1	0.05	Additional environmental and engineering work is required for Big Triangle Pond due to the construction of a dam and the presence of a scheduled salmon river.
Source Proximity	Distance of source from population centres.	A source closer to existing population centres receives a higher score on a scale of 1 to 5.	5%	4	0.2	2	0.1	
Water Rights	Extent to which source could be used for drinking water without interference from existing users.	Qualitative judgement on a scale of 1 to 5 where the source water is currently being used for other purposes receives a lower score.	10%	1	0.1	5	0.5	Newfoundland Power is currently using water at Thomas Pond for hydroelectric generation. Big Triangle Pond will be subject to environmental approvals to accommodate the scheduled salmon river.
		TOTALS	**100%**		**4.2**		**3.32**	
		MAXIMUMS	**100%**		**5**		**5**	
		PERCENT			**84%**		**66%**	

Based on this evaluation, the City should focus on Thomas Pond as the source for development, if/when a new source is necessary. It is assumed that an agreement can be made with Newfoundland Power to extract 21,000 m^3/d from Thomas Pond.

Referring to Table 6.1, a supply of 21,000 m^3/d could nearly meet the future MDD estimates for the Town of CBS for 2036 (23,103 m^3/d) and 2046 (23,596 m^3/d).

8.2 Recommendations

The key recommendations are:

- Contact Newfoundland Power to discuss the use of Thomas Pond as a potable water supply.
- Commence discussions with customers, regulatory agencies, and general public regarding the use of Thomas Pond as a potable water source.
- Continue monitoring water quality.
- Continue monitoring and limiting activities in the watershed.
- Continue and enhance water conservation measures.

Prepared by:

Jennifer Bursey, P.Eng.
Civil Engineer

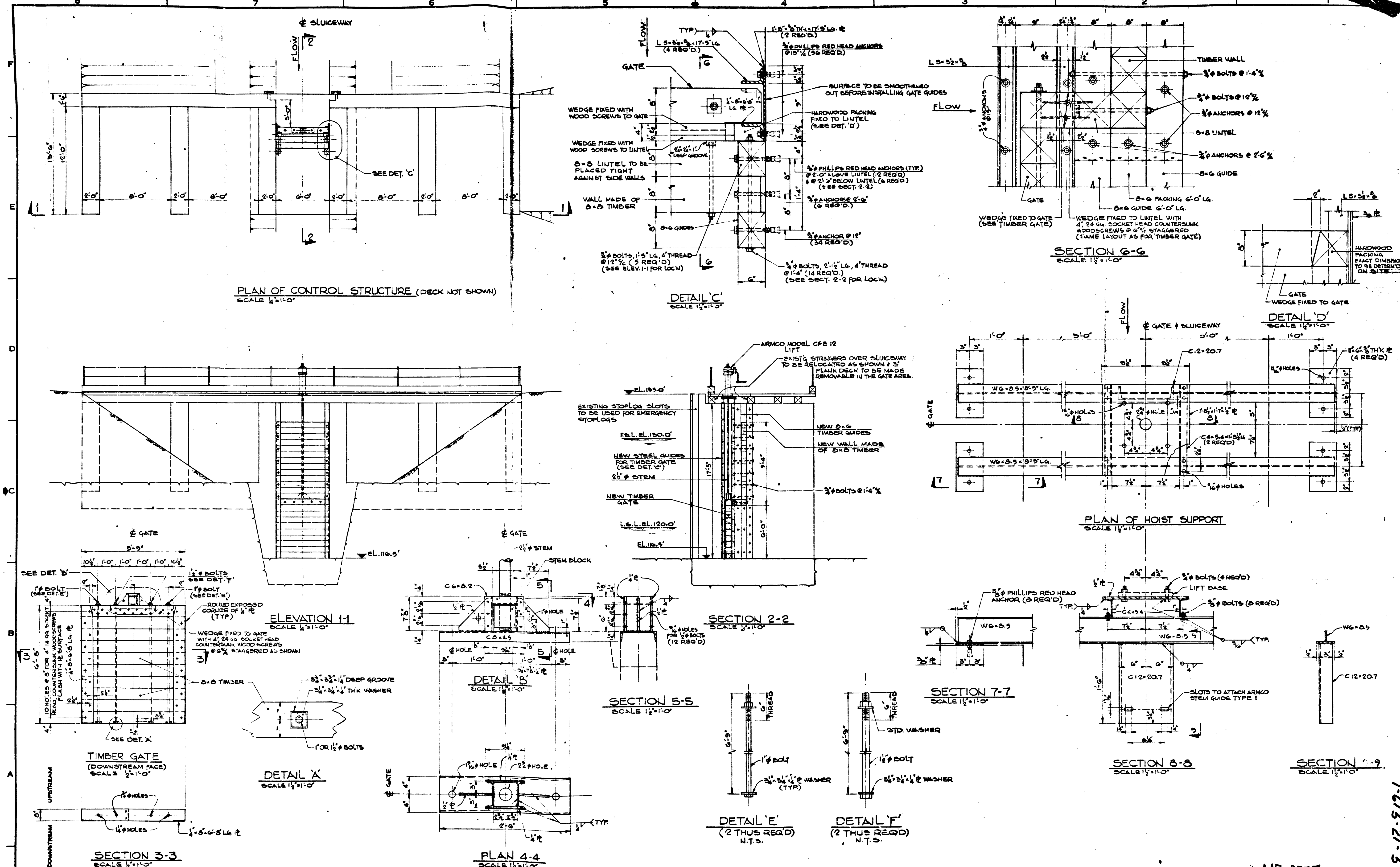
Melissa Fraser, P.Eng.
Process Engineer

Reviewed by:

Greg Sheppard, P.Eng.
Senior Civil Engineer

APPENDIX A

Thomas Pond Regulating Gate Drawing



MF 8775

SCALE AS NOTED	NEWFOUNDLAND LIGHT & POWER CO. LTD.
DRAWN J.LESCALEIRA	THOMAS POND DAM
DATE 21-JUNE-1976	REGULATING GATE LAYOUT & DETAILS
	MONTREAL ENGINEERING CO., LTD.
	W.O. No. N.L.P. 0512-0 DWG. No. F49795

REFERENCE DRAWINGS

REVISIONS

ORIGINAL PREPARED IN MONTREAL

APPENDIX B

Topsail Pond Hydroelectric Power Generation System Operating Procedures

NEWFOUNDLAND POWER
A FORTIS COMPANY

Bulletin Number: POG100.03.07
Date Issued: 1999 08 18
Date Revised: 2018 08 20
Date Reviewed: 2018 08 20

Topsail Operating Procedures

Created By: L. Thompson
Revised By: M. Brown

Reviewed By: M. Brown
Approved By: G. Humby

UNIT LOADING										
	Best Efficiency				Maximum Load				Rough Zone	
Unit	Load (kW)	Gate Limit (%)	Flow (m^3/s)	Eff. ($kW/m^3/s$)	Load (kW)	Gate Limit (%)	Flow (m^3/s)	Eff. ($kW/m^3/s$)	Min.	Max.
#1	2230	72	2.97	757.6	2550	80	3.43	743.4	1100	2000

NORMAL WATER MANAGEMENT ELEVATIONS (Ft.) (TOPSAIL POND LEVEL)		
Level (Feet)	G1 Normal Inflow	G1 Low Inflow
Below 6.2	Shut Down	Shut Down
6.2 to 6.8	Efficient Loading	Shut Down
6.8 to 7.2	Efficient Loading	Efficient Loading
Above 7.2	Peak Loading	Peak Loading

NORMAL WATER MANAGEMNT START AND SHUTDOWN LEVEL (Ft) (TOPSAIL POND LEVEL)		
	G1 Normal Inflow	G2 Low Inflow (summer)
Auto Shutdown	6.2	6.4
Auto Start	7.2	7.2

Topsail Operating Procedures

Created By: L. Thompson
Revised By: M. Brown
Reviewed By: M. Brown
Approved By: G. Humby

STORAGE ELEVATION LIMITS (Ft.)									
	Upper			Lower (Normal)			Lower (Summer)		
Location	Legacy (ft)	Meters	Feet	Legacy (ft)	Meters	Feet	Legacy (ft)	Meters	Feet
Topsail Pond (pond level)	7.3	109.367	358.8	5.0	108.666	356.5	6.5	109.123	358.0
Three Island Pond	5.9	117.380	385.1	2.0	116.191	381.2	5.2	116.953	383.7
Three Arm Pond	5.0	122.000	400.3	2.0	121.086	397.3	2.0	121.086	397.3
Paddy's Pond	7.0	130.592	428.5	2.5	129.220	424.0	6.0	130.287	427.5
Thomas Pond	14.5	146.562	480.8	6.0	143.971	472.3	6.0	143.971	472.3

- Summer elevation is a minimum that the reservoir will be operated at between May 15 and October 15 under normal conditions. If we need to reduce pond level further in summer mode, Superintendent Generation Operations or designate must be contacted to notify home owners in advance.

Flow Delay

- Thomas Pond to Paddy's Pond: 8 hours
- Paddy's Pond to Three Arm Pond: 2 hours
- Three Arm Pond to Three Island Pond: 2 hours

1. Operate Topsail Plant at best efficiency unless risk of spilling.

2. Elevation shown on SCADA is of the Topsail forebay.

3. Usual operation is to fill Three Arm Pond and allow to spill into Three Island Pond. When Three Island Pond fills, run Topsail Plant for a day or two until the Three Island Pond elevation reaches 3 feet. Topsail Plant is then shut until Three Island Pond fills up again.

4. In the event of a predicted rainstorm, the gate at Thomas Pond and Paddy's Pond should be closed to the minimum. Three Island Pond gate should be opened and Topsail Plant operated to get as much water out of the system as possible before the storm.

5. Thomas Pond and Paddy's Pond spill out of the system. Cochrane Pond, from the Petty Harbour system, spills into Paddy's Pond.

Topsail Operating Procedures

Created By: L. Thompson | Reviewed By: M. Brown
Revised By: M. Brown | Approved By: G. Humby

---

6. All gates to be left open a minimum of 1inch to maintain flow for fisheries. If gate has to be closed, an alternate method of maintaining flow must be established.

7. Paddy's Pond elevation should be no lower than 6.0 feet during summer months to accommodate float plane operations. If the elevation falls below 6.0 feet for any reason, contact Ray Hawco with the Avalon Float Plane Association. Contact information:

   Ray Hawco
   29 Sunset Drive
   Goulds, NL
   364-2855

APPENDIX C

Water Quality Sample Reports

57 Old Pennywell Road, Unit I
St. John's, NL
CANADA A1E 6A8
TEL (709)747-8573
FAX (709 747-2139
http://www.agatlabs.com

CLIENT NAME: CBCL LIMITED
187 KENMOUNT ROAD
ST.JOHN'S, NL A1B3P9
(709) 364-8623

ATTENTION TO: Greg Sheppard

PROJECT: 203000.00

AGAT WORK ORDER: 20K651132

TRACE ORGANICS REVIEWED BY: Amy Hunter, Trace Organics Supervisor, B.Sc.

WATER ANALYSIS REVIEWED BY: Marta Manka, Data Reporter

DATE REPORTED: Sep 25, 2020

PAGES (INCLUDING COVER): 14

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*Notes

Disclaimer:

- *All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.*
- *All samples will be disposed of within 30 days following analysis, unless expressly agreed otherwise in writing. Please contact your Client Project Manager if you require additional sample storage time.*
- *AGAT's liability in connection with any delay, performance or non-performance of these services is only to the Client and does not extend to any other third party. Unless expressly agreed otherwise in writing, AGAT's liability is limited to the actual cost of the specific analysis or analyses included in the services.*
- *This Certificate shall not be reproduced except in full, without the written approval of the laboratory.*
- *The test results reported herewith relate only to the samples as received by the laboratory.*
- *Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, warranties of merchantability, fitness for a particular purpose, or non-infringement. AGAT assumes no responsibility for any errors or omissions in the guidelines contained in this document.*
- *All reportable information as specified by ISO/IEC 17025:2017 is available from AGAT Laboratories upon request.*

AGAT Laboratories
57 Old Pennywell Road, Unit I
St. John's, NL
CANADA A1E 6A8
TEL (709)747-8573
FAX (709 747-2139
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 20K651132
PROJECT: 203000.00

CLIENT NAME: CBCL LIMITED
SAMPLING SITE:

ATTENTION TO: Greg Sheppard
SAMPLED BY:

OC Pesticides + PCBs (Water)

DATE RECEIVED: 2020-09-15

DATE REPORTED: 2020-09-25

			SAMPLE DESCRIPTION:	THOMAS POND #1	BIG TRI. POND #1
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	2020-09-15 15:15	2020-09-15 15:15
Parameter	Unit	G / S	RDL	1449687	1449810
Gamma-Hexachlorocyclohexane	ug/L		0.01	<0.01	<0.01
Heptachlor	ug/L		0.01	<0.01	<0.01
Aldrin	ug/L		0.01	<0.01	<0.01
Heptachlor Epoxide	ug/L		0.01	<0.01	<0.01
Endosulfan	ug/L		0.05	<0.05	<0.05
Chlordane	ug/L		0.04	<0.04	<0.04
DDE	ug/L		0.01	<0.01	<0.01
DDD	ug/L		0.05	<0.05	<0.05
DDT	ug/L		0.04	<0.04	<0.04
Dieldrin	ug/L		0.02	<0.02	<0.02
Endrin	ug/L		0.05	<0.05	<0.05
Methoxychlor	ug/L		0.04	<0.04	<0.04
Hexachlorobenzene	ug/L		0.01	<0.01	<0.01
Hexachlorobutadiene	ug/L		0.01	<0.01	<0.01
Hexachloroethane	ug/L		0.01	<0.01	<0.01
Aroclor 1242	ug/L		0.1	<0.1	<0.1
Aroclor 1248	ug/L		0.1	<0.1	<0.1
Aroclor 1254	ug/L		0.1	<0.1	<0.1
Aroclor 1260	ug/L		0.1	<0.1	<0.1
Polychlorinated Biphenyls	ug/L		0.1	<0.1	<0.1
Surrogate	Unit	Acceptable Limits			
TCMX	%	50-140		84	85
Decachlorobiphenyl	%	60-140		89	89

Certified By:

Results relate only to the items tested. Results apply to samples as received.

AGAT Laboratories
57 Old Pennywell Road, Unit I
St. John's, NL
CANADA A1E 6A8
TEL (709)747-8573
FAX (709 747-2139
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 20K651132
PROJECT: 203000.00

CLIENT NAME: CBCL LIMITED
ATTENTION TO: Greg Sheppard
SAMPLING SITE:
SAMPLED BY:

OC Pesticides + PCBs (Water)

DATE RECEIVED: 2020-09-15
DATE REPORTED: 2020-09-25

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

1449687-1449810 DDT total is a calculated parameter. The calculated value is the sum of op'DDT and pp'DDT.
DDD total is a calculated parameter. The calculated value is the sum of op'DDD and pp'DDD.
DDE total is a calculated parameter. The calculated value is the sum of op'DDE and pp'DDE.
Endosulfan total is a calculated parameter. The calculated value is the sum of Endosulfan I and Endosulfan II.
Chlordane total is a calculated parameter. The calculated value is the sum of Alpha-Chlordane and Gamma-Chlordane.
PCB total is a calculated parameter. The calculated value is the sum of Aroclor 1242, Aroclor 1248, Aroclor 1254 and Aroclor 1260.
The calculated parameters are non-accredited. The parameters that are components of the calculation are accredited.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

AGAT Laboratories

57 Old Pennywell Road, Unit I
St. John's, NL
CANADA A1E 6A8
TEL (709)747-8573
FAX (709 747-2139
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 20K651132
PROJECT: 203000.00

CLIENT NAME: CBCL LIMITED
ATTENTION TO: Greg Sheppard
SAMPLING SITE:
SAMPLED BY:

DOC

DATE RECEIVED: 2020-09-15
DATE REPORTED: 2020-09-25

			SAMPLE DESCRIPTION:	THOMAS POND #1	BIG TRI. POND #1
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	2020-09-15 15:15	2020-09-15 15:15
Parameter	Unit	G / S	RDL	1449687	1449810
Dissolved Organic Carbon	mg/L		0.5	11.0	9.7

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
Analysis performed at AGAT Halifax (unless marked by *)

Certified By: Marta Manta

AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 20K651132

PROJECT: 203000.00

57 Old Pennywell Road, Unit I
St. John's, NL
CANADA A1E 6A8
TEL (709)747-8573
FAX (709 747-2139
http://www.agatlabs.com

CLIENT NAME: CBCL LIMITED

ATTENTION TO: Greg Sheppard

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2020-09-15

DATE REPORTED: 2020-09-25

			SAMPLE DESCRIPTION:	THOMAS POND #1	BIG TRI. POND #1
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	2020-09-15 15:15	2020-09-15 15:15
Parameter	Unit	G / S	RDL	1449687	1449810
pH				6.42	7.03
Reactive Silica as SiO2	mg/L		0.5	<0.5	1.4
Chloride	mg/L		1	6	7
Fluoride	mg/L		0.12	<0.12	<0.12
Sulphate	mg/L		2	<2	<2
Alkalinity	mg/L		5	<5	8
True Color	TCU		5	107	66
Turbidity	NTU		0.5	1.8	1.1
Electrical Conductivity	umho/cm		1	35	51
Nitrate + Nitrite as N	mg/L		0.05	0.05	0.08
Nitrate as N	mg/L		0.05	0.05	0.08
Nitrite as N	mg/L		0.05	<0.05	<0.05
Ammonia as N	mg/L		0.03	0.11	0.07
Total Organic Carbon	mg/L		0.5	12.0	9.3
Ortho-Phosphate as P	mg/L		0.01	<0.01	<0.01
Total Sodium	mg/L		0.1	5.0	5.1
Total Potassium	mg/L		0.1	0.3	0.2
Total Calcium	mg/L		0.1	1.6	4.3
Total Magnesium	mg/L		0.1	0.6	0.7
Bicarb. Alkalinity (as CaCO3)	mg/L		5	<5	8
Carb. Alkalinity (as CaCO3)	mg/L		10	<10	<10
Hydroxide	mg/L		5	<5	<5
Calculated TDS	mg/L		1	16	23
Hardness	mg/L			6.5	13.6
Langelier Index (@20C)	NA			-4.20	-2.96
Langelier Index (@ 4C)	NA			-4.52	-3.28
Saturation pH (@ 20C)	NA			10.6	9.99
Saturation pH (@ 4C)	NA			10.9	10.3

Certified By: Marta Manta

Certificate of Analysis

AGAT WORK ORDER: 20K651132
PROJECT: 203000.00

57 Old Pennywell Road, Unit I
St. John's, NL
CANADA A1E 6A8
TEL (709)747-8573
FAX (709 747-2139
http://www.agatlabs.com

CLIENT NAME: CBCL LIMITED
ATTENTION TO: Greg Sheppard
SAMPLING SITE:
SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2020-09-15
DATE REPORTED: 2020-09-25

			SAMPLE DESCRIPTION:	THOMAS POND #1	BIG TRI. POND #1
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	2020-09-15 15:15	2020-09-15 15:15
Parameter	Unit	G / S	RDL	1449687	1449810
Anion Sum	me/L			0.17	0.36
Cation sum	me/L			0.45	0.52
% Difference/ Ion Balance	%			44.7	18.1
Total Aluminum	ug/L		5	212	94
Total Antimony	ug/L		2	<2	<2
Total Arsenic	ug/L		2	<2	<2
Total Barium	ug/L		5	<5	13
Total Beryllium	ug/L		2	<2	<2
Total Bismuth	ug/L		2	<2	<2
Total Boron	ug/L		5	6	5
Total Cadmium	ug/L		0.017	<0.017	<0.017
Total Chromium	ug/L		1	<1	<1
Total Cobalt	ug/L		1	<1	<1
Total Copper	ug/L		1	<1	2
Total Iron	ug/L		50	1710	213
Total Lead	ug/L		0.5	<0.5	<0.5
Total Manganese	ug/L		2	121	43
Total Molybdenum	ug/L		2	<2	<2
Total Nickel	ug/L		2	<2	<2
Total Phosphorus	mg/L		0.1	<0.1	<0.1
Total Selenium	ug/L		1	<1	<1
Total Silver	ug/L		0.1	<0.1	<0.1
Total Strontium	ug/L		5	7	17
Total Thallium	ug/L		0.1	<0.1	<0.1
Total Tin	ug/L		2	<2	<2
Total Titanium	ug/L		2	5	<2
Total Uranium	ug/L		0.1	<0.1	0.1
Total Vanadium	ug/L		2	<2	<2

Certified By: Marta Manta

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AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 20K651132
PROJECT: 203000.00

CLIENT NAME: CBCL LIMITED
SAMPLING SITE:

ATTENTION TO: Greg Sheppard
SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2020-09-15 DATE REPORTED: 2020-09-25

			SAMPLE DESCRIPTION:	THOMAS POND #1	BIG TRI. POND #1
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	2020-09-15 15:15	2020-09-15 15:15
Parameter	Unit	G / S	RDL	1449687	1449810
Total Zinc	ug/L		5	<5	<5

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

1449687-1449810 % Difference / Ion Balance, Hardness, Langelier Index, Nitrate + Nitrite, Hydroxide and Saturation pH are calculated parameters. The calculated parameters are non-accredited. The component parameters of the calculations are accredited.

When the cation and anion sums are at, or below 1 me/L, the acceptable criteria is less than 0.3me/L

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

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Quality Assurance

CLIENT NAME: CBCL LIMITED
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Trace Organics Analysis

RPT Date: Sep 25, 2020			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
OC Pesticides + PCBs (Water)															
Gamma-Hexachlorocyclohexane	1447003		< 0.01	< 0.01	NA	< 0.01	99%	50%	140%	89%	50%	140%	90%	50%	140%
Heptachlor	1447003		< 0.01	< 0.01	NA	< 0.01	92%	50%	140%	85%	50%	140%	89%	50%	140%
Aldrin	1447003		< 0.01	< 0.01	NA	< 0.01	104%	50%	140%	90%	50%	140%	90%	50%	140%
Heptachlor Epoxide	1447003		< 0.01	< 0.01	NA	< 0.01	97%	50%	140%	90%	50%	140%	85%	50%	140%
Endosulfan	1447003		< 0.05	< 0.05	NA	< 0.05	98%	50%	140%	89%	50%	140%	86%	50%	140%
Chlordane	1447003		< 0.04	< 0.04	NA	< 0.04	98%	50%	140%	80%	50%	140%	85%	50%	140%
DDE	1447003		< 0.01	< 0.01	NA	< 0.01	100%	50%	140%	95%	50%	140%	87%	50%	140%
DDD	1447003		< 0.05	< 0.05	NA	< 0.05	98%	50%	140%	84%	50%	140%	88%	50%	140%
DDT	1447003		< 0.04	< 0.04	NA	< 0.04	89%	50%	140%	82%	50%	140%	92%	50%	140%
Dieldrin	1447003		< 0.02	< 0.02	NA	< 0.02	100%	50%	140%	79%	50%	140%	85%	50%	140%
Endrin	1447003		< 0.05	< 0.05	NA	< 0.05	86%	50%	140%	88%	50%	140%	92%	50%	140%
Methoxychlor	1447003		< 0.04	< 0.04	NA	< 0.04	84%	50%	140%	87%	50%	140%	92%	50%	140%
Hexachlorobenzene	1447003		< 0.01	< 0.01	NA	< 0.01	102%	50%	140%	91%	50%	140%	83%	50%	140%
Hexachlorobutadiene	1447003		< 0.01	< 0.01	NA	< 0.01	101%	50%	140%	87%	50%	140%	88%	50%	140%
Hexachloroethane	1447003		< 0.01	< 0.01	NA	< 0.01	90%	50%	140%	88%	50%	140%	89%	50%	140%
Aroclor 1242	1447003		< 0.1	< 0.1	NA	< 0.1	102%	60%	140%	NA	60%	140%	NA	60%	140%
Aroclor 1248	1447003		< 0.1	< 0.1	NA	< 0.1	104%	60%	140%	NA	60%	140%	NA	60%	140%
Aroclor 1254	1447003		< 0.1	< 0.1	NA	< 0.1	106%	60%	140%	NA	60%	140%	NA	60%	140%
Aroclor 1260	1447003		< 0.1	< 0.1	NA	< 0.1	105%	60%	140%	NA	60%	140%	NA	60%	140%
Polychlorinated Biphenyls	1447003		< 0.1	< 0.1	NA	< 0.1	102%	60%	140%	91%	60%	140%	98%	60%	140%

Comments: When the average of the sample and duplicate results is less than 5x the RDL, the Relative Percent Difference (RPD) will be indicated as Not Applicable (NA).

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Quality Assurance

CLIENT NAME: CBCL LIMITED
PROJECT: 203000.00
SAMPLING SITE:

AGAT WORK ORDER: 20K651132
ATTENTION TO: Greg Sheppard
SAMPLED BY:

Water Analysis

RPT Date: Sep 25, 2020			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Standard Water Analysis + Total Metals															
pH	1449687	1449687	6.42	7.02	8.9%	<	100%	80%	120%	NA			NA		
Reactive Silica as SiO2	1447816		0.8	0.9	NA	< 0.5	96%	80%	120%	87%	80%	120%	94%	80%	120%
Chloride	1448975		5	5	NA	< 1	92%	80%	120%	NA	80%	120%	91%	70%	130%
Fluoride	1448975		<0.12	<0.12	NA	< 0.12	113%	80%	120%	NA	80%	120%	100%	70%	130%
Sulphate	1448975		5	5	NA	< 2	118%	80%	120%	NA	80%	120%	102%	70%	130%
Alkalinity	1449687	1449687	<5	10	NA	< 5	93%	80%	120%	NA			NA		
True Color	1449687	1443687	107	115	7.2%	< 5	120%	80%	120%						
Turbidity	1456730	1456763	42.7	36.2	16.5%	< 0.5	90%	80%	120%						
Nitrate as N	1448975		0.13	0.06	NA	< 0.05	97%	80%	120%	NA	80%	120%	70%	70%	130%
Nitrite as N	1448975		<0.05	<0.05	NA	< 0.05	84%	80%	120%	NA	80%	120%	112%	70%	130%
Ammonia as N	1450752		<0.03	<0.03	NA	< 0.03	101%	80%	120%	99%	80%	120%	92%	70%	130%
Total Organic Carbon	1449687	1449687	12.0	12.0	0.6%	< 0.5	96%	80%	120%	NA	80%	120%	105%	80%	120%
Ortho-Phosphate as P	1447816		<0.01	<0.01	NA	< 0.01	87%	80%	120%	104%	80%	120%	102%	80%	120%
Total Sodium	1453887		6.2	6.1	2.7%	< 0.1	110%	80%	120%	109%	80%	120%	NA	70%	130%
Total Potassium	1453887		0.6	0.6	1.2%	< 0.1	106%	80%	120%	106%	80%	120%	102%	70%	130%
Total Calcium	1453887		8.1	8.4	4.0%	< 0.1	105%	80%	120%	107%	80%	120%	NA	70%	130%
Total Magnesium	1453887		0.8	0.8	2.3%	< 0.1	105%	80%	120%	109%	80%	120%	98%	70%	130%
Bicarb. Alkalinity (as CaCO3)	1449687	1449687	<5	10	NA	< 5	NA	80%	120%	NA			NA		
Carb. Alkalinity (as CaCO3)	1449687	1449687	<10	<10	NA	< 10	NA	80%	120%	NA			NA		
Hydroxide	1449687	1449687	<5	<5	NA	< 5	NA	80%	120%	NA			NA		
Total Aluminum	1453887		10	10	NA	< 5	105%	80%	120%	104%	80%	120%	95%	70%	130%
Total Antimony	1453887		<2	<2	NA	< 2	92%	80%	120%	97%	80%	120%	94%	70%	130%
Total Arsenic	1453887		<2	<2	NA	< 2	96%	80%	120%	94%	80%	120%	92%	70%	130%
Total Barium	1453887		20	22	NA	< 5	97%	80%	120%	98%	80%	120%	105%	70%	130%
Total Beryllium	1453887		<2	<2	NA	< 2	86%	80%	120%	88%	80%	120%	88%	70%	130%
Total Bismuth	1453887		<2	<2	NA	< 2	94%	80%	120%	96%	80%	120%	97%	70%	130%
Total Boron	1453887		<5	<5	NA	< 5	84%	80%	120%	85%	80%	120%	93%	70%	130%
Total Cadmium	1453887		<0.017	<0.017	NA	< 0.017	90%	80%	120%	96%	80%	120%	89%	70%	130%
Total Chromium	1453887		<1	<1	NA	< 1	97%	80%	120%	99%	80%	120%	103%	70%	130%
Total Cobalt	1453887		<1	<1	NA	< 1	95%	80%	120%	100%	80%	120%	107%	70%	130%
Total Copper	1453887		119	118	0.8%	< 1	101%	80%	120%	101%	80%	120%	NA	70%	130%
Total Iron	1453887		144	153	NA	< 50	97%	80%	120%	100%	80%	120%	114%	70%	130%
Total Lead	1453887		<0.5	<0.5	NA	< 0.5	94%	80%	120%	95%	80%	120%	96%	70%	130%
Total Manganese	1453887		7	7	NA	< 2	96%	80%	120%	98%	80%	120%	110%	70%	130%
Total Molybdenum	1453887		<2	<2	NA	< 2	91%	80%	120%	89%	80%	120%	107%	70%	130%
Total Nickel	1453887		<2	<2	NA	< 2	99%	80%	120%	98%	80%	120%	106%	70%	130%
Total Phosphorus	1456573		<0.1	<0.1	NA	< 0.1	99%	80%	120%	102%	80%	120%	130%	70%	130%
Total Selenium	1453887		<1	<1	NA	< 1	95%	80%	120%	91%	80%	120%	85%	70%	130%
Total Silver	1453887		<0.1	<0.1	NA	< 0.1	95%	80%	120%	98%	80%	120%	101%	70%	130%

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Quality Assurance

CLIENT NAME: CBCL LIMITED
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AGAT WORK ORDER: 20K651132
ATTENTION TO: Greg Sheppard
SAMPLED BY:

Water Analysis (Continued)

RPT Date: Sep 25, 2020			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Total Strontium	1453887		33	36	9.4%	< 5	89%	80%	120%	92%	80%	120%	NA	70%	130%
Total Thallium	1453887		<0.1	<0.1	NA	< 0.1	97%	80%	120%	98%	80%	120%	102%	70%	130%
Total Tin	1453887		<2	<2	NA	< 2	97%	80%	120%	99%	80%	120%	101%	70%	130%
Total Titanium	1453887		<2	<2	NA	< 2	103%	80%	120%	106%	80%	120%	103%	70%	130%
Total Uranium	1453887		<0.1	<0.1	NA	< 0.1	99%	80%	120%	99%	80%	120%	107%	70%	130%
Total Vanadium	1453887		<2	<2	NA	< 2	94%	80%	120%	93%	80%	120%	101%	70%	130%
Total Zinc	1453887		<5	<5	NA	< 5	95%	80%	120%	96%	80%	120%	91%	70%	130%

Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

DOC

PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Lower	Upper	Recovery	Lower	Upper	Recovery	Lower	Upper
Dissolved Organic Carbon	1449810		NA	NA	NA	< 0.5	96%	80%	120%	NA	80%	120%	NA	80%	120%

Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Standard Water Analysis + Total Metals

PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Lower	Upper	Recovery	Lower	Upper	Recovery	Lower	Upper
Total Organic Carbon	1448991		12.0	12.1	0.7%	< 0.5	106%	80%	120%	NA	80%	120%	118%	80%	120%

Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

DOC

PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Lower	Upper	Recovery	Lower	Upper	Recovery	Lower	Upper
Dissolved Organic Carbon	1448991		12.0	12.1	0.7%	< 0.5	106%	80%	120%	NA	80%	120%	118%	80%	120%

Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By: Marta Manta

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Method Summary

CLIENT NAME: CBCL LIMITED
AGAT WORK ORDER: 20K651132
PROJECT: 203000.00
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SAMPLING SITE:
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Gamma-Hexachlorocyclohexane	ORG-91-5112	modified from EPA SW-846 3510 & 8081	GC/ECD
Heptachlor	ORG-91-5112	modified from EPA SW-846 3510 & 8081	GC/ECD
Aldrin	ORG-91-5112	modified from EPA SW-846 3510 & 8081	GC/ECD
Heptachlor Epoxide	ORG-91-5112	modified from EPA SW-846 3510 & 8081	GC/ECD
Endosulfan	ORG-91-5112	modified from EPA SW-846 3510 & 8081	GC/ECD
Chlordane	ORG-91-5112	modified from EPA SW-846 3510 & 8081	GC/ECD
DDE	ORG-91-5112	modified from EPA SW-846 3510 & 8081	GC/ECD
DDD	ORG-91-5112	modified from EPA SW-846 3510 & 8081	GC/ECD
DDT	ORG-91-5112	modified from EPA SW-846 3510 & 8081	GC/ECD
Dieldrin	ORG-91-5112	modified from EPA SW-846 3510 & 8081	GC/ECD
Endrin	ORG-91-5112	modified from EPA SW-846 3510 & 8081	GC/ECD
Methoxychlor	ORG-91-5112	modified from EPA SW-846 3510 & 8081	GC/ECD
Hexachlorobenzene	ORG-91-5112	modified from EPA SW-846 3510 & 8081	GC/ECD
Hexachlorobutadiene	ORG-91-5112	modified from EPA SW-846 3510 & 8081	GC/ECD
Hexachloroethane	ORG-91-5112	modified from EPA SW-846 3510 & 8081	GC/ECD
Aroclor 1242	ORG-91-5112	modified from EPA SW-846 3510 & 8082	GC/ECD
Aroclor 1248	ORG-91-5112	modified from EPA SW-846 3510 & 8082	GC/ECD
Aroclor 1254	ORG-91-5112	modified from EPA SW-846 3510 & 8082	GC/ECD
Aroclor 1260	ORG-91-5112	modified from EPA SW-846 3510 & 8082	GC/ECD
Polychlorinated Biphenyls	ORG-91-5112	modified from EPA SW-846 3510 & 8082	GC/ECD
TCMX	ORG-91-5112	modified from EPA SW-846 3510 & 8081	GC/ECD
Decachlorobiphenyl	ORG-91-5112	modified from EPA SW-846 3510 & 8081	GC/ECD

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PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Dissolved Organic Carbon	INOR-121-6026	SM 5310 B	TOC ANALYZER
pH	INOR-121-6001	SM 4500 H+B	PC TITRATE
Reactive Silica as SiO2	INOR-121-6027	SM 4500-SiO2 F	COLORIMETER
Chloride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Fluoride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Sulphate	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Alkalinity	INOR-121-6001	SM 2320 B	
True Color	INOR-121-6014	SM 2120 C	NEPHELOMETER
Turbidity	INOR-121-6022	SM 2130 B	NEPHELOMETER
Electrical Conductivity	INOR-121-6001	SM 2510 B	PC TITRATE
Nitrate + Nitrite as N	INORG-121-6005	SM 4110 B	CALCULATION
Nitrate as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Ammonia as N	INOR-121-6047	SM 4500-NH3 H	COLORIMETER
Total Organic Carbon	INOR-121-6026	SM 5310 B	TOC ANALYZER
Ortho-Phosphate as P	INOR-121-6012	SM 4500-P G	COLORIMETER
Total Sodium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Potassium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Calcium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Magnesium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Bicarb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC TITRATE
Carb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC TITRATE
Hydroxide	INORG-121-6001	SM 2320 B	PC-TITRATE
Calculated TDS	CALCULATION	SM 1030E	CALCULATION
Hardness	CALCULATION	SM 2340B	CALCULATION
Langelier Index (@20C)	CALCULATION	CALCULATION	CALCULATION
Langelier Index (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 20C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Anion Sum	CALCULATION	SM 1030E	CALCULATION
Cation sum	CALCULATION	SM 1030E	CALCULATION
% Difference/ Ion Balance	CALCULATION	SM 1030E	CALCULATION
Total Aluminum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Antimony	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Arsenic	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Barium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Beryllium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Bismuth	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Boron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Cadmium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS

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PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Total Chromium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Cobalt	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Copper	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Iron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Lead	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Manganese	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Molybdenum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Nickel	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Phosphorus	MET-121-6104 and MET-121-6113	SM 3120B	ICP/OES
Total Selenium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Silver	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Strontium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Thallium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Tin	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Titanium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Uranium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Vanadium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Zinc	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS

AGAT Laboratories

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Chain of Custody Record

Laboratory Use Only

Arrival Condition: ☐ Good ☐ Poor (see notes)
Arrival Temperature: 18.7, 19.1, 18.7 *Sampled Same day
Hold Time:
AGAT Job Number: 20K651132
Notes:

Report Information

Company: CBCL Limited
Contact: Greg Sheppard
Address: 187 Kenmount Road
St. John's, NL
Phone: 709-364-8623 Fax:
Client Project #: 203000.00
AGAT Quotation:
Please Note: If quotation number is not provided client will be billed full price for analysis.

Report Information (Please print):

1. Name: Greg Sheppard
Email: gregs @ cbcl. Ca
2. Name:
Email:

Report Format

☐ Single Sample per page
☐ Multiple Samples per page
☐ Excel Format Included
☐ Export

Turnaround Time Required (TAT)

Regular TAT ☐ 5 to 7 working days
Rush TAT ☐ Same day ☐ 1 day
☐ 2 days ☐ 3 days
Date Required:

Invoice To Same Yes ☒ / No ☐

Company:
Contact:
Address:
Phone: Fax:
PO/Credit Card#:

Regulatory Requirements (Check):

☐ List Guidelines on Report ☐ Do not list Guidelines on Report
☐ PIRI
☐ Tier 1 ☐ Res ☐ Pot ☐ Coarse
☐ Tier 2 ☐ Com ☐ N/Pot ☐ Fine
☐ Gas ☐ Fuel ☐ Lube
☐ CCME ☐ CDWQ
☐ Industrial ☐ NSEQS-Cont Sites
☐ Commercial ☐ HRM 101
☐ Res/Park ☐ Storm Water
☐ Agricultural ☐ Waste Water
☐ FWAL
☐ Sediment ☐ Other

Drinking Water Sample: ☐ Yes ☐ No Salt Water Sample ☐ Yes ☐ No
Reg. No.:

Sample Identification	Date/Time Sampled	Sample Matrix	# Containers	Comments – Site/Sample Info. Sample Containment	Field Filtered/Preserved	Standard Water Analysis	Metals: Total / Diss / Available	Mercury	BOD / CBOD	pH	TSS / TDS / VSS	TKN	Total Phosphorus	Phenols	Tier 1: TPH/BTEX (PIRI) low level	Tier 2: TPH/BTEX Fractionation	CCME-CWS TPH/BTEX	VOC	THM	HAA	PAH	PCB	TC + EC / P/A / MPN / MF	HPC / Pseudomonas	Fecal Coliform / MPN / MF	Other:	Other:	Hazardous (Y/N)
THOMAS POND #1	15/09/20 15:15 ~~14:45~~		1																									
THOMAS POND #1	15/09/20 15:15 ~~14:45~~		1																									
THOMAS POND #1	15/09/20 15:15 ~~14:45~~		1																									
THOMAS POND #1	15/09/20 15:15 ~~14:45~~		1																									
THOMAS POND #1	15/09/20 15:15 ~~14:45~~		1																									
THOMAS POND #1	16/09/20 15:15 ~~14:45~~		1																									
BIG TRI. POND #1	15/09/20 14:45		1																									
BIG TRI. POND #1	15/09/20 14:45		1																									
BIG TRI. POND #1	15/09/20 14:45		1																									
BIG TRI. POND #1	15/09/20 14:45		1																									
BIG TRI. POND #1	15/09/20 14:45		1																									
BIG TRI. POND #1	15/09/20 14:45		1																									

Samples Relinquished By (Print Name): Date/Time
Samples Relinquished By (Sign): Date/Time
Samples Received By (Print Name): Date/Time Sept 15 345pm
Samples Received By (Sign): Date/Time

Pink Copy - Client
Yellow Copy - AGAT
White Copy - AGAT

Page ☐ of ☐
Nº:

Document ID: DIV-133-1502.002

Date revised: May 19, 2016

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

21-September-2020

CBCL Limited
Attn : Greg Sheppard, Donna Morrison

1505 Barrington St, Suite 901
Halifax, NS
B3J 2R7,

Phone: 902-421-7241
Fax:

Date Rec. : 16 September 2020
LR Report: **CA16697-SEP20**
Reference: CSJ - New Regional Water Source

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Sample ID	Sample Date & Time	Temperature Upon Receipt °C	Geosmin ng/L	MIB ng/L	Microcystin (Quantitative) ug/L
1: Analysis Start Date		---	16-Sep-20	16-Sep-20	18-Sep-20
2: Analysis Start Time		---	22:17	22:17	09:32
3: Analysis Completed Date		---	21-Sep-20	21-Sep-20	18-Sep-20
4: Analysis Completed Time		---	10:50	10:50	12:45
6: MDL		---	3	3	0.1
7: NR Big Triangle Pond #1	15-Sep-20 14:43	---	< 3	< 3	< 0.1
8: NR Thomas Pond #1	15-Sep-20 15:15	17.0	< 3	< 3	< 0.1

MDL - SGS Method Detection Limit

Patti Stark
Project Specialist,
Environment, Health & Safety

OnLine LIMS

0002262594

57 Old Pennywell Road, Unit I
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CANADA A1E 6A8
TEL (709)747-8573
FAX (709 747-2139
http://www.agatlabs.com

CLIENT NAME:	CBCL LIMITED 187 KENMOUNT ROAD ST.JOHN'S, NL A1B3P9 (709) 364-8623
ATTENTION TO:	Greg Sheppard
PROJECT:	203000.00
AGAT WORK ORDER:	20K687486
WATER ANALYSIS REVIEWED BY:	Marta Manka, Data Reporter
DATE REPORTED:	Dec 17, 2020
PAGES (INCLUDING COVER):	11
VERSION*:	1

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*Notes

Certificate of Analysis

AGAT WORK ORDER: 20K687486

PROJECT: 203000.00

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http://www.agatlabs.com

CLIENT NAME: CBCL LIMITED

ATTENTION TO: Greg Sheppard

SAMPLING SITE:

SAMPLED BY:

DOC

DATE RECEIVED: 2020-12-08

DATE REPORTED: 2020-12-17

Parameter	Unit	G / S	RDL	1793235	1793281
SAMPLE DESCRIPTION:				BTP	TP
SAMPLE TYPE:				Water	Water
DATE SAMPLED:				2020-12-08 10:30	2020-12-08 10:30
Dissolved Organic Carbon	mg/L		0.5	8.5	10.2

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 20K687486

PROJECT: 203000.00

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CLIENT NAME: CBCL LIMITED

ATTENTION TO: Greg Sheppard

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2020-12-08

DATE REPORTED: 2020-12-17

Parameter	Unit	G / S	RDL	BTP	TP
			SAMPLE DESCRIPTION:	BTP	TP
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	2020-12-08 10:30	2020-12-08 10:30
				1793235	1793281
pH				6.75	5.80
Reactive Silica as SiO2	mg/L		0.5	2.7	2.3
Chloride	mg/L		1	8	7
Fluoride	mg/L		0.12	<0.12	<0.12
Sulphate	mg/L		2	<2	<2
Alkalinity	mg/L		5	6	<5
True Color	TCU		5.00	62.7	81.8
Turbidity	NTU		0.5	1.0	1.5
Electrical Conductivity	umho/cm		1	52	37
Nitrate + Nitrite as N	mg/L		0.05	<0.05	<0.05
Nitrate as N	mg/L		0.05	<0.05	<0.05
Nitrite as N	mg/L		0.05	<0.05	<0.05
Ammonia as N	mg/L		0.03	<0.03	<0.03
Total Organic Carbon	mg/L		0.5	8.6	10.2
Ortho-Phosphate as P	mg/L		0.01	0.01	0.01
Total Sodium	mg/L		0.1	5.4	4.3
Total Potassium	mg/L		0.1	0.3	0.4
Total Calcium	mg/L		0.1	3.6	1.2
Total Magnesium	mg/L		0.1	0.6	0.6
Bicarb. Alkalinity (as CaCO3)	mg/L		5	6	<5
Carb. Alkalinity (as CaCO3)	mg/L		10	<10	<10
Hydroxide	mg/L		5	<5	<5
Calculated TDS	mg/L		1	22	14
Hardness	mg/L			11.5	5.5
Langelier Index (@20C)	NA			-3.44	-4.94
Langelier Index (@ 4C)	NA			-3.76	-5.26
Saturation pH (@ 20C)	NA			10.2	10.7
Saturation pH (@ 4C)	NA			10.5	11.1
Anion Sum	me/L			0.35	0.20

Certified By: Marta Manta

Certificate of Analysis

AGAT WORK ORDER: 20K687486
PROJECT: 203000.00

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CLIENT NAME: CBCL LIMITED
ATTENTION TO: Greg Sheppard
SAMPLING SITE:
SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2020-12-08
DATE REPORTED: 2020-12-17

Parameter	Unit	G / S	RDL	BTP	TP
			SAMPLE DESCRIPTION:	BTP	TP
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	2020-12-08 10:30	2020-12-08 10:30
				1793235	1793281
Cation sum	me/L			0.49	0.35
% Difference/ Ion Balance	%			17.7	27.5
Total Aluminum	ug/L		5	125	156
Total Antimony	ug/L		2	<2	<2
Total Arsenic	ug/L		2	<2	<2
Total Barium	ug/L		5	9	<5
Total Beryllium	ug/L		2	<2	<2
Total Bismuth	ug/L		2	<2	<2
Total Boron	ug/L		5	<5	<5
Total Cadmium	ug/L		0.017	<0.017	<0.017
Total Chromium	ug/L		1	<1	<1
Total Cobalt	ug/L		1	<1	<1
Total Copper	ug/L		1	<1	<1
Total Iron	ug/L		50	218	592
Total Lead	ug/L		0.5	<0.5	<0.5
Total Manganese	ug/L		2	11	23
Total Molybdenum	ug/L		2	<2	<2
Total Nickel	ug/L		2	<2	<2
Total Phosphorous	mg/L		0.02	0.02	0.03
Total Selenium	ug/L		1	<1	<1
Total Silver	ug/L		0.1	<0.1	<0.1
Total Strontium	ug/L		5	14	5
Total Thallium	ug/L		0.1	<0.1	<0.1
Total Tin	ug/L		2	<2	<2
Total Titanium	ug/L		2	<2	3
Total Uranium	ug/L		0.1	<0.1	<0.1
Total Vanadium	ug/L		2	<2	<2
Total Zinc	ug/L		5	<5	<5

Certified By: Marta Manta

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Certificate of Analysis

AGAT WORK ORDER: 20K687486
PROJECT: 203000.00

CLIENT NAME: CBCL LIMITED
ATTENTION TO: Greg Sheppard
SAMPLING SITE:
SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2020-12-08
DATE REPORTED: 2020-12-17

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

1793235-1793281 % Difference / Ion Balance, Hardness, Langelier Index, Nitrate + Nitrite, Hydroxide and Saturation pH are calculated parameters. The calculated parameters are non-accredited. The component parameters of the calculations are accredited.

When the cation and anion sums are at, or below 1 me/L, the acceptable criteria is less than 0.3me/L

Analysis performed at AGAT Halifax (unless marked by *)

Certified By: Marta Manta

AGAT Laboratories

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St. John's, NL
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http://www.agatlabs.com

Quality Assurance

CLIENT NAME: CBCL LIMITED
PROJECT: 203000.00
SAMPLING SITE:

AGAT WORK ORDER: 20K687486
ATTENTION TO: Greg Sheppard
SAMPLED BY:

Water Analysis

RPT Date: Dec 17, 2020			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Standard Water Analysis + Total Metals															
pH	1794643		6.71	6.71	0.0%	<	102%	80%	120%	NA			NA		
Reactive Silica as SiO2	1794636		8.5	9.0	5.9%	< 0.5	99%	80%	120%	95%	80%	120%	107%	80%	120%
Chloride	1792889		4	4	NA	< 1	90%	80%	120%	NA	80%	120%	92%	70%	130%
Fluoride	1792889		<0.12	<0.12	NA	< 0.12	103%	80%	120%	NA	80%	120%	118%	70%	130%
Sulphate	1792889		12	12	1%	< 2	98%	80%	120%	NA	80%	120%	NA	70%	130%
Alkalinity	1794643		7	8	NA	6	91%	80%	120%	NA			NA		
True Color	1794636		<5.00	<5.00	NA	< 5	101%	80%	120%	96%	80%	120%	NA		
Turbidity	1807095		<0.5	<0.5	NA	< 0.5	94%	80%	120%	NA			NA		
Electrical Conductivity	1794643		109	109	0.1%	< 1	102%	90%	110%	NA			NA		
Nitrate as N	1792889		<0.05	<0.05	NA	< 0.05	93%	80%	120%	NA	80%	120%	87%	70%	130%
Nitrite as N	1792889		<0.05	<0.05	NA	< 0.05	90%	80%	120%	NA	80%	120%	117%	70%	130%
Ammonia as N	1798259		0.03	<0.03	NA	< 0.03	95%	80%	120%	99%	80%	120%	92%	70%	130%
Total Organic Carbon	1794638		1.4	1.5	NA	< 0.5	90%	80%	120%	NA	80%	120%	80%	80%	120%
Ortho-Phosphate as P	1794636		0.70	0.75	6.9%	< 0.01	96%	80%	120%	99%	80%	120%	96%	80%	120%
Total Sodium	1798113		20.7	18.9	9.4%	< 0.1	108%	80%	120%	107%	80%	120%	NA	70%	130%
Total Potassium	1798113		0.3	0.3	NA	< 0.1	102%	80%	120%	105%	80%	120%	109%	70%	130%
Total Calcium	1798113		10.5	10.3	1.4%	< 0.1	99%	80%	120%	107%	80%	120%	NA	70%	130%
Total Magnesium	1798113		1.0	0.9	10.6%	< 0.1	103%	80%	120%	105%	80%	120%	NA	70%	130%
Bicarb. Alkalinity (as CaCO3)	1794643		7	8	NA	6	NA	80%	120%	NA			NA		
Carb. Alkalinity (as CaCO3)	1794643		<10	<10	NA	< 10	NA	80%	120%	NA			NA		
Hydroxide	1794643		<5	<5	NA	< 5	NA	80%	120%	NA			NA		
Total Aluminum	1798113		262	234	11.3%	< 5	104%	80%	120%	104%	80%	120%	NA	70%	130%
Total Antimony	1798113		<2	<2	NA	< 2	77%	80%	120%	97%	80%	120%	97%	70%	130%
Total Arsenic	1798113		<2	<2	NA	< 2	100%	80%	120%	103%	80%	120%	104%	70%	130%
Total Barium	1798113		15	13	NA	< 5	94%	80%	120%	92%	80%	120%	110%	70%	130%
Total Beryllium	1798113		<2	<2	NA	< 2	109%	80%	120%	111%	80%	120%	109%	70%	130%
Total Bismuth	1798113		<2	<2	NA	< 2	101%	80%	120%	101%	80%	120%	107%	70%	130%
Total Boron	1798113		20	19	NA	< 5	108%	80%	120%	99%	80%	120%	120%	70%	130%
Total Cadmium	1798113		0.048	0.071	NA	< 0.017	90%	80%	120%	87%	80%	120%	88%	70%	130%
Total Chromium	1798113		<1	<1	NA	< 1	94%	80%	120%	99%	80%	120%	104%	70%	130%
Total Cobalt	1798113		<1	<1	NA	< 1	96%	80%	120%	98%	80%	120%	106%	70%	130%
Total Copper	1798113		3	3	NA	< 1	99%	80%	120%	99%	80%	120%	110%	70%	130%
Total Iron	1798113		387	363	6.3%	< 50	96%	80%	120%	101%	80%	120%	NA	70%	130%
Total Lead	1798113		0.8	0.7	NA	< 0.5	102%	80%	120%	101%	80%	120%	110%	70%	130%
Total Manganese	1798113		69	62	10.3%	< 2	96%	80%	120%	98%	80%	120%	NA	70%	130%
Total Molybdenum	1798113		<2	<2	NA	< 2	90%	80%	120%	96%	80%	120%	104%	70%	130%
Total Nickel	1798113		7	7	NA	< 2	97%	80%	120%	95%	80%	120%	122%	70%	130%
Total Phosphorous	1798113		0.02	<0.02	NA	< 0.02	117%	80%	120%	114%	80%	120%	117%	70%	130%
Total Selenium	1798113		<1	<1	NA	< 1	106%	80%	120%	105%	80%	120%	107%	70%	130%

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AGAT Laboratories

Quality Assurance

CLIENT NAME: CBCL LIMITED | AGAT WORK ORDER: 20K687486
PROJECT: 203000.00 | ATTENTION TO: Greg Sheppard
SAMPLING SITE: | SAMPLED BY:

Water Analysis (Continued)

RPT Date: Dec 17, 2020			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Total Silver	1798113		<0.1	<0.1	NA	< 0.1	93%	80%	120%	92%	80%	120%	101%	70%	130%
Total Strontium	1798113		28	25	8.8%	< 5	96%	80%	120%	97%	80%	120%	NA	70%	130%
Total Thallium	1798113		<0.1	<0.1	NA	< 0.1	102%	80%	120%	98%	80%	120%	109%	70%	130%
Total Tin	1798113		<2	<2	NA	< 2	97%	80%	120%	91%	80%	120%	96%	70%	130%
Total Titanium	1798113		4	4	NA	< 2	100%	80%	120%	99%	80%	120%	119%	70%	130%
Total Uranium	1798113		<0.1	<0.1	NA	< 0.1	100%	80%	120%	99%	80%	120%	112%	70%	130%
Total Vanadium	1798113		<2	<2	NA	< 2	92%	80%	120%	93%	80%	120%	104%	70%	130%
Total Zinc	1798113		15	13	NA	< 5	98%	80%	120%	98%	80%	120%	100%	70%	130%

Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.
Reference Material: Less than 10% of elements not within acceptance limits.

DOC															
Dissolved Organic Carbon	1794638		1.4	1.46	NA	< 0.5	90%	80%	120%	NA	80%	120%	80%	80%	120%

Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By:

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QA Violation

CLIENT NAME: CBCL LIMITED | AGAT WORK ORDER: 20K687486

PROJECT: 203000.00 | ATTENTION TO: Greg Sheppard

RPT Date: Dec 17, 2020			REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Sample Id	Sample Description	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
				Lower	Upper		Lower	Upper		Lower	Upper
Standard Water Analysis + Total Metals											
Total Antimony		BTP	77%	80%	120%	97%	80%	120%	97%	70%	130%

Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.
Reference Material: Less than 10% of elements not within acceptance limits.

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Method Summary

CLIENT NAME: CBCL LIMITED
PROJECT: 203000.00
SAMPLING SITE:

AGAT WORK ORDER: 20K687486
ATTENTION TO: Greg Sheppard
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Dissolved Organic Carbon	INOR-121-6026	SM 5310 B	TOC ANALYZER
pH	INOR-121-6001	SM 4500 H+B	PC TITRATE
Reactive Silica as SiO2	INOR-121-6027	SM 4500-SiO2 F	COLORIMETER
Chloride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Fluoride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Sulphate	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Alkalinity	INOR-121-6001	SM 2320 B	
True Color	INOR-121-6008	SM 2120 B	LACHAT FIA
Turbidity	INOR-121-6022	SM 2130 B	NEPHELOMETER
Electrical Conductivity	INOR-121-6001	SM 2510 B	PC TITRATE
Nitrate + Nitrite as N	INORG-121-6005	SM 4110 B	CALCULATION
Nitrate as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Ammonia as N	INOR-121-6047	SM 4500-NH3 H	COLORIMETER
Total Organic Carbon	INOR-121-6026	SM 5310 B	TOC ANALYZER
Ortho-Phosphate as P	INOR-121-6012	SM 4500-P G	COLORIMETER
Total Sodium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Potassium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Calcium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Magnesium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Bicarb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC TITRATE
Carb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC TITRATE
Hydroxide	INORG-121-6001	SM 2320 B	PC-TITRATE
Calculated TDS	CALCULATION	SM 1030E	CALCULATION
Hardness	CALCULATION	SM 2340B	CALCULATION
Langelier Index (@20C)	CALCULATION	CALCULATION	CALCULATION
Langelier Index (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 20C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Anion Sum	CALCULATION	SM 1030E	CALCULATION
Cation sum	CALCULATION	SM 1030E	CALCULATION
% Difference/ Ion Balance	CALCULATION	SM 1030E	CALCULATION
Total Aluminum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Antimony	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Arsenic	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Barium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Beryllium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Bismuth	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Boron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Cadmium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS

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Method Summary

CLIENT NAME: CBCL LIMITED
PROJECT: 203000.00
SAMPLING SITE:

AGAT WORK ORDER: 20K687486
ATTENTION TO: Greg Sheppard
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Total Chromium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Cobalt	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Copper	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Iron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Lead	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Manganese	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Molybdenum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Nickel	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Phosphorous	MET-121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Selenium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Silver	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Strontium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Thallium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Tin	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Titanium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Uranium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Vanadium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Zinc	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS

AGAT Laboratories

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Chain of Custody Record

Laboratory Use Only

Arrival Condition: ☒ Good ☐ Poor (see notes)
Arrival Temperature: 8.4, 8.9, 9.5
Hold Time:
AGAT Job Number: 20K687486
Notes:

Report Information

Company: CBCL
Contact: Greg Sheppard
Address: 187 Kenmount Rd
St. John's NL
Phone: 364 8623 Fax:
Client Project #: 203000.00
AGAT Quotation:
Please Note: If quotation number is not provided client will be billed full price for analysis.

Report Information (Please print):

1. Name: Greg Sheppard
Email: gregs@cbcl.ca
2. Name:
Email:

Report Format

☐ Single Sample per page
☐ Multiple Samples per page
☐ Excel Format Included
☐ Export

Turnaround Time Required (TAT)

Regular TAT ☑ 5 to 7 working days
Rush TAT ☐ Same day ☐ 1 day ☐ 2 days ☐ 3 days
Date Required:

Regulatory Requirements (Check):

☐ List Guidelines on Report ☐ Do not list Guidelines on Report
☐ PIRI
☐ Tier 1 ☐ Res ☐ Pot ☐ Coarse
☐ Tier 2 ☐ Com ☐ N/Pot ☐ Fine
☐ Gas ☐ Fuel ☐ Lube
☐ CCME ☐ CDWQ
☐ Industrial ☐ NSEQS-Cont Sites
☐ Commercial
☐ Res/Park ☐ HRM 101
☐ Agricultural ☐ Storm Water
☐ FWAL ☐ Waste Water
☐ Sediment ☐ Other

Drinking Water Sample: ☐ Yes ☐ No **Salt Water Sample** ☐ Yes ☐ No
Reg. No.:

Invoice To Same Yes ☑ / No ☐

Company:
Contact:
Address:
Phone: Fax:
PO/Credit Card#:

Sample Identification	Date/Time Sampled	Sample Matrix	# Containers	Comments – Site/Sample Info. Sample Containment	Field Filtered/Preserved	Standard Water Analysis	Metals: ☒ Total ☐ Diss ☐ Available	Mercury	☐ BOD ☐ CBOD	pH	☐ TSS ☐ TDS ☐ VSS	TKN	Total Phosphorus	Phenols	Tier 1: TPH/BTEX (PIRI) ☐ low level	Tier 2: TPH/BTEX Fractionation	CCME-CWS TPH/BTEX	VOC	THM	HAA	PAH	PCB	TC + EC ☐ P/A ☐ MPN ☐ MF	☐ HPC ☐ Pseudomonas	Fecal Coliform ☐ MPN ☐ MF	Other: DOC	Other:	Hazardous (Y/N)
1 (BTP)	9/12/20 10:30		1			X																						
2 (BTP)	" "		1			X																						
3 (BTP)	" "		1			✓	X																					
Blank no label (BTP)	" "		1																							X		
5 (Thomson)	" 11:00		1			X																						
6 (TP)	" "		1			X																						
7 (TP)	" "		1				X																					
Blank no label (TP)	" "		1																							X		

Samples Relinquished By (Print Name): Riley Tanner Date/Time:
Samples Relinquished By (Sign): [signature] Date/Time:
Samples Received By (Print Name): [signature] Date/Time: Re 8/1130
Samples Received By (Sign): Date/Time:

Pink Copy - Client
Yellow Copy - AGAT
White Copy - AGAT

Page [ ] of [ ]
Nº:

Document ID: DIV-78-1502.002
Date Issued: May 18, 2016

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CLIENT NAME:	CBCL LIMITED 187 KENMOUNT ROAD ST.JOHN'S, NL A1B3P9 (709) 364-8623
ATTENTION TO:	Greg Sheppard
PROJECT:	203000.00
AGAT WORK ORDER:	21K724164
WATER ANALYSIS REVIEWED BY:	Marta Manka, Data Reporter
DATE REPORTED:	Apr 01, 2021
PAGES (INCLUDING COVER):	10
VERSION*:	1

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*Notes

Disclaimer:

- All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.
- All samples will be disposed of within 30 days following analysis, unless expressly agreed otherwise in writing. Please contact your Client Project Manager if you require additional sample storage time.
- AGAT's liability in connection with any delay, performance or non-performance of these services is only to the Client and does not extend to any other third party. Unless expressly agreed otherwise in writing, AGAT's liability is limited to the actual cost of the specific analysis or analyses included in the services.
- This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
- The test results reported herewith relate only to the samples as received by the laboratory.
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- All reportable information as specified by ISO/IEC 17025:2017 is available from AGAT Laboratories upon request.

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Western Enviro-Agricultural Laboratory Association (WEALA)
Environmental Services Association of Alberta (ESAA)

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Certificate of Analysis

AGAT WORK ORDER: 21K724164
PROJECT: 203000.00

CLIENT NAME: CBCL LIMITED
ATTENTION TO: Greg Sheppard
SAMPLING SITE:
SAMPLED BY:

DOC

DATE RECEIVED: 2021-03-22
DATE REPORTED: 2021-04-01

			SAMPLE DESCRIPTION:	THOMAS POND 1	BIG TRIANGLE POND 1
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	2021-03-22 11:00	2021-03-22 10:00
Parameter	Unit	G / S	RDL	2241862	2241873
Dissolved Organic Carbon	mg/L		0.5	6.1	5.4

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
Analysis performed at AGAT Halifax (unless marked by *)

Certified By: Marta Manta

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AGAT WORK ORDER: 21K724164
PROJECT: 203000.00

CLIENT NAME: CBCL LIMITED
ATTENTION TO: Greg Sheppard
SAMPLING SITE:
SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2021-03-22
DATE REPORTED: 2021-04-01

			SAMPLE DESCRIPTION:	THOMAS POND 1	BIG TRIANGLE POND 1
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	2021-03-22 11:00	2021-03-22 10:00
Parameter	Unit	G / S	RDL	2241862	2241873
pH				5.88	6.48
Reactive Silica as SiO2	mg/L		0.5	2.6	2.8
Chloride	mg/L		1	6	6
Fluoride	mg/L		0.12	<0.12	<0.12
Sulphate	mg/L		2	<2	<2
Alkalinity	mg/L		5	<5	7
True Color	TCU		5.00	45.1	48.0
Turbidity	NTU		0.5	1.3	0.8
Electrical Conductivity	umho/cm		1	29	41
Nitrate + Nitrite as N	mg/L		0.05	<0.05	<0.05
Nitrate as N	mg/L		0.05	<0.05	<0.05
Nitrite as N	mg/L		0.05	<0.05	<0.05
Ammonia as N	mg/L		0.03	<0.03	<0.03
Total Organic Carbon	mg/L		0.5	6.3	5.6
Ortho-Phosphate as P	mg/L		0.01	0.01	0.01
Total Sodium	mg/L		0.1	3.4	4.0
Total Potassium	mg/L		0.1	0.3	0.4
Total Calcium	mg/L		0.1	0.9	2.4
Total Magnesium	mg/L		0.1	0.5	0.6
Bicarb. Alkalinity (as CaCO3)	mg/L		5	<5	7
Carb. Alkalinity (as CaCO3)	mg/L		10	<10	<10
Hydroxide	mg/L		5	<5	<5
Calculated TDS	mg/L		1	12	18
Hardness	mg/L			4.3	8.5
Langelier Index (@20C)	NA			-4.98	-3.81
Langelier Index (@ 4C)	NA			-5.30	-4.13
Saturation pH (@ 20C)	NA			10.9	10.3
Saturation pH (@ 4C)	NA			11.2	10.6

Certified By: Marta Manta

Certificate of Analysis

AGAT WORK ORDER: 21K724164
PROJECT: 203000.00

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CLIENT NAME: CBCL LIMITED
ATTENTION TO: Greg Sheppard
SAMPLING SITE:
SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2021-03-22
DATE REPORTED: 2021-04-01

			SAMPLE DESCRIPTION:	THOMAS POND 1	BIG TRIANGLE POND 1
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	2021-03-22 11:00	2021-03-22 10:00
Parameter	Unit	G / S	RDL	2241862	2241873
Anion Sum	me/L			0.17	0.31
Cation sum	me/L			0.27	0.37
% Difference/ Ion Balance	%			23.3	9.1
Total Aluminum	ug/L		5	112	108
Total Antimony	ug/L		2	<2	<2
Total Arsenic	ug/L		2	<2	<2
Total Barium	ug/L		5	<5	9
Total Beryllium	ug/L		2	<2	<2
Total Bismuth	ug/L		2	<2	<2
Total Boron	ug/L		5	<5	<5
Total Cadmium	ug/L		0.017	<0.017	<0.017
Total Chromium	ug/L		1	<1	<1
Total Cobalt	ug/L		1	<1	<1
Total Copper	ug/L		1	3	<1
Total Iron	ug/L		50	422	138
Total Lead	ug/L		0.5	<0.5	<0.5
Total Manganese	ug/L		2	43	14
Total Molybdenum	ug/L		2	<2	<2
Total Nickel	ug/L		2	<2	<2
Total Phosphorous	mg/L		0.02	0.02	<0.02
Total Selenium	ug/L		1	<1	<1
Total Silver	ug/L		0.1	<0.1	<0.1
Total Strontium	ug/L		5	<5	12
Total Thallium	ug/L		0.1	<0.1	<0.1
Total Tin	ug/L		2	<2	<2
Total Titanium	ug/L		2	2	<2
Total Uranium	ug/L		0.2	<0.2	<0.2
Total Vanadium	ug/L		2	<2	<2

Certified By: Marta Manta

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Certificate of Analysis

AGAT WORK ORDER: 21K724164
PROJECT: 203000.00

CLIENT NAME: CBCL LIMITED
SAMPLING SITE:

ATTENTION TO: Greg Sheppard
SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2021-03-22

DATE REPORTED: 2021-04-01

			SAMPLE DESCRIPTION:	THOMAS POND 1	BIG TRIANGLE POND 1
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	2021-03-22 11:00	2021-03-22 10:00
Parameter	Unit	G / S	RDL	2241862	2241873
Total Zinc	ug/L		5	<5	<5

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

2241862-2241873 % Difference / Ion Balance, Hardness, Langelier Index, Nitrate + Nitrite, Hydroxide and Saturation pH are calculated parameters. The calculated parameters are non-accredited. The component parameters of the calculations are accredited.

The cation and anion sums are at, or below, 1 me/L, therefore the acceptable criteria is a difference of less than 0.3me/L.

Analysis performed at AGAT Halifax (unless marked by *)

Certified By: Marta Manta

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Quality Assurance

CLIENT NAME: CBCL LIMITED
PROJECT: 203000.00
SAMPLING SITE:

AGAT WORK ORDER: 21K724164
ATTENTION TO: Greg Sheppard
SAMPLED BY:

Water Analysis

RPT Date: Apr 01, 2021			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Standard Water Analysis + Total Metals															
pH	2260835		6.90	6.92	0.3%	<	100%	80%	120%	NA			NA		
Reactive Silica as SiO2	2252765		14.8	15.7	6.1%	< 0.5	97%	80%	120%	109%	80%	120%	114%	80%	120%
Chloride	2258688		50	51	1.7%	< 1	96%	80%	120%	NA	80%	120%	NA	70%	130%
Fluoride	2258688		0.88	0.90	1.6%	< 0.12	108%	80%	120%	NA	80%	120%	90%	70%	130%
Sulphate	2258688		8	8	NA	< 2	105%	80%	120%	NA	80%	120%	105%	70%	130%
Alkalinity	2260835		22	21	NA	< 5	95%	80%	120%	NA			NA		
True Color	2252765		<5.00	<5.00	NA	< 5	92%	80%	120%	96%	80%	120%	NA		
Turbidity	2263562		193	196	1.5%	< 0.5	96%	80%	120%	NA			NA		
Electrical Conductivity	2260835		150	145	3.1%	< 1	102%	90%	110%	NA			NA		
Nitrate as N	2258688		<0.05	<0.05	NA	< 0.05	97%	80%	120%	NA	80%	120%	97%	70%	130%
Nitrite as N	2258688		<0.05	<0.05	NA	< 0.05	104%	80%	120%	NA	80%	120%	93%	70%	130%
Ammonia as N	2251153		<0.03	<0.03	NA	< 0.03	100%	80%	120%	102%	80%	120%	102%	70%	130%
Total Organic Carbon	2251377		7.3	7.7	5.7%	< 0.5	84%	80%	120%	NA	80%	120%	NA	80%	120%
Ortho-Phosphate as P	2252765		0.03	0.02	NA	< 0.01	80%	80%	120%	81%	80%	120%	89%	80%	120%
Total Sodium	2252089		5.1	5.2	2.2%	< 0.1	103%	80%	120%	106%	80%	120%	NA	70%	130%
Total Potassium	2252089		<0.1	<0.1	NA	< 0.1	104%	80%	120%	110%	80%	120%	109%	70%	130%
Total Calcium	2252089		<0.1	<0.1	NA	< 0.1	99%	80%	120%	107%	80%	120%	116%	70%	130%
Total Magnesium	2252089		<0.1	<0.1	NA	< 0.1	101%	80%	120%	108%	80%	120%	107%	70%	130%
Bicarb. Alkalinity (as CaCO3)	2260835		22	21	NA	< 5	NA	80%	120%	NA			NA		
Carb. Alkalinity (as CaCO3)	2260835		<10	<10	NA	< 10	NA	80%	120%	NA			NA		
Hydroxide	2260835		<5	<5	NA	< 5	NA	80%	120%	NA			NA		
Total Aluminum	2252089		5	6	NA	< 5	97%	80%	120%	109%	80%	120%	108%	70%	130%
Total Antimony	2252089		<2	<2	NA	< 2	99%	80%	120%	106%	80%	120%	97%	70%	130%
Total Arsenic	2252089		204	216	5.7%	< 2	98%	80%	120%	96%	80%	120%	NA	70%	130%
Total Barium	2252089		6	6	NA	< 5	103%	80%	120%	108%	80%	120%	115%	70%	130%
Total Beryllium	2252089		<2	<2	NA	< 2	102%	80%	120%	107%	80%	120%	95%	70%	130%
Total Bismuth	2252089		<2	<2	NA	< 2	100%	80%	120%	106%	80%	120%	100%	70%	130%
Total Boron	2252089		27	28	4.0%	< 5	101%	80%	120%	105%	80%	120%	105%	70%	130%
Total Cadmium	2252089		<0.017	<0.017	NA	< 0.017	99%	80%	120%	104%	80%	120%	97%	70%	130%
Total Chromium	2252089		<1	<1	NA	< 1	96%	80%	120%	103%	80%	120%	97%	70%	130%
Total Cobalt	2252089		<1	<1	NA	< 1	98%	80%	120%	103%	80%	120%	102%	70%	130%
Total Copper	2252089		6	2	NA	< 1	100%	80%	120%	106%	80%	120%	88%	70%	130%
Total Iron	2252089		545	571	4.8%	< 50	102%	80%	120%	107%	80%	120%	NA	70%	130%
Total Lead	2252089		0.8	0.7	NA	< 0.5	98%	80%	120%	103%	80%	120%	98%	70%	130%
Total Manganese	2252089		4	4	NA	< 2	101%	80%	120%	105%	80%	120%	109%	70%	130%
Total Molybdenum	2252089		<2	<2	NA	< 2	95%	80%	120%	99%	80%	120%	101%	70%	130%
Total Nickel	2252089		<2	<2	NA	< 2	98%	80%	120%	109%	80%	120%	103%	70%	130%
Total Phosphorous	2252089		0.03	0.03	NA	< 0.02	106%	80%	120%	110%	80%	120%	94%	70%	130%
Total Selenium	2252089		<1	<1	NA	< 1	96%	80%	120%	98%	80%	120%	86%	70%	130%

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Quality Assurance

CLIENT NAME: CBCL LIMITED
PROJECT: 203000.00
SAMPLING SITE:

AGAT WORK ORDER: 21K724164
ATTENTION TO: Greg Sheppard
SAMPLED BY:

Water Analysis (Continued)

RPT Date: Apr 01, 2021			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Total Silver	2252089		<0.1	<0.1	NA	< 0.1	100%	80%	120%	101%	80%	120%	100%	70%	130%
Total Strontium	2252089		<5	<5	NA	< 5	100%	80%	120%	104%	80%	120%	108%	70%	130%
Total Thallium	2252089		<0.1	<0.1	NA	< 0.1	95%	80%	120%	100%	80%	120%	97%	70%	130%
Total Tin	2252089		<2	<2	NA	< 2	99%	80%	120%	103%	80%	120%	100%	70%	130%
Total Titanium	2252089		<2	<2	NA	< 2	100%	80%	120%	107%	80%	120%	111%	70%	130%
Total Uranium	2252089		<0.2	<0.2	NA	< 0.2	98%	80%	120%	104%	80%	120%	100%	70%	130%
Total Vanadium	2252089		<2	<2	NA	< 2	95%	80%	120%	100%	80%	120%	97%	70%	130%
Total Zinc	2252089		28	27	5.2%	< 5	99%	80%	120%	104%	80%	120%	90%	70%	130%

Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

DOC															
Dissolved Organic Carbon	2251377		7.3	7.7	5.3%	< 0.5	84%	80%	120%	NA	80%	120%	NA	80%	120%

Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By: Marta Manta

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Method Summary

CLIENT NAME: CBCL LIMITED
AGAT WORK ORDER: 21K724164
PROJECT: 203000.00
ATTENTION TO: Greg Sheppard
SAMPLING SITE:
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Dissolved Organic Carbon	INOR-121-6026	SM 5310 B	TOC ANALYZER
pH	INOR-121-6001	SM 4500 H+B	PC TITRATE
Reactive Silica as SiO2	INOR-121-6027	SM 4500-SiO2 F	COLORIMETER
Chloride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Fluoride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Sulphate	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Alkalinity	INOR-121-6001	SM 2320 B	
True Color	INOR-121-6008	SM 2120 B	LACHAT FIA
Turbidity	INOR-121-6022	SM 2130 B	NEPHELOMETER
Electrical Conductivity	INOR-121-6001	SM 2510 B	PC TITRATE
Nitrate + Nitrite as N	INORG-121-6005	SM 4110 B	CALCULATION
Nitrate as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Ammonia as N	INOR-121-6047	SM 4500-NH3 H	COLORIMETER
Total Organic Carbon	INOR-121-6026	SM 5310 B	TOC ANALYZER
Ortho-Phosphate as P	INOR-121-6012	SM 4500-P G	COLORIMETER
Total Sodium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Potassium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Calcium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Magnesium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Bicarb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC TITRATE
Carb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC TITRATE
Hydroxide	INORG-121-6001	SM 2320 B	PC-TITRATE
Calculated TDS	CALCULATION	SM 1030E	CALCULATION
Hardness	CALCULATION	SM 2340B	CALCULATION
Langelier Index (@20C)	CALCULATION	CALCULATION	CALCULATION
Langelier Index (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 20C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Anion Sum	CALCULATION	SM 1030E	CALCULATION
Cation sum	CALCULATION	SM 1030E	CALCULATION
% Difference/ Ion Balance	CALCULATION	SM 1030E	CALCULATION
Total Aluminum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Antimony	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Arsenic	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Barium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Beryllium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Bismuth	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Boron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Cadmium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS

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Method Summary

CLIENT NAME: CBCL LIMITED
PROJECT: 203000.00
SAMPLING SITE:

AGAT WORK ORDER: 21K724164
ATTENTION TO: Greg Sheppard
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Total Chromium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Cobalt	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Copper	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Iron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Lead	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Manganese	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Molybdenum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Nickel	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Phosphorous	MET-121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Selenium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Silver	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Strontium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Thallium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Tin	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Titanium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Uranium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Vanadium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Zinc	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS

AGAT Laboratories

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Chain of Custody Record

P: 709.747.8573 • F: 709.747.2139

Laboratory Use Only

Arrival Condition: ☒ Good ☐ Poor (see notes)
Arrival Temperature: 8.1, 6.2, 5.6
Hold Time:
AGAT Job Number: 21K724164
Notes:

Report Information

Company: CBCL Limited
Contact: Greg Sheppard
Address: 187 Kenmount Road
St. John's NL
Phone: 709 364 8623 Fax:
Client Project #: 203000.00
AGAT Quotation:
Please Note: If quotation number is not provided client will be billed full price for analysis.

Report Information (Please print):

1. Name: Greg Sheppard
Email: gregs@cbcl.ca
2. Name: Riley Tanner
Email: rtanner@cbcl.ca

Report Format

☒ Single Sample per page
☐ Multiple Samples per page
☐ Excel Format Included

Turnaround Time Required (TAT)

Regular TAT ☒ 5 to 7 working days
Rush TAT ☐ Same day ☐ 1 day ☐ 2 days ☐ 3 days
Date Required:

Invoice To Same Yes ☒ / No ☐

Company:
Contact:
Address:
Phone: Fax:
PO/Credit Card#:

Regulatory Requirements (Check):

☐ List Guidelines on Report ☐ Do not list Guidelines on Report
☐ PIRI
☐ Tier 1 ☐ Res ☐ Pot ☐ Coarse
☐ Tier 2 ☐ Com ☐ N/Pot ☐ Fine
☐ Gas ☐ Fuel ☐ Lube
☐ CCME ☐ CDWQ
☐ Industrial ☐ NL DOEC GW
☐ Commercial
☐ Res/Park ☐ NLDOEC Discharge
☐ Agricultural
☐ FWAL
☐ Sediment ☐ Other

Drinking Water Sample: ☐ Yes ☐ No Salt Water: ☐ Yes ☐ No
Reg. No.:

Sample Identification	Date/Time Sampled	Sample Matrix	# Containers	Comments – Site/Sample Info. Sample Containment	Field Filtered/Preserved	Standard Water Analysis	Metals: ☒ Total ☐ Diss ☐ Available	Mercury	☐ BOD ☐ CBOD	pH	☐ TSS ☐ TDS ☐ VSS	TKN	Total Phosphorus	Phenols	Tier 1: TPH/BTEX (PIRI) ☐ low level	Tier 2: TPH/BTEX Fractionation	CCME-CWS TPH/BTEX	VOC	THM	HAA	NaHSO	4 PCB	TC + EC ☐ P/A ☐ MPN ☐ MF	☐ HPC ☐ Pseudomonas	Fecal Coliform ☐ MPN ☐ MF	Other: DOC	Other:	Hazardous (Y/N)
Thomas Pond 1	03/22/21 11:00		1			✓	✓																			✓		
Thomas Pond 2	03/22/21 11:00		1	hm as per																								
Thomas Pond 3	03/22/21 11:00		1	AC																								
BIG Triangle Pond 1	03/22/21 10:00		1			✓	✓																			✓		
BIG Triangle Pond 2	03/22/21 10:00		1	hm as per																								
BIG Triangle Pond 3	03/22/21 10:00		1	AC																								

Samples Relinquished By (Print Name): Riley Tanner Date/Time: 03/22/21
Samples Relinquished By (Sign): [signature] Date/Time: 03/22/21
Samples Received By (Print Name): Ryan Mackey Date/Time: Mar 22 1140
Samples Received By (Sign): [signature] Date/Time:

Pink Copy - Client
Yellow Copy - AGAT
White Copy- AGAT

Page 1 of 1
Nº:

Document ID: DIV-136-1502.003
Date revised: Nov 12 2020

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

29-March-2021

CBCL Limited
Attn : Greg Sheppard, Donna Morrison

1505 Barrington St, Suite 901
Halifax, NS
B3J 2R7,

Phone: 902-421-7241
Fax:

Date Rec. : 23 March 2021
LR Report: **CA13566-MAR21**
Reference: Project: 203000.00

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	**1: Analysis Start Date**	**2: Analysis Start Time**	**3: Analysis Completed Date**	**4: Analysis Completed Time**	**5: MDL**	**6: Thomas Pond**	**7: Triangle Pond**
Sample Date & Time						22-Mar-21 11:00	22-Mar-21 10:00
Temperature Upon Receipt [°C]	---	---	---	---	---	8.0	8.0
MIB [ng/L]	23-Mar-21	17:18	25-Mar-21	14:38	3	<3	<3
Geosmin [ng/L]	23-Mar-21	17:18	25-Mar-21	14:38	3	<3	<3
Microcystin (Quantitative) [ug/L]	26-Mar-21	14:56	26-Mar-21	17:59	0.1	<0.1	<0.1

MDL - SGS Method Detection Limit

Patti Stark
Project Specialist,
Environment, Health & Safety

OnLine LIMS

0002444808

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Dartmouth, Nova Scotia
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FAX (902)468-8924
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CLIENT NAME:	CBCL LIMITED 187 KENMOUNT ROAD ST.JOHN'S, NL A1B3P9 (709) 364-8623
ATTENTION TO:	Greg Sheppard
PROJECT:	203000.00
AGAT WORK ORDER:	21K772172
MISCELLANEOUS ANALYSIS REVIEWED BY:	Ashley Dussault, Report Writer
WATER ANALYSIS REVIEWED BY:	Ashley Dussault, Report Writer
DATE REPORTED:	Jul 20, 2021
PAGES (INCLUDING COVER):	12
VERSION*:	1

Should you require any information regarding this analysis please contact your client services representative at (902) 468-8718

*Notes

Disclaimer:
- All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.
- All samples will be disposed of within 30 days after receipt unless a Long Term Storage Agreement is signed and returned. Some specialty analysis may be exempt, please contact your Client Project Manager for details.
- AGAT's liability in connection with any delay, performance or non-performance of these services is only to the Client and does not extend to any other third party. Unless expressly agreed otherwise in writing, AGAT's liability is limited to the actual cost of the specific analysis or analyses included in the services.
- This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
- The test results reported herewith relate only to the samples as received by the laboratory.
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Western Enviro-Agricultural Laboratory Association (WEALA)
Environmental Services Association of Alberta (ESAA)

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AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 21K772172
PROJECT: 203000.00

CLIENT NAME: CBCL LIMITED
ATTENTION TO: Greg Sheppard
SAMPLING SITE:
SAMPLED BY:

Subcontracted Data Received

DATE RECEIVED: 2021-07-08
DATE REPORTED: 2021-07-20

Parameter	Unit	G / S	RDL	2715134	2715188
SAMPLE DESCRIPTION:				Thomas Pond (TP)	Big Triangle Pond (BTP)
SAMPLE TYPE:				Water	Water
DATE SAMPLED:				2021-07-08 08:30	2021-07-08 08:00
Subcontracted Data				y	y

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

Certificate of Analysis

AGAT WORK ORDER: 21K772172
PROJECT: 203000.00

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CLIENT NAME: CBCL LIMITED
SAMPLING SITE:

ATTENTION TO: Greg Sheppard
SAMPLED BY:

Chlorophyll-a in Water (µg/L)

DATE RECEIVED: 2021-07-08

DATE REPORTED: 2021-07-20

			SAMPLE DESCRIPTION:	Thomas Pond (TP)	Big Triangle Pond (BTP)
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	2021-07-08 08:30	2021-07-08 08:00
Parameter	Unit	G / S	RDL	2715134	2715188
Chlorophyll-a	µg/L		0.25	2.57	0.86

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
Analysis performed at AGAT Vancouver (unless marked by *)

Certified By: Ashley Dussault

Certificate of Analysis

AGAT WORK ORDER: 21K772172

PROJECT: 203000.00

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CLIENT NAME: CBCL LIMITED

ATTENTION TO: Greg Sheppard

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2021-07-08

DATE REPORTED: 2021-07-20

			SAMPLE DESCRIPTION:	Thomas Pond (TP)	Big Triangle Pond (BTP)
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	2021-07-08 08:30	2021-07-08 08:00
Parameter	Unit	G / S	RDL	2715134	2715188
pH				6.31	6.62
Reactive Silica as SiO2	mg/L		0.5	9.0	<0.5
Chloride	mg/L		1	5	5
Fluoride	mg/L		0.12	0.16	<0.12
Sulphate	mg/L		2	<2	<2
Alkalinity	mg/L		5	<5	11
True Color	TCU		5.00	246	6.72
Turbidity	NTU		0.5	1.2	1.0
Electrical Conductivity	umho/cm		1	30	52
Nitrate + Nitrite as N	mg/L		0.05	<0.05	<0.05
Nitrate as N	mg/L		0.05	<0.05	<0.05
Nitrite as N	mg/L		0.05	<0.05	<0.05
Ammonia as N	mg/L		0.03	<0.03	<0.03
Total Organic Carbon	mg/L		0.5	6.8	4.1
Ortho-Phosphate as P	mg/L		0.01	0.01	0.01
Total Sodium	mg/L		0.1	3.6	4.0
Total Potassium	mg/L		0.1	0.3	0.3
Total Calcium	mg/L		0.1	0.9	4.0
Total Magnesium	mg/L		0.1	0.4	0.5
Bicarb. Alkalinity (as CaCO3)	mg/L		5	<5	11
Carb. Alkalinity (as CaCO3)	mg/L		10	<10	<10
Hydroxide	mg/L		5	<5	<5
Calculated TDS	mg/L		1	11	21
Hardness	mg/L			3.9	12.0
Langelier Index (@20C)	NA			-4.54	-3.26
Langelier Index (@ 4C)	NA			-4.86	-3.57
Saturation pH (@ 20C)	NA			10.9	9.88
Saturation pH (@ 4C)	NA			11.2	10.2

Certified By: Ashley Dussault

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Certificate of Analysis

AGAT WORK ORDER: 21K772172
PROJECT: 203000.00

CLIENT NAME: CBCL LIMITED
SAMPLING SITE:

ATTENTION TO: Greg Sheppard
SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2021-07-08

DATE REPORTED: 2021-07-20

			SAMPLE DESCRIPTION:	Thomas Pond (TP)	Big Triangle Pond (BTP)
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	2021-07-08 08:30	2021-07-08 08:00
Parameter	Unit	G / S	RDL	2715134	2715188
Anion Sum	me/L			0.14	0.36
Cation sum	me/L			0.28	0.43
% Difference/ Ion Balance	%			32.4	8.6
Total Aluminum	ug/L		5	110	30
Total Antimony	ug/L		2	<2	<2
Total Arsenic	ug/L		2	<2	<2
Total Barium	ug/L		5	<5	9
Total Beryllium	ug/L		2	<2	<2
Total Bismuth	ug/L		2	<2	<2
Total Boron	ug/L		5	<5	<5
Total Cadmium	ug/L		0.09	<0.09	<0.09
Total Chromium	ug/L		1	<1	<1
Total Cobalt	ug/L		1	<1	<1
Total Copper	ug/L		1	<1	<1
Total Iron	ug/L		50	529	59
Total Lead	ug/L		0.5	1.4	<0.5
Total Manganese	ug/L		2	76	23
Total Molybdenum	ug/L		2	<2	<2
Total Nickel	ug/L		2	<2	<2
Total Phosphorous	mg/L		0.02	<0.02	<0.02
Total Selenium	ug/L		1	<1	<1
Total Silver	ug/L		0.1	<0.1	<0.1
Total Strontium	ug/L		5	<5	16
Total Thallium	ug/L		0.1	<0.1	<0.1
Total Tin	ug/L		2	<2	<2
Total Titanium	ug/L		2	2	<2
Total Uranium	ug/L		0.2	<0.2	<0.2
Total Vanadium	ug/L		2	<2	<2

Certified By: Ashley Dussault

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Certificate of Analysis

AGAT WORK ORDER: 21K772172
PROJECT: 203000.00

CLIENT NAME: CBCL LIMITED
SAMPLING SITE:

ATTENTION TO: Greg Sheppard
SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2021-07-08

DATE REPORTED: 2021-07-20

			SAMPLE DESCRIPTION:	Thomas Pond (TP)	Big Triangle Pond (BTP)
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	2021-07-08 08:30	2021-07-08 08:00
Parameter	Unit	G / S	RDL	2715134	2715188
Total Zinc	ug/L		5	<5	<5

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

2715134-2715188 % Difference / Ion Balance, Hardness, Langelier Index, Nitrate + Nitrite, Hydroxide and Saturation pH are calculated parameters. The calculated parameters are non-accredited. The component parameters of the calculations are accredited.
When the cation and anion sums are at, or below 1 me/L, the acceptable criteria is less than 0.3me/L

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

AGAT Laboratories
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Dartmouth, Nova Scotia
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TEL (902)468-8718
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http://www.agatlabs.com

Quality Assurance

CLIENT NAME: CBCL LIMITED
PROJECT: 203000.00
SAMPLING SITE:

AGAT WORK ORDER: 21K772172
ATTENTION TO: Greg Sheppard
SAMPLED BY:

Water Analysis

RPT Date: Jul 20, 2021			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Standard Water Analysis + Total Metals															
pH	2715134	2715134	6.31	5.95	5.9%	<	101%	80%	120%	NA			NA		
Reactive Silica as SiO2	2714470		10.2	10.0	1.4%	< 0.5	103%	80%	120%	99%	80%	120%	108%	80%	120%
Chloride	2714664		24	24	0.7%	< 1	95%	80%	120%	NA	80%	120%	NA	70%	130%
Fluoride	2714664		1.83	1.92	4.7%	< 0.12	108%	80%	120%	NA	80%	120%	NA	70%	130%
Sulphate	2714664		30	29	1.8%	< 2	106%	80%	120%	NA	80%	120%	NA	70%	130%
Alkalinity	2715134	2715134	<5	<5	NA	< 5	92%	80%	120%	NA			NA		
True Color	2714470		<5.00	<5.00	NA	<5	104%	80%	120%	106%	80%	120%	NA		
Turbidity	2698887		<0.5	<0.5	NA	< 0.5	95%	80%	120%	NA			NA		
Electrical Conductivity	2715134	2715134	30	31	0.3%	< 1	107%	90%	110%	NA			NA		
Nitrate as N	2714664		21.1	21.8	3.3%	< 0.05	95%	80%	120%	NA	80%	120%	NA	70%	130%
Nitrite as N	2714664		<0.05	<0.05	NA	< 0.05	104%	80%	120%	NA	80%	120%	103%	70%	130%
Ammonia as N	2716209		0.20	0.23	11.3%	< 0.03	100%	80%	120%	97%	80%	120%	103%	70%	130%
Total Organic Carbon	2716209		6.5	6.5	0.0%	< 0.5	95%	80%	120%	NA	80%	120%	89%	80%	120%
Ortho-Phosphate as P	2714470		0.01	<0.01	NA	< 0.01	96%	80%	120%	100%	80%	120%	98%	80%	120%
Total Sodium	2716432		39.8	39.4	1.0%	< 0.1	104%	80%	120%	107%	80%	120%	NA	70%	130%
Total Potassium	2716432		0.3	0.3	NA	< 0.1	102%	80%	120%	104%	80%	120%	95%	70%	130%
Total Calcium	2716432		<0.1	<0.1	NA	< 0.1	98%	80%	120%	102%	80%	120%	102%	70%	130%
Total Magnesium	2716432		<0.1	<0.1	NA	< 0.1	99%	80%	120%	102%	80%	120%	97%	70%	130%
Bicarb. Alkalinity (as CaCO3)	2715134	2715134	<5	<5	NA	< 5	NA	80%	120%	NA			NA		
Carb. Alkalinity (as CaCO3)	2715134	2715134	<10	<10	NA	< 10	NA	80%	120%	NA			NA		
Hydroxide	2715134	2715134	<5	<5	NA	< 5	NA	80%	120%	NA			NA		
Total Aluminum	2716432		17	19	NA	< 5	98%	80%	120%	102%	80%	120%	107%	70%	130%
Total Antimony	2716432		<2	<2	NA	< 2	99%	80%	120%	105%	80%	120%	104%	70%	130%
Total Arsenic	2716432		10	11	3.6%	< 2	104%	80%	120%	109%	80%	120%	NA	70%	130%
Total Barium	2716432		<5	<5	NA	< 5	92%	80%	120%	94%	80%	120%	91%	70%	130%
Total Beryllium	2716432		<2	<2	NA	< 2	100%	80%	120%	102%	80%	120%	98%	70%	130%
Total Bismuth	2716432		<2	<2	NA	< 2	103%	80%	120%	104%	80%	120%	97%	70%	130%
Total Boron	2716432		12	12	NA	< 5	98%	80%	120%	99%	80%	120%	97%	70%	130%
Total Cadmium	2716432		<0.09	<0.09	NA	< 0.09	103%	80%	120%	103%	80%	120%	103%	70%	130%
Total Chromium	2716432		<1	<1	NA	< 1	94%	80%	120%	96%	80%	120%	NA	70%	130%
Total Cobalt	2716432		<1	<1	NA	< 1	97%	80%	120%	101%	80%	120%	101%	70%	130%
Total Copper	2716432		2	2	NA	< 1	99%	80%	120%	102%	80%	120%	125%	70%	130%
Total Iron	2716432		<50	<50	NA	< 50	95%	80%	120%	99%	80%	120%	126%	70%	130%
Total Lead	2716432		<0.5	<0.5	NA	< 0.5	99%	80%	120%	103%	80%	120%	102%	70%	130%
Total Manganese	2716432		<2	<2	NA	< 2	95%	80%	120%	98%	80%	120%	102%	70%	130%
Total Molybdenum	2716432		<2	<2	NA	< 2	97%	80%	120%	100%	80%	120%	NA	70%	130%
Total Nickel	2716432		<2	<2	NA	< 2	99%	80%	120%	100%	80%	120%	118%	70%	130%
Total Phosphorous	2716432		0.20	0.20	1.0%	< 0.02	104%	80%	120%	107%	80%	120%	NA	70%	130%
Total Selenium	2716432		<1	<1	NA	< 1	113%	80%	120%	116%	80%	120%	97%	70%	130%

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Quality Assurance

CLIENT NAME: CBCL LIMITED
PROJECT: 203000.00
SAMPLING SITE:

AGAT WORK ORDER: 21K772172
ATTENTION TO: Greg Sheppard
SAMPLED BY:

Water Analysis (Continued)

RPT Date: Jul 20, 2021			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Total Silver	2716432		<0.1	<0.1	NA	< 0.1	102%	80%	120%	107%	80%	120%	105%	70%	130%
Total Strontium	2716432		<5	<5	NA	< 5	94%	80%	120%	97%	80%	120%	105%	70%	130%
Total Thallium	2716432		<0.1	<0.1	NA	< 0.1	100%	80%	120%	102%	80%	120%	98%	70%	130%
Total Tin	2716432		<2	<2	NA	< 2	100%	80%	120%	102%	80%	120%	105%	70%	130%
Total Titanium	2716432		<2	<2	NA	< 2	100%	80%	120%	102%	80%	120%	105%	70%	130%
Total Uranium	2716432		<0.2	<0.2	NA	< 0.2	98%	80%	120%	101%	80%	120%	101%	70%	130%
Total Vanadium	2716432		<2	<2	NA	< 2	95%	80%	120%	97%	80%	120%	99%	70%	130%
Total Zinc	2716432		6	7	NA	< 5	100%	80%	120%	102%	80%	120%	99%	70%	130%

Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Chlorophyll-a in Water (µg/L)															
Chlorophyll-a	2715134	2715134	891	930	4.3%	< 0.25	102%	85%	115%						

Certified By:

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Method Summary

CLIENT NAME: CBCL LIMITED
PROJECT: 203000.00
SAMPLING SITE:

AGAT WORK ORDER: 21K772172
ATTENTION TO: Greg Sheppard
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Miscellaneous Analysis			
Subcontracted Data			

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Method Summary

CLIENT NAME: CBCL LIMITED
PROJECT: 203000.00
SAMPLING SITE:
AGAT WORK ORDER: 21K772172
ATTENTION TO: Greg Sheppard
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Chlorophyll-a		SM 10200 H	SPECTROPHOTOMETER
pH	INOR-121-6001	SM 4500 H+B	PC TITRATE
Reactive Silica as SiO2	INOR-121-6027	SM 4500-SiO2 F	COLORIMETER
Chloride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Fluoride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Sulphate	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Alkalinity	INOR-121-6001	SM 2320 B	
True Color	INOR-121-6008	SM 2120 B	LACHAT FIA
Turbidity	INOR-121-6022	SM 2130 B	NEPHELOMETER
Electrical Conductivity	INOR-121-6001	SM 2510 B	PC TITRATE
Nitrate + Nitrite as N	INORG-121-6005	SM 4110 B	CALCULATION
Nitrate as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Ammonia as N	INOR-121-6047	SM 4500-NH3 H	COLORIMETER
Total Organic Carbon	INOR-121-6026	SM 5310 B	TOC ANALYZER
Ortho-Phosphate as P	INOR-121-6012	SM 4500-P G	COLORIMETER
Total Sodium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Potassium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Calcium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Magnesium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Bicarb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC TITRATE
Carb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC TITRATE
Hydroxide	INORG-121-6001	SM 2320 B	PC-TITRATE
Calculated TDS	CALCULATION	SM 1030E	CALCULATION
Hardness	CALCULATION	SM 2340B	CALCULATION
Langelier Index (@20C)	CALCULATION	CALCULATION	CALCULATION
Langelier Index (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 20C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Anion Sum	CALCULATION	SM 1030E	CALCULATION
Cation sum	CALCULATION	SM 1030E	CALCULATION
% Difference/ Ion Balance	CALCULATION	SM 1030E	CALCULATION
Total Aluminum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Antimony	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Arsenic	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Barium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Beryllium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Bismuth	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Boron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Cadmium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS

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Method Summary

CLIENT NAME: CBCL LIMITED
PROJECT: 203000.00
SAMPLING SITE:

AGAT WORK ORDER: 21K772172
ATTENTION TO: Greg Sheppard
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Total Chromium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Cobalt	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Copper	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Iron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Lead	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Manganese	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Molybdenum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Nickel	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Phosphorous	MET-121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Selenium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Silver	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Strontium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Thallium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Tin	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Titanium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Uranium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Vanadium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Zinc	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS

AGAT Laboratories

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Chain of Custody Record

Laboratory Use Only
Arrival Condition: ☑ Good ☐ Poor (see notes)
Arrival Temperature: 16.4, 16.6, 16.3
Hold Time:
AGAT Job Number: 21K772172
Notes: Collected Same day

Report Information
Company: CBCL Limited
Contact: Greg Sheppard
Address: 187 Kenmount Road
Phone: 709-364-8623 Fax:
Client Project #: 203000.00
AGAT Quotation:
Please Note: If quotation number is not provided client will be billed full price for analysis.

Report Information (Please print):
1. Name: Greg Sheppard
   Email: gregs@cbcl.ca
2. Name: Riley Tanner
   Email: rtanner@cbcl.ca

Report Format
☑ Single Sample per page
☐ Multiple Samples per page
☐ Excel Format Included
☐ Export

Turnaround Time Required (TAT)
Regular TAT ☑ 5 to 7 working days — As per RT July 8/21
Rush TAT ☐ Same day ☐ 1 day ☐ 2 days ☐ 3 days
Date Required:

Regulatory Requirements (Check):
☐ List Guidelines on Report ☐ Do not list Guidelines on Report
☐ PIRI
☐ Tier 1 ☐ Res ☐ Pot ☐ Coarse
☐ Tier 2 ☐ Com ☐ N/Pot ☐ Fine
☐ Gas ☐ Fuel ☐ Lube
☐ CCME ☐ CDWQ
☐ Industrial ☐ NSEQS-Cont Sites
☐ Commercial ☐ HRM 101
☐ Res/Park ☐ Storm Water
☐ Agricultural ☐ Waste Water
☐ FWAL
☐ Sediment ☐ Other

Drinking Water Sample: ☐ Yes ☐ No   Salt Water Sample ☐ Yes ☐ No
Reg. No.:

Invoice To Same Yes ☑ / No ☐
Company:
Contact:
Address:
Phone: Fax:
PO/Credit Card#:

Sample Identification	Date/Time Sampled	Sample Matrix	# Containers	Comments – Site/Sample Info. Sample Containment	Field Filtered/Preserved	Standard Water Analysis	Metals: ☑ Total ☐ Diss ☐ Available	Mercury	☐ BOD ☐ CBOD	pH	☐ TSS ☐ TDS ☐ VSS	TKN	Total Phosphorus	Phenols	Tier 1: TPH/BTEX (PIRI) ☐ low level	Tier 2: TPH/BTEX Fractionation	CCME-CWS TPH/BTEX	VOC	THM	HAA	PAH	PCB	TC + EC ☐ P/A ☐ MPN ☐ MF	☐ HPC ☐ Pseudomonas	Fecal Coliform ☐ MPN ☐ MF	Other: Microcystin	Other: Geosmin	Chlorophyll-a / Hazardous (Y/N)
Thomas Pond (TP)-1	8/7/21	8:30	1		■	X	X																					
TP-2	8/7/21	8:30	1			X	X																					
TP-3	8/7/21	8:30	1			X	X																					
TP-4	8/7/21	8:30	1																							X		
TP-5	8/7/21	8:30	1																								X	
TP-6	8/7/21	8:30	1																									X
Big Triangle Pond (BTP)-1	8/7/21	8:00	1			X	X																					
BTP-2	8/7/21	8:00	1			X	X																					
BTP-3	8/7/21	8:00	1			X	X																					
BTP-4	8/7/21	8:00	1																							X		
BTP-5	8/7/21	8:00	1																								X	
BTP-6	8/7/21	8:00	1																									X

Samples Relinquished By (Print Name): Riley Tanner — Date/Time: 8/7/21
Samples Relinquished By (Sign): [signature] — Date/Time: 9:00 am
Samples Received By (Print Name): [signature] July 8/21 @ — Date/Time: 8:50
Samples Received By (Sign):

Pink Copy - Client
Yellow Copy - AGAT
White Copy - AGAT

Page ___ of ___
Nº: 56810

Document ID: DIV-133-1501.004
Date revised: May 19, 2010

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

16-July-2021

AGAT Laboratories - NS
Attn : AGAT Halifax PM

Unit 122, 11 Morris Drive
Dartmouth, NS
B3B 1M2, Canada

Phone: 902-468-8751
Fax:

Date Rec. : 13 July 2021
LR Report: **CA13353-JUL21**
Reference: PO#:168914 - Agat Job#: 21K772172

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Sample ID	Sample Date & Time	Temperature Upon Receipt °C	Geosmin ng/L	MIB ng/L
1: Analysis Start Date		---	13-Jul-21	13-Jul-21
2: Analysis Start Time		---	17:05	17:05
3: Analysis Completed Date		---	15-Jul-21	15-Jul-21
4: Analysis Completed Time		---	11:32	11:32
5: QC - Blank		---	< 3	< 3
6: QC - STD % Recovery		---	95%	90%
7: QC - DUP % RPD		---	NSS	NSS
8: RL		---	3	3
9: 21K772172 - 2715134 - Thomas Pond (TP)	08-Jul-21 08:30	9.5	16	< 3
10: 21K772172 - 2715188 - Big Triangle Pond (BTP)	08-Jul-21 08:00	9.5	< 3	< 3

RL - SGS Reporting Limit
NSS - Not sufficient sample

Kimberley Didsbury
Project Specialist,
Environment, Health & Safety

OnLine LIMS

0002566177

Jar Testing Results

Thomas Pond

Alum pH 6

	Coagulant Dose (mg/L)			
	20	30	40	50
UV254	0.093	0.047	0.054	0.042
Turbidity	2.32	1.33	1.128167	0.9445
TOC				
DOC	2.864	2.14275	1.95675	1.819

Alum pH 7

	Coagulant Dose (mg/L)			
	20	30	40	50
UV254	0.087	0.048	0.044	0.041
Turbidity	1.9836	1.0116	0.986	1.736
TOC				
DOC	1.751	1.737	1.797	1.756

PACl pH 6.5

	Coagulant Dose (mg/L)			
	10	20	30	40
UV254	0.046	0.028	0.025	0.025
Turbidity	0.745	0.698	1.48025	1.523
TOC	3.0605	3.098	3.806	3.161
DOC	1.96975	1.70025	1.62775	1.63925

PACl pH 7

	Coagulant Dose (mg/L)			
	10	20	30	40
UV254	0.051	0.042	0.042	0.037
Turbidity	0.42275	0.4125	0.41825	0.43175
TOC	2.7435	2.6725	2.502	2.397
DOC	2.1455	2.039	2.0455	1.91975

Big Triangle Pond

Alum pH 6

	Coagulant Dose (mg/L)			
	20	30	40	50
UV254	0.071	0.046	0.038	0.036
Turbidity	2.438333	1.6	1.3275	1.019833
TOC				
DOC	3.4255	2.63125	2.736	2.2095

Alum pH 7

	Coagulant Dose (mg/L)			
	20	30	40	50
UV254	0.039	0.036	0.034	0.042
Turbidity	1.5695	2.123	3.55	4.4075
TOC	3.2785	2.6455	2.7095	3.314
DOC	2.376667	2.023667	1.776667	2.042333

PACl pH 6.5

	Coagulant Dose (mg/L)			
	10	20	30	40
UV254	0.030	0.025	0.023	0.023
Turbidity	0.8925	0.5795	0.63925	0.831
TOC	2.49	2.34	1.839	2.1445
DOC	1.74675	1.60725	1.49375	1.530333

PACl pH 7

	Coagulant Dose (mg/L)			
	10	20	30	40
UV254	0.040	0.031	0.030	0.029
Turbidity	0.497	0.50425	0.41875	0.67575
TOC	2.5165	2.0045	2.2185	2.0475
DOC	2.004	1.802	1.7635	1.647

APPENDIX D

Cost Opinions

DATE:	May 2, 2022
CBCL FILE No.:	203000.00
PREPARED BY:	PG
REVIEWED BY:	GS
EST. DESCRIPTION :	Conceptual

CBCL

OPINION of PROBABLE CONSTRUCTION COSTS

City of St. John's - New Regional Water Source Water Treatment Plant

Thomas Pond Location

Based on Feb 2022 sketches of potential locations

No.	DESCRIPTION		COST	RATIO
	ESTIMATED CONSTRUCTION COSTS			
1	Water Transmission Main		$ 19,100,000	
	Design Development Contingency (Item 1)	10%	$ 1,910,000	
	Prime Contractor Overhead & Fees		Included	
	Location Factor - ***Note 1***		Included	
2	Water Treatment Plant		$ 38,663,000	
3	Low Lift Pump Station, including Intake Piping		$ 8,730,000	
4	Site Work		$ 4,120,000	
	Design Development Contingency (Items 2-4)	30%	$ 15,460,000	
	Prime Contractor Overhead & Fees		Included	
	Location Factor - ***Note 1***		Included	
	ESTIMATE BEFORE CONSTRUCTION CONTINGENCY			**$87,983,000**
	Construction Contingency - ***Note 2***	15%	$ 13,198,000	
	Escalation / Inflation - (Based on Current dollars) -***Note 3***	0%	Not Included	
	TOTAL ESTIMATE OF PROBABLE COSTS (no Taxes included)			**$101,181,000**

THIS OPINION OF PROBABLE COSTS IS PRESENTED ON THE BASIS OF EXPERIENCE, QUALIFICATIONS, AND BEST JUDGEMENT. IT HAS BEEN PREPARED IN ACCORDANCE WITH ACCEPTABLE PRINCIPLES AND PRACTICES. SUDDEN MARKET TREND CHANGES, NON-COMPETITIVE BIDDING SITUATIONS, UNFORESEEN LABOUR AND MATERIAL ADJUSTMENTS, UNFORESEEN SITE CONDITIONS, AND THE LIKE ARE BEYOND THE CONTROL OF CBCL LIMITED. IT IS NOT A PREDICTION OF LOW PRICE. AS SUCH WE CANNOT WARRANT OR GUARANTEE THAT ACTUAL COSTS WILL NOT VARY FROM THE OPINION PROVIDED. IT IS BASED ON THE DATE OF THIS BUDGET.

Note 1	The Location Factor is for variances between construction costs at location of the project & historical costs data
Note 2	A Construction Contingency is to allow for changes during construction and after Contract Award
Note 3	The Escalation/Inflation allowance is for increases in construction costs from time the budget to Tender Cal

OPINION of PROBABLE CONSTRUCTION COSTS

City of St. John's - New Regional Water Source Water Treatment Plant

Big Triangle Pond Location

Based on Feb 2022 sketches of potential locations

DATE:	May 2, 2022
CBCL FILE No.:	203000.00
PREPARED BY:	PG
REVIEWED BY:	GS
EST. DESCRIPTION :	Conceptual

No.	DESCRIPTION		COST	RATIO
	ESTIMATED CONSTRUCTION COSTS			
	Water Transmission Main		$ 72,110,000	
1	Design Development Contingency (Item 1)	10%	$ 7,220,000	
	Prime Contractor Overhead & Fees		Included	
	Location Factor - ***Note 1***		Included	
2	Water Treatment Plant		$ 38,663,000	
3	Dam		$ 8,810,000	
4	Low Lift Pump Station, including Intake Piping		$ 8,730,000	
5	Site Work		$ 15,210,000	
6	Intermediate Pump Station		$ 1,250,000	
	Design Development Contingency (Items 2-6)	30%	$ 21,800,000	
	Prime Contractor Overhead & Fees		Included	
	Location Factor - ***Note 1***		Included	
	ESTIMATE BEFORE CONSTRUCTION CONTINGENCY			**$173,793,000**
	Construction Contingency - ***Note 2***	15%	$ 26,069,000	
	Escalation / Inflation - (Based on Current dollars) -***Note 3***	0%	Not Included	
	TOTAL ESTIMATE OF PROBABLE COSTS (no Taxes included)			**$199,862,000**

THIS OPINION OF PROBABLE COSTS IS PRESENTED ON THE BASIS OF EXPERIENCE, QUALIFICATIONS, AND BEST JUDGEMENT. IT HAS BEEN PREPARED IN ACCORDANCE WITH ACCEPTABLE PRINCIPLES AND PRACTICES. SUDDEN MARKET TREND CHANGES, NON-COMPETITIVE BIDDING SITUATIONS, UNFORESEEN LABOUR AND MATERIAL ADJUSTMENTS, UNFORESEEN SITE CONDITIONS, AND THE LIKE ARE BEYOND THE CONTROL OF CBCL LIMITED. IT IS NOT A PREDICTION OF LOW PRICE. AS SUCH WE CANNOT WARRANT OR GUARANTEE THAT ACTUAL COSTS WILL NOT VARY FROM THE OPINION PROVIDED. IT IS BASED ON THE DATE OF THIS BUDGET.

Note 1	The Location Factor is for variances between construction costs at location of the project & historical costs data
Note 2	A Construction Contingency is to allow for changes during construction and after Contract Award
Note 3	The Escalation/Inflation allowance is for increases in construction costs from time the budget to Tender Cal

OPINION of PROBABLE OPERATIONS COSTS

City of St. John's - New Regional Water Source Water Treatment Plant

DATE:	May 10, 2022
CBCL FILE No.:	203000.00
PREPARED BY:	MF
REVIEWED BY:	MC
EST. DESCRIPTION :	Conceptual

No.	DESCRIPTION		COST	RATIO
	ESTIMATED ANNUAL OPERATIONAL COSTS			
	Labour		$ 655,000	
	Power		$ 629,000	
	Chemical		$ 1,669,000	
	Miscellaneous		$ 190,000	
	ESTIMATED ANNUAL OPERATING COSTS			**$3,143,000**
	Operating Period (years)	20		
	Discount Rate	6%		
	NET PRESENT VALUE OF OPERATING COSTS			**$36,050,000**

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