December 2016

Lake Major Dam Replacement
Environmental Assessment Registration

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EXECUTIVE SUMMARY

Halifax Water has proposed to replace the existing Lake Major Dam in Lake Major, Nova Scotia. The new dam will consist of a concrete structure with sluiceway, spillway, and fish ladder and will have a new full supply level of 19.5 m. The proposed Project site is located 35 m upstream from the existing structure at the southern edge of Lake Major (44°42'55.35" N, 63°28'3.30" W).

The existing dam is comprised of a rock-filled timber crib structure, originally built for a private milling operation in the 1940s. Halifax Water assumed ownership of the dam in 1996 and constructed the Lake Major Water Supply Plant in 1999. A Dam Safety Review (DSR) in 2012 identified several issues of concern with the structure, recommending that consideration be given to replacement or upgrade of the dam. In 2014, a storm damaged the fish ladder, resulting in its decommissioning, and further weakening the dam. During flooding in 2015, the dam was further weakened and downstream residences were evacuated for concern of dam failure.

The proposed Lake Major Dam Replacement (the Project) is considered a Class 1 undertaking under the Nova Scotia Environmental Assessment Regulations and as such, requires a registered Environmental Assessment as identified under Schedule 'A' of the Regulations. The Environmental Assessment and the registration document have been completed according to the methodologies and requirements outlined in the document 'A Proponent's Guide to Environmental Assessment', as well as accepted best practices for conducting environmental assessments.

A number of environmental components were evaluated for this assessment. Based on field data and associated research, mitigation strategies and best management practices were identified to avoid or mitigate potential effects of the Project for the majority of the components. Following the preliminary assessment, the valued ecosystem components determined for further assessment were:

- Geophysical Environment;
- Freshwater Environment;
- Terrestrial Environment;
- Avifauna;
- Socio-Economic Environment; and
- Cultural and Heritage Resources.

The effects assessment for these components determined that residual effects are expected to be not significant. Cumulative effects were also considered to be not significant.

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LIST OF ACRONYMS

ACCDC	Atlantic Canada Conservation Data Centre
ARD	Acid Rock Drainage
BMP	Best Management Practices
CCME	Canadian Council of Ministers of the Environment
CDA	Canadian Dam Association
CEAA	*Canadian Environmental Assessment Act*
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CRM	Cultural Resource Management
CWS	Canadian Wildlife Service
DFO	Fisheries and Oceans Canada
DO	Dissolved Oxygen
DSR	Dam Safety Review
EA	Environmental Assessment
EC	Environment Canada
EPP	Environmental Protection Plan
ESC	Erosion and Sediment Control
ESCP	Erosion and Sediment Control Plan
FSL	Full Supply Level
HRM	Halifax Regional Municipality
IBA	Important Bird Area
IDF	Inflow Design Flood
MBBA	Maritime Breeding Bird Atlas
MBCA	*Migratory Birds Convention Act*
NSCCH	Nova Scotia Communities, Culture and Heritage
NSDAF	Nova Scotia Department of Agriculture and Fisheries
NSDNR	Nova Scotia Department of Natural Resources
NSE	Nova Scotia Environment
NSEA	*Nova Scotia Environment Act*
NS *ESA*	*Nova Scotia Endangered Species Act*
NSTIR	Nova Scotia Transportation and Infrastructure
PWA	Protected Water Area
RCMP	Royal Canadian Mounted Police
RQD	Rock Quality Designation
SARA	*Species at Risk Act*
SOCI	Species of Conservation Interest
SWQMP	Source Water Quality Monitoring Program
TDS	Total Dissolved Solids
TSI	Trophic State Index
VEC	Valued Ecosystem Component
WSRLLWA	Waverley-Salmon River Long Lake Wilderness Area
WAM	Wet Areas Mapping
WHMIS	Workplace Hazardous Materials Information System

1.0 INTRODUCTION

Halifax Regional Water Commission (Halifax Water) has proposed to replace the existing Lake Major Dam, located at the outflow of Lake Major, immediately upstream of Lake Major Road Bridge in Lake Major, Nova Scotia. The existing dam is comprised of a rock-filled timber crib structure, originally built for a private milling operation in the 1940s. Halifax Water assumed ownership of the dam in 1996 and constructed the Lake Major Water Supply Plant in 1999. A Dam Safety Review (DSR) in 2012 identified several issues of concern with the structure, recommending that consideration be given to replacement or upgrade of the dam. During flooding in 2015, the dam was further weakened and downstream residences were evacuated for concern of dam failure.

Following a thorough review of several design options and locations, the existing dam will be replaced with a concrete structure complete with sluiceway and fish ladder. The new dam is proposed to be located ~ 35 m upstream of the existing dam (Drawing 1.1). As a result of the replacement of the dam it is anticipated that the full supply level (FSL) in Lake Major will increase approximately 0.4 above the existing lake level.

1.1 Proponent Information

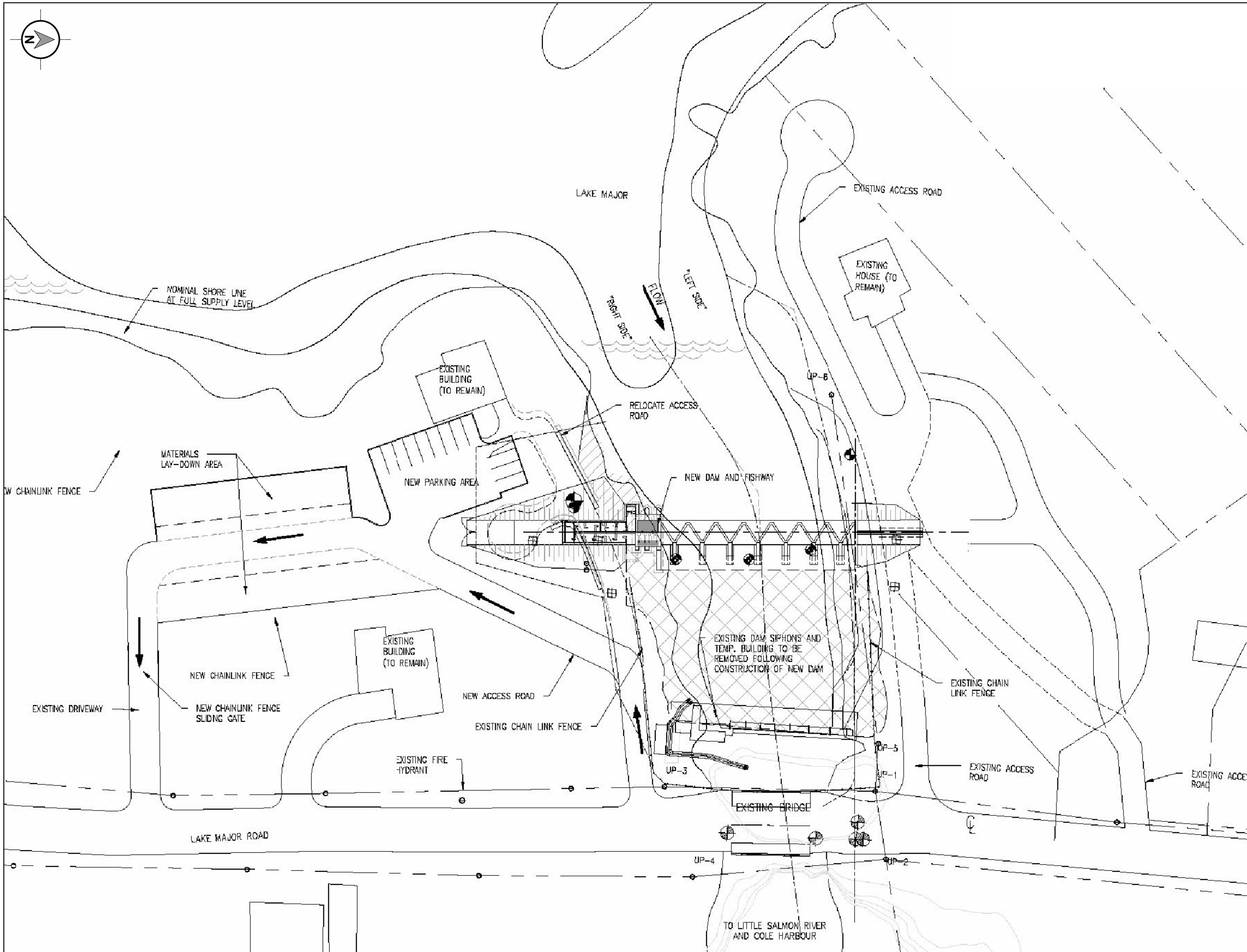
Halifax Water is the municipal water, wastewater, and stormwater utility serving the residents of the Halifax Regional Municipality (HRM), pursuant to the *Public Utilities Act*, as regulated by the Nova Scotia Utility and Review Board.

The utility is incorporated under the Halifax Regional Water Commission Act, with authority to own and operate water supply, wastewater, and stormwater facilities for the benefit of its over 80,000 customers. With respect to its property and assets, Halifax Water is a joint stock company with all of its shares deemed to be owned by HRM. Halifax Water employs approximately 450 employees, with its head office located at 450 Cowie Hill Road, Halifax, NS, with auxiliary offices throughout HRM.

Proponent and consultant contact information is provided in Table 1.1. Registry of joint stocks for the proponent company is included in Appendix A.

Table 1.1. Proponent Information

PROPONENT	
Name	Halifax Water
Address	450 Cowie Hill Road Halifax, NS B3K 5M1
Telephone	(902) 490-4820
Website	www.halifax.ca/hwc/
Proponent Contact	
Name	Jonathan MacDonald
Official Title	Project Engineer, Water Infrastructure
Address	Same as above
Telephone	(902) 818-0913
Email	jonathanm@halifaxwater.ca



KEY PLAN:
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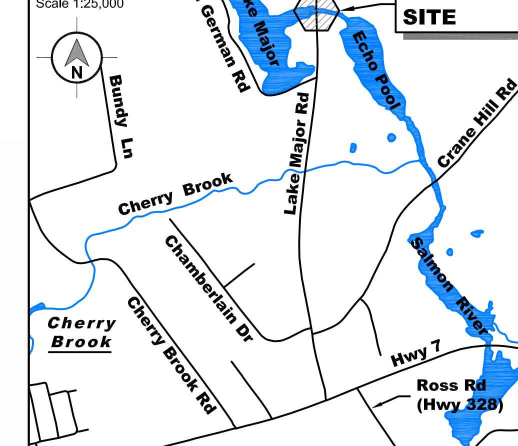


GENERAL NOTES:

1. REFERENCE: DESIGN DRAWINGS SUPPLIED BY MECO ENGINEERING.
2. PROJECTION: NAD83(CSRS), UTM ZONE 20 NORTH.
3. SITE FEATURES ARE APPROXIMATE. THIS DRAWING IS FOR GENERAL LOCATION AND PRESENTATION ONLY AND NOT INTENDED FOR LEGAL USED.
4. "RIGHT SIDE" AND "LEFT SIDE" OF DAM ARE RELATIVE TO THE FLOW DIRECTION OF WATER.

Meco

PROJECT:

LAKE MAJOR DAM REPLACEMENT

LOCATION:

LAKE MAJOR ROAD
LAKE MAJOR, NOVA SCOTIA

TITLE:

PROPOSED PROJECT

CONSULTANT:

Strum CONSULTING 20 YEARS Taking Charge

Engineering * Surveying * Environmental
Bedford * Antigonish * Moncton * Deer Lake

SCALE: H: N.T.S	V: N.T.S	
DATE: DECEMBER 2016		DRAWN: MECO
DESIGNED: MECO	CHECKED: H. MOSHER	APPR'D: S. DUNCAN
PROJECT No.: 16-5799		
DRAWING No.: 1.1		

S:\Strum Project Files\2016 Files\16-5799\Drawings\CAD Drawings\Dam Replacement EA\16-5799 - Drawing 1.1 Proposed Project.dwg

ENVIRONMENTAL CONSULTANT CONTACT	
Name	Shawn Duncan
Title	Vice-President
Address	1355 Bedford Hwy Bedford, NS B4A 1C5
Telephone	(902) 835-5560
Fax	(902) 835-5574
Email	sduncan@strum.com

1.2 Project Information

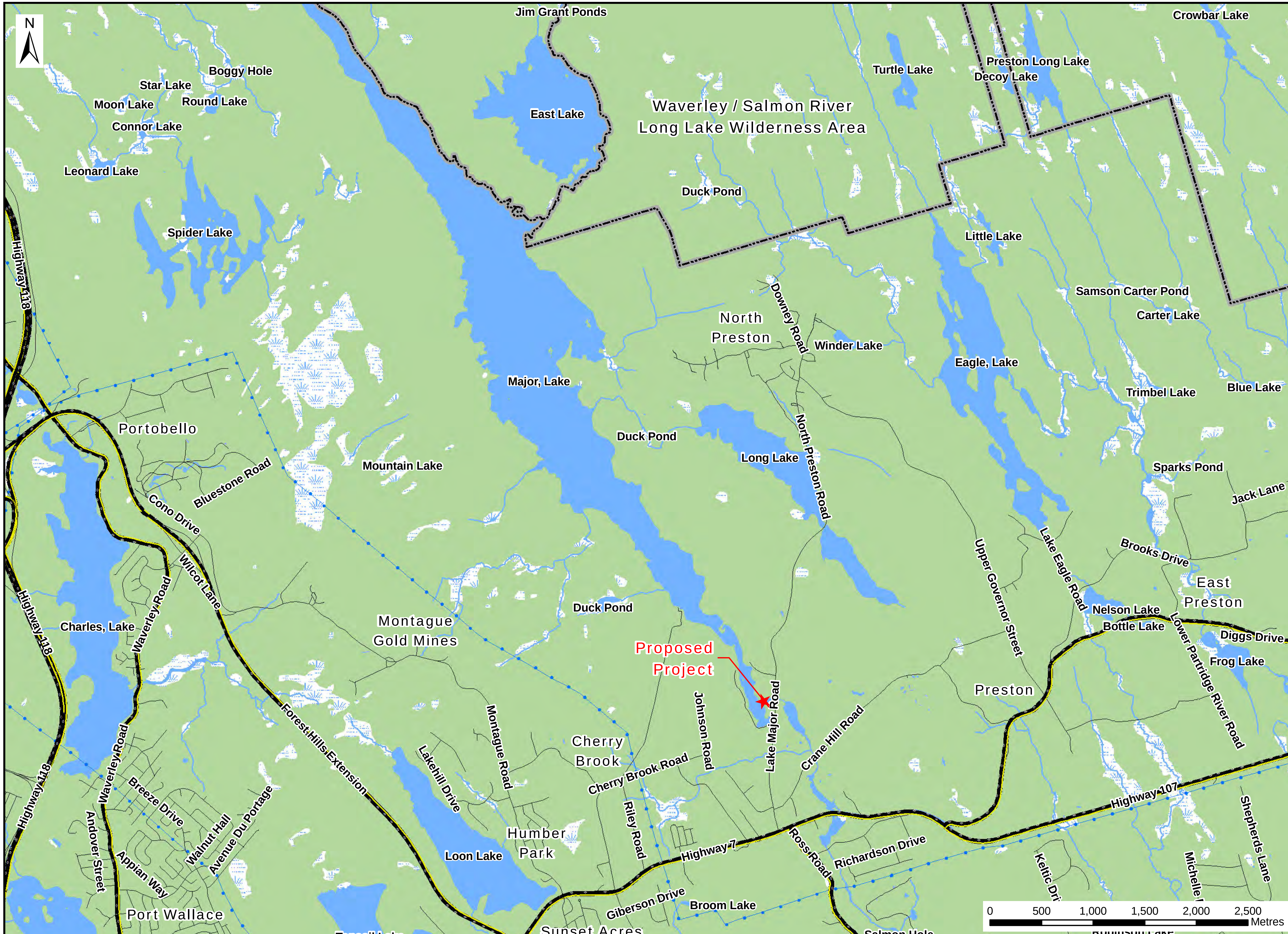
Name of the Undertaking: Lake Major Dam Replacement ('the Project')
Location of the Undertaking: Lake Major, Nova Scotia

The Project is located in Lake Major in the HRM (Drawing 1.2). The Study Area encompasses the area surrounding Lake Major consisting of the properties listed in Table 1.2 (Drawing 1.3).

Table 1.2. Properties Adjacent to Lake Major

Property Identification Number (PID)	Land Owner	Civic Address
41040593	Crown Land	Three Mile Lake, Waverley
40747149	Crown Land	Spider Lake, Waverley
40164717	Halifax Water	Lake Major, Waverley
40164725	Halifax Water	
40164824	Crown Land	
40164709	Halifax Water	
40164758	Halifax Water	
40164691	Halifax Water	
40164808	Halifax Water	
40164733	Halifax Water	
40164816	Halifax Water	
40164790	Crown Land	
40164683	Halifax Water	
40225575	Halifax Water	Lake Major, Portobello
40225559	Halifax Water	Lake Major, Montague Gold Mines
40225617	Halifax Water	
00653584	Halifax Water	Cherry Brook Road, Lake Loon
40612442	Halifax Water	Lake Major, North Preston
40818569	Henry Cain	Simmonds Road, North Preston
40168247	Halifax Water	Reddy Drive, Westphal
40139891	Halifax Water	
00495143	Halifax Water	

Property Identification Number (PID)	Land Owner	Civic Address
00653618	Halifax Water	Old German Road, Lake Major
00653550	Halifax Water	
00653543	Halifax Water	
00653105	Halifax Water	
00653642	Halifax Water	
00653295	Halifax Water	
00653527	Halifax Water	
00653535	Mabel Mary McMenemy; John Reginal McMenemy	
00653204	Mabel Mary McMenemy; John Reginal McMenemy	
00653394	Halifax Water	
00653675	Halifax Regional Municipality	
00653048	Halifax Water	
00653386	Cyril L Sullivan; Peter F Ritchie; Mary Christine Ritchie; Joanne Marie Ritchie; Peter Francis Ritchie; Maria Therese Alley; Victoria Marie Ritchie; Cyril Lawrence Sullivan; Stephen Douglas Sullivan; Daniel Frederick Sullivan; Patricia Ann Emmett: Terence Cyril Sullivan	
00653329	Robert Patrick Power	
00653154	Halifax Water	
00653469	Halifax Water	
00653477	Halifax Water	
00653436	Halifax Water	
00653147	Halifax Water	
00653287	Halifax Water	
00653253	Halifax Water	
00653592	Halifax Water	
40554289	Halifax Water	
40554297	Halifax Water	
00653196	Halifax Water	
00653410	Halifax Water	Lake Major Road, Lake Major
00653428	Halifax Water	
00653097	Halifax Water	
00653626	Halifax Water	
00653966	Halifax Water	
40166498	Halifax Water	
40166506	Halifax Water	
40169013	Halifax Water	
40168312	Halifax Water	
40168270	Halifax Water	
40184756	Halifax Water	



Notes:

1. Reference: Digital Topogrpahic Mapping by Nova Scotia Geomatics Centre.
2. Projection: NAD83(CSRS), UTM Zone 20 North

Legend:

- Game Management
- Public Roads
- Major Roads and Highways
- Existing Transmission Lines
- Mapped Stream
- Mapped Wet Areas
- Water Bodies

Lake Major Dam Replacement - Site Location

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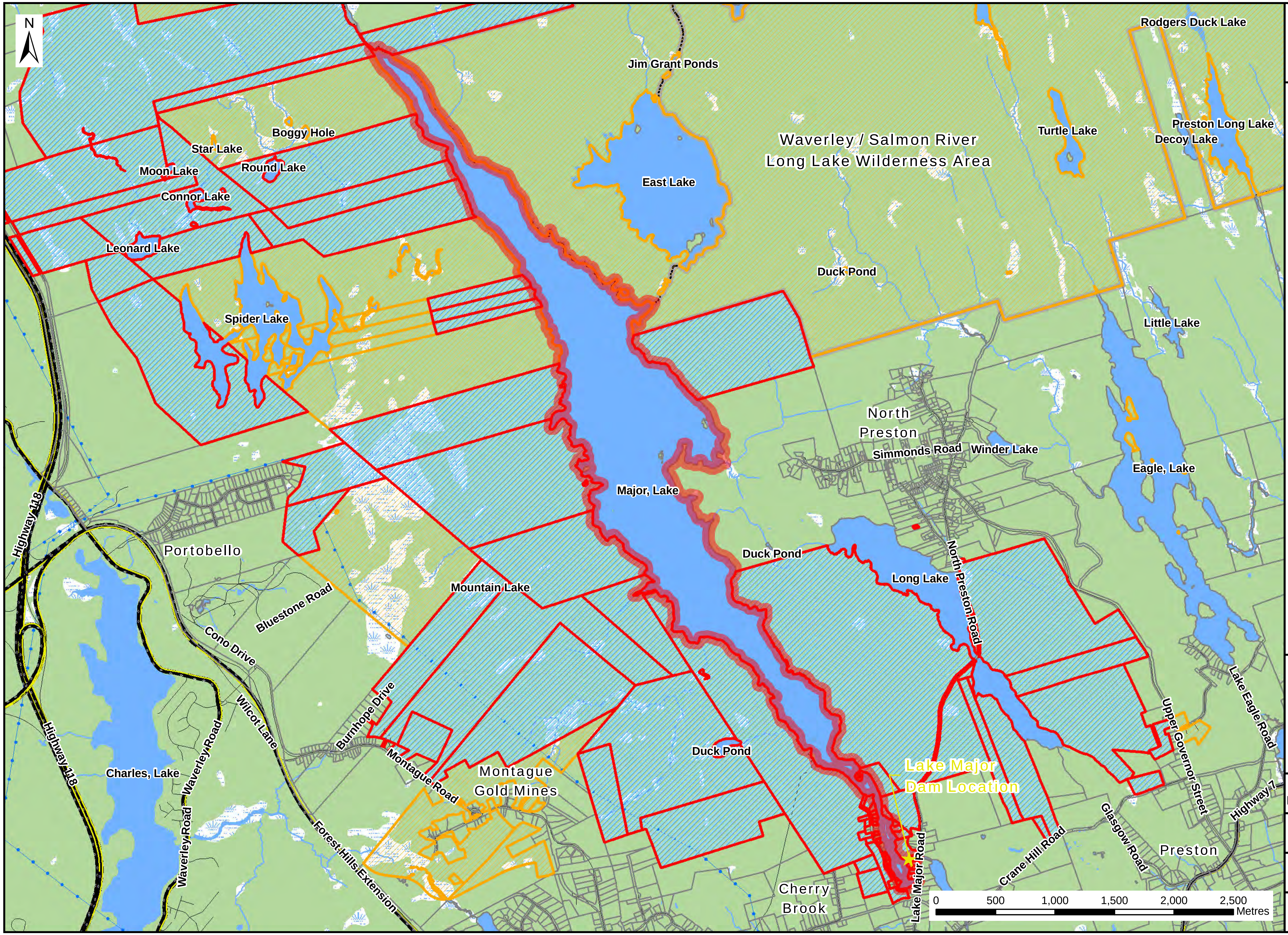
*Bedford * Antigonish * Moncton * Deer Lake*

Date: December 2016	Project #: 16-5799
Scale: 1:35,000	Drawing #: 1.2
Drawn By: H. Serhan	
Checked By: H. Mosher	



Notes:

1. Reference: Digital Topogrpahic Mapping by Nova Scotia Geomatics Centre.
2. Projection: NAD83(CSRS), UTM Zone 20 North

Legend:

- Study Area
- Hlifax Water Commission
- Crown Land
- Privately Owned Lands
- Game Management
- Public Roads
- Major Roads and Highways
- Existing Transmission Lines
- Mapped Stream
- Mapped Wet Areas
- Water Bodies

Lake Major Dam Replacement - Land Ownership

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*Bedford * Antigonish * Moncton * Deer Lake*

Date: December 2016	Project #: 16-5799
Scale: 1:30,000	Drawing #: 1.3
Drawn By: H. Serhan	
Checked By: H. Mosher	

1.3 Purpose and Need for the Project

The existing Lake Major Dam is located upstream of the Lake Major Road bridge. It was originally built for a private milling operation in the 1940s and consists of rock-filled timber crib overflow abutments and central overflow spillway with a vertical slot fish ladder at the right abutment. Halifax Water assumed ownership of the dam in 1996 and constructed the Lake Major Water Supply Plant in 1999.

A dam safety review was completed for the Lake Major Dam in 2012 and recommended that the dam be classified as a High Consequence structure. The review identified a range of issues associated with structural integrity of the dam, including significant deterioration of certain timber dam members that compromised the internal rigidity of the structure. It was recommended that the dam be replaced or upgraded.

The dam was equipped with a timber fish ladder. During flooding in 2015, the fish ladder was damaged and was assessed as unstable and liable to collapse. They were able to temporarily stabilize the structure by infilling the fishway with rockfill and by applying shotcrete under the existing timbers. A fish pump and syphon system was installed in 2015 to provide short-term fish passage over the dam during migratory periods. However, the pump and syphon is not a permanent fixture and there is no fish passage available during the year except during migratory periods when it is deployed. A permanent fish passage structure is required.

Additionally, the existing dam does not have multi-year storage and all water is either consumed by customers, discharged as riparian flow, or as spill over the spillway crest. The dry summer of 2016 exemplified the necessity of having multi-year storage to ensure a consistent water supply to Dartmouth even during dry periods. The new dam will also incorporate greater flood control of downstream waters to accommodate extreme precipitation events.

1.4 Regulatory Framework

1.4.1 Federal

A federal EA is not required for the Project as it is not located on federal land or listed as a physical activity that constitutes a "designated project" as listed under the Regulations Designating Physical Activities of the *Canadian Environmental Assessment Act (CEAA) (*2012)*.*
Additional federal requirements are provided in Section 15.0.

1.4.2 Provincial

The Project is subject to a Class 1 EA as defined by the Environmental Assessment Regulations under the Nova Scotia *Environment Act (*NS*EA)* due to the potential impact to greater than 2.0 hectares of wetland habitat. As such, the proponents are required to register the Project with Nova Scotia Environment (NSE) and subsequently comply with the Class 1 registration process as defined by the document “A Proponent’s Guide to Environmental Assessment” (NSE 2014).

Lake Major is the public water supply for Dartmouth, Cole Harbour, Eastern Passage, Westphal, Cherry Brook, North Preston, and Montague Gold Mines (HRM 2015a). Designated as a Protected Water Area (PWA) in 1986, the Lake Major Watershed encompasses approximately 7000 hectares, and is protected under the Lake Major Watershed Protected Water Area Regulations (NS Reg. 57/86) of the NS*EA*. These regulations set restrictions on all activities within the PWA such as recreational activities, vehicles/vessels, fishing, forestry, chemical application, landfills, construction of corridors, soil erosion and sedimentation controls, and road building and maintenance. Project-related activities are subject to the PWA regulations cited above.

Approximately 30% of the designated watershed area is part of the Waverley-Salmon River Long Lake Wilderness Area and protected under the Wilderness Areas Protection Act (1998). The Waverley Game Sanctuary also overlaps approximately 30% of the watershed area and has associated designation and regulations under the Wildlife Act (NS Reg. 84/74).

The use of provincial roads during the construction, operation, and decommissioning phases of the Project will be in compliance with the “Nova Scotia Temporary Workplace Traffic Control Manual” (NSTIR 2009).

Additional provincial permits will be required as outlined in Section 12.0.

1.4.3 Municipal

Lands surrounding Lake Major fall within four municipal planning areas. Adjacent lands south of Lake Major and along the southeastern boundary lie within the North Preston, Lake Major, Lake Loon, Cherry Brook, and East Preston Plan Area. Land surrounding the central portion of Lake Major and extending along the west-southwestern border of the lake are situated within the Cole Harbour/Westphal Plan Area. The majority of land surrounding the northern portion of Lake Major is within Planning Districts 14 & 17 (Shubenacadie Lakes) with the exception of a 260 m portion of the shoreline along the northeastern boundary which lies within Planning District 8 & 9 (Lake Echo/Porters Lake). Each plan area has their own set of land use policies and by-laws which specifically apply to them. The following Municipal Planning Strategies and Land Use By-Laws are applicable to lands surrounding Lake Major:

- Municipal Planning Strategy for North Preston, Lake Major, Lake Loon, Cherry Brook, and East Preston (HRM 1993);
- Land Use By-Law North Preston, Lake Major, Lake Loon, Cherry Brook, East Preston (HRM 2014);
- Municipal Planning Strategy for Cole Harbour/Westphal (HRM 2012);
- Land Use By-Law Cole Harbour/Westphal (HRM 2016a);
- Municipal Planning Strategy Planning Districts 14/17 (Shubenacadie Lakes) (HRM 2016b);
- Land Use By-Law Planning District 14/17 (Shubenacadie Lakes) (HRM 2016c);
- Municipal Planning Strategy Planning Districts 8 & 9 (Lake Echo/Porters Lake) (HRM 2006); and
- Land Use By-Law Planning Districts 8 & 9 (Lake Echo/Porters Lake) (HRM 2015b).

All required municipal permits (Section 12.0) and approvals will be obtained prior to construction.

1.5 Scope of the EA

EA is a planning tool used to predict the environmental effects of a proposed project, identify measures to mitigate adverse environmental effects, and predict whether there will be significant adverse environmental effect after mitigation is implemented. The methodology used in this EA has been developed to meet the requirements of the NS*EA*. This framework is based on a structured approach that:

- focuses on issues of greatest concern;
- considers Aboriginal concerns as well as concerns raised by the public and other stakeholders; and
- integrates mitigative measures into Project design.

The EA provides an overview of the baseline conditions and individual Project components. Within the specified spatial and temporal boundaries, potential interactions between the Project and the environment are identified for the determination of Valued Ecosystem Components (VECs) that reflect key issues of concern. Project effects on individual VECs is assessed using the results of preliminary investigations, guidance from regulators, and the collective knowledge and expertise of the Project team. The ultimate focus of the assessment is on residual environmental effects that remain after planned mitigation has been applied.

1.5.1 Spatial and Temporal Boundaries

The spatial limitations of the EA include Lake Major, the land surrounding the lake that may be impacted by the anticipated rise in water level, and the area of downstream watercourse between the existing dam and the Lake Major Road bridge (Drawing 1.4).

The temporal limitations of the EA extend from site preparation and construction, through operation and decommissioning. It is expected that the new dam's lifespan should exceed 60 years.

2.0 PROJECT DESCRIPTION

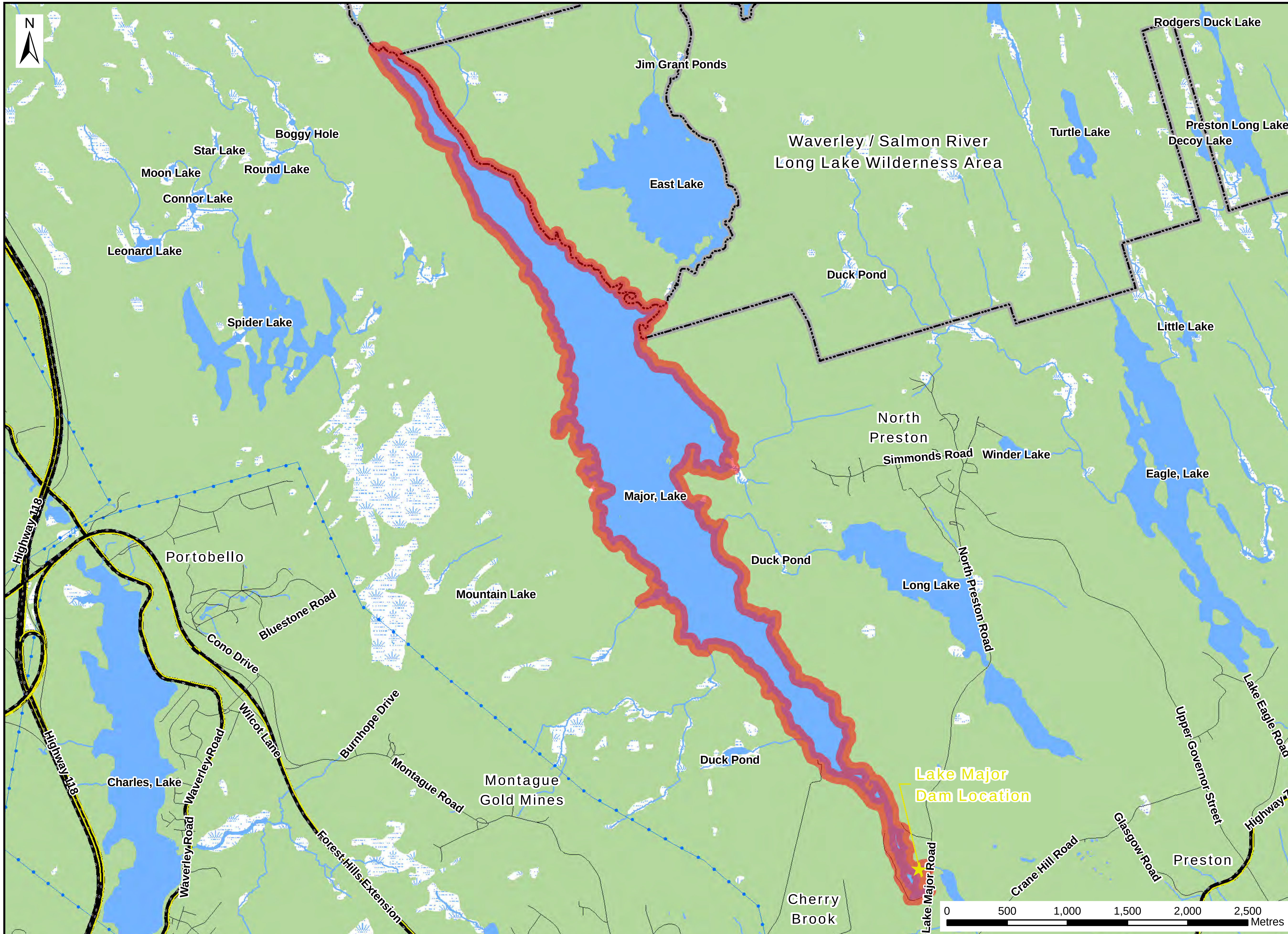
The proposed new dam is a low overflow dam that behaves according to historical patterns. Riparian flow requirements can be achieved with conventional discharge structures, including an overflow spillway and fish ladder, as well as the culvert near the intersection of Old German Road. Design details and Project components are described in the following sections.

2.1 Proposed Dam Design

The proposed new dam will continue to be a water supply dam intended to meet functional, technical, and aesthetic requirements of Halifax Water and the residents of Dartmouth (Table 2.1).

Table 2.1. Dam Requirements

Functional Requirements	Maintain fish passage upstream and downstream of the dam.
	Retain as much water as possible and only spill during periods of excess inflow.
	Safely discharge an inflow design flood (IDF) with a peak equal to one-third the difference between a flood with an annual exceedence probability of 1,000 years and probably maximum flood.



Notes:

1. Reference: Digital Topogrpahic Mapping by Nova Scotia Geomatics Centre.
2. Projection: NAD83(CSRS), UTM Zone 20 North

Legend:

- Study Area
- Game Management
- Public Roads
- Major Roads and Highways
- Existing Transmission Lines
- Mapped Stream
- Mapped Wet Areas
- Water Bodies

Lake Major Dam Replacement - Study Area

Strum CONSULTING 20 YEARS Taking Charge

*Engineering * Surveying * Environmental*
*Bedford * Antigonish * Moncton * Deer Lake*

Date: December 2016	Project #: 16-5799
Scale: 1:30,000	Drawing #: **1.4**
Drawn By: H. Serhan	
Checked By: H. Mosher	

Technical Requirements	Maintain an adequate factor of safety is required for different load combinations defined in the Canadian Dam Association (CDA) Guidelines.
	Resultant of all forces should be in the middle third of the base for normal load conditions and the middle half for all other loading events.
	Have adequate freeboard to mitigate against internal erosion, erosion of the foundation and erosion of the shell.
	Incorporate special considerations for frost penetration, vertical and horizontal deformation, and susceptibility to vibration loading.
	Embankment structures will have an adequate factor of safety for slope stability, adequate freeboard at the crest and adequate internal controls to mitigate risk of internal erosion of the dam and foundation.
Aesthetics Requirements	Appear neat, articulate and balanced.
	Fit into the surrounding environment by either enhancing it or melting into it.

The proposed new dam consists of four components: left and right abutments, spillway, sluiceway and fishway (Drawing 2.1). The total footprint of the new dam will be 450 m^2. The primary construction material will be reinforced concrete, but the dam will be blended with the natural environment with earthfill abutments and a rock filled energy dissipation zone downstream of the spillway. Thru structure should blend into the existing environment as a linear landform with a local relief of about 3 m. All structures, including the fishway, spillway, and sluiceway, directly discharge square to the main dam axis. The structure is compact with neat lines and will fit into the existing landscape.

Concrete is a common dam construction material as it is largely resistant to erosion and can respond to large loads without deformation. With a concrete construction, the lifespan of the new dam is expected to exceed fifty years. Creating the new dam from wood components, to mimic the existing dam, is not feasible as a ban on using treated timber at a water supply will reduce the lifespan of the new dam.

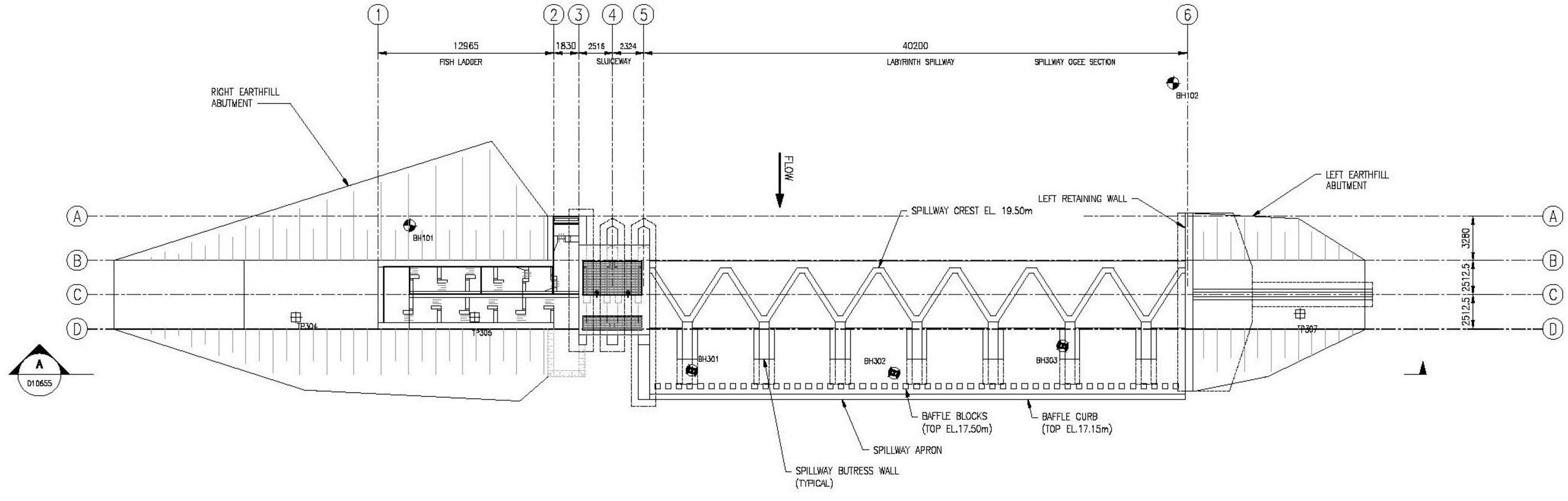
2.1.1 Left and Right Abutments

The left and right abutments consist of cantilevered retaining walls extending upstream and downstream flanked to natural grade by a zoned embankment dam (elevation 21.5 m). The main stem of the cantilevers section will be 0.5 m thick (+/-) while the base width will vary as per stability needs, generally assumed to be 80% of the wall height. The embankment will slope 2:5:1 on the upstream and 2:2:1 on the downstream, and have a combined blanked and chimney filter.

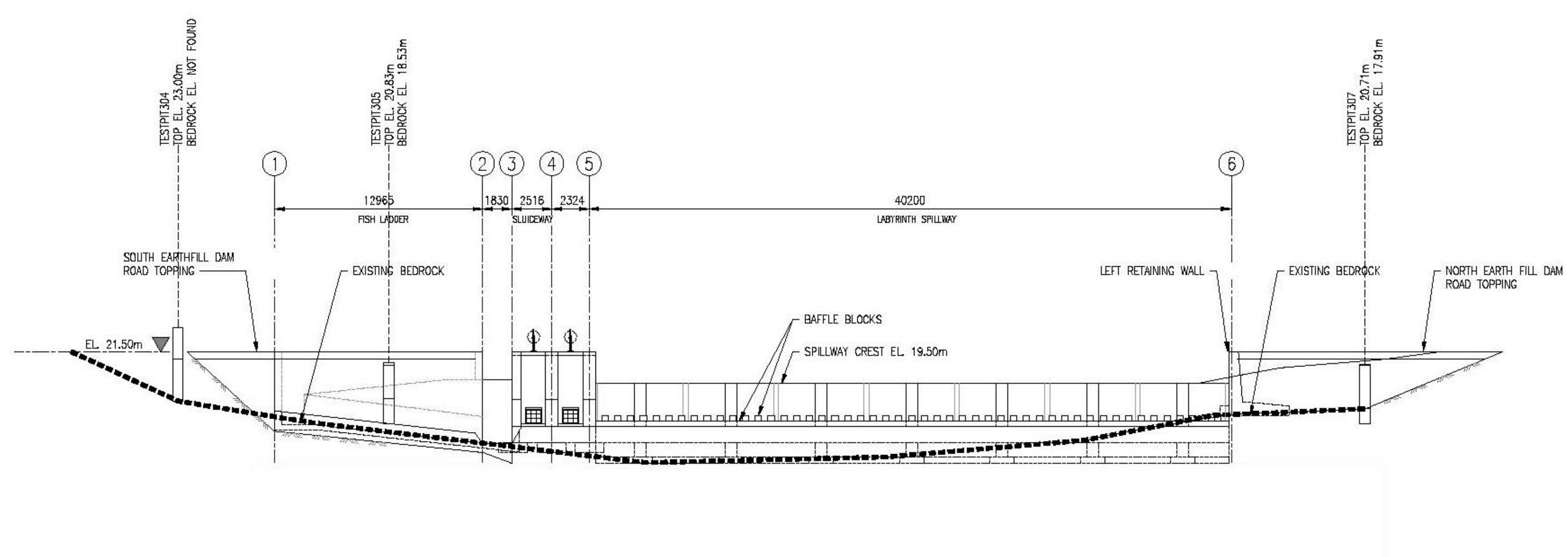
The upstream slope will be protected by riprap. Downstream fill will consist of a rock fill mattress sized to sustain plunging action of the water from the spillway control.

2.1.2 Spillway and Sluiceway

The proposed spillway is a labyrinth overflow weir structure that uses geometry of the weir shape to enhance spillway discharge per unit length. Labyrinth structures are more effective when capacity to surcharge the reservoir is limited, as is the case at Lake Major. The spillway crest will be located at 19.5 m elevation and will maintain a FSL of 19.4 m (an increase from 19.0 in the existing dam). This



PLAN - GENERAL ARRANGEMENT



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010655
PROFILE - GENERAL ARRANGEMENT

GENERAL NOTES:

1. REFERENCE: DESIGN DRAWINGS SUPPLIED BY MECO ENGINEERING.
2. THIS DRAWING IS A GENERAL PLAN AND PROFILE FOR PRESENTATION ONLY AND NOT INTENDED FOR LEGAL USED.
3. OPERATING LEVELS = 17.5m TO 19.5m.
   MAXIMUM FLOOR LEVEL = 20.5m.

Meco

PROJECT:

LAKE MAJOR DAM REPLACEMENT

LOCATION:

LAKE MAJOR ROAD
LAKE MAJOR, NOVA SCOTIA

TITLE:

PROPOSED DAM PLAN AND PROFILE

CONSULTANT:

Strum CONSULTING 20 YEARS Taking Charge

Engineering * Surveying * Environmental
Bedford * Antigonish * Moncton * Deer Lake

SCALE: H: N.T.S	V: N.T.S	
DATE: DECEMBER 2016		DRAWN: MECO
DESIGNED: MECO	CHECKED: H. MOSHER	APPR'D: S. DUNCAN
PROJECT No.: 16-5799		
DRAWING No.: **2.1**		

S:\Strum Project Files\2016 Files\16-5799\Drawings\CAD Drawings\Dam Replacement EA\16-5799 - Drawing 2.1 Dam Plan & Profile.dwg will increase yield of the system and allow the dam to pass a 1 in 100 year storm event without the risk of flooding the pump station, which is located at 20.0 m elevation.

The spillway includes two low level vertical lift gate sluice structure, each 1 m^2. Annual flows and environmental maintenance flows will be discharged through the sluice structures, with larger flow events discharging over the labyrinth weir. Downstream of the weir and gates, an energy dissipation slab is constructed to manage erosion from discharge of the flood waters.

2.1.3 Fishway

The main fish species requiring passage at the Lake Major Dam is Gaspereau (*Alosa pseudoharengus)*, although Brook Trout (*Salvelinus fontinalis*) and American Eel (*Anguilla rostrata*) will also make their way up Salmon River and require passage at the dam. The proposed fish passage will consist of a pool and weir structure, similar to the current fishway design, but incorporating an adjustable weir profile to compensate for the variable water levels in Lake Major during periods of low flow (Drawings 2.2A and 2.2B).

The Fishway will require approximately 15 cells, with a drop of 200 mm between cells. This is a decrease from the 290 mm drops present in the current structure, due to the recommended requirements for Gaspereau. The final number of cells will vary depending on the final head drop across the dam. The overall slope will be 10% (+/-).

Each pool in the fishway is 1.8 m x 1.8 m and is to have a minimum depth of 0.9 m, identical to the existing fishway. The weir height at the entrance is adjustable to an elevation of 18.5 m. Below reservoir elevations of 18.5 m, the fishway is inoperable. The structure is being founded on bedrock with ballast between. The substrate for each pool will be either concrete or rock ballast.

2.2 Project Components

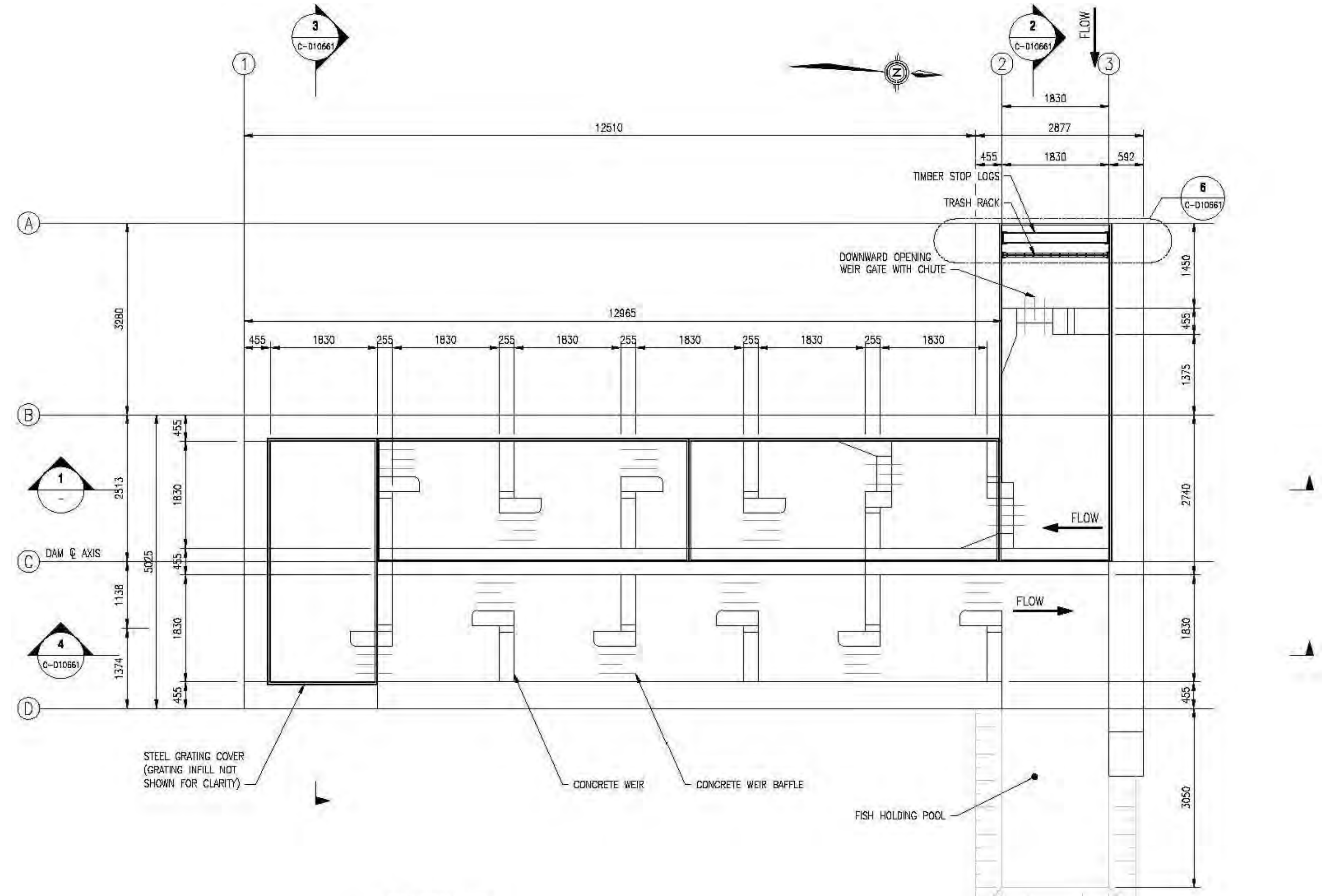
2.2.1 Construction

Project construction will involve construction of the new dam, followed by the decommissioning of the existing dam and will be completed in four phases:

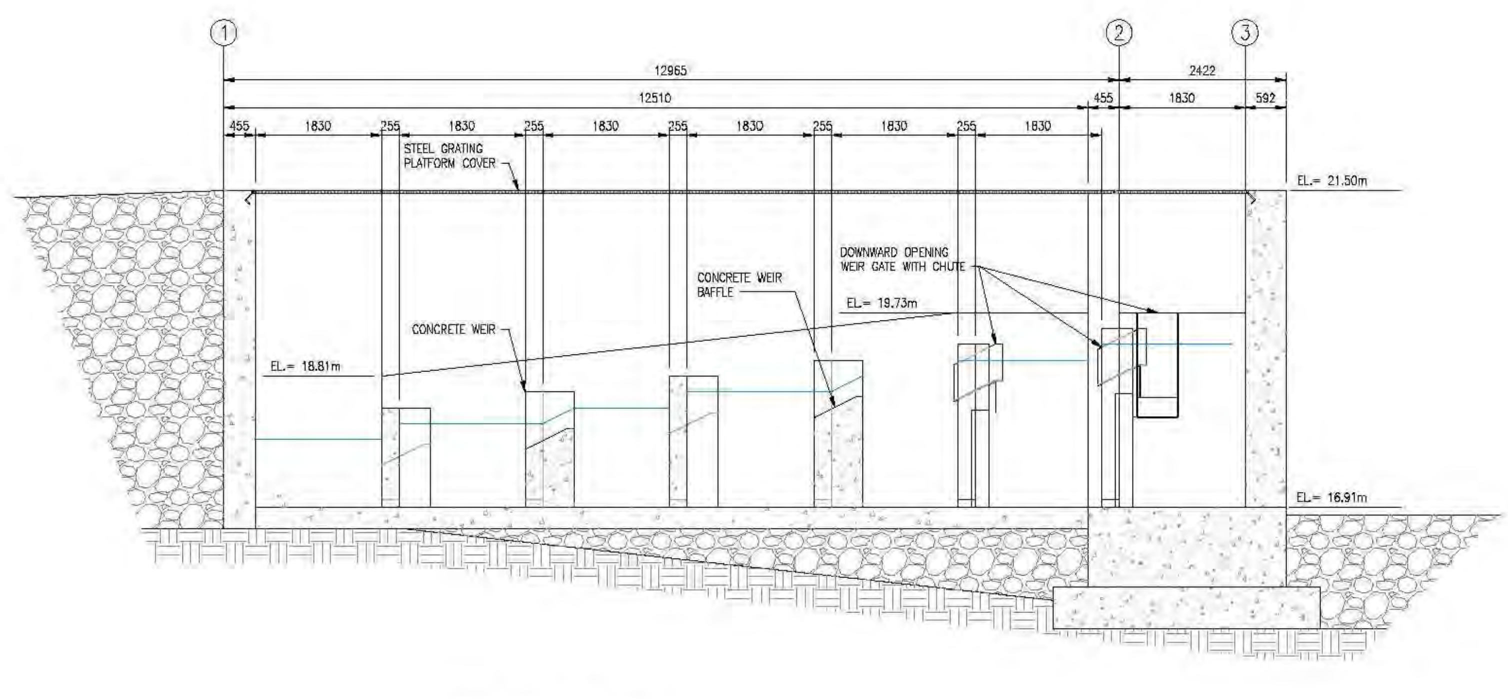
- Phase 1: A sand bag cofferdam, approximately 250 m^2 in area, will be installed at the site of the new dam, isolating the left hand of the channel (Appendix B). The left portion of the dam, consisting of the fish ladder and the sluicegate, will be constructed within the area of the cofferdam. The cofferdam will be dewatered and silt will be excavated to bedrock at an elevation of approximately 10.5 m. New concrete foundation will be poured on the bedrock and will be continued for the rest of the superstructure. Water flow will be unrestricted in the right portion of the channel, providing fish passage during Phase 1 of construction.
- Phase 2: Upon completion of Phase 1, the cofferdam will be transferred to the right side of the channel. Dewatering and excavation to bedrock will follow, with the pouring of a concrete foundation. Fish passage during this phase will be provided via the fish ladder on the left side of the new dam, and the sluice gate will allow normal water flow to occur during construction.

GENERAL NOTES:

1. REFERENCE: DESIGN DRAWINGS SUPPLIED BY MECO ENGINEERING.
2. THIS DRAWING IS A GENERAL PLAN AND SECTION FOR PRESENTATION ONLY AND NOT INTENDED FOR LEGAL USED.



PLAN - FISH LADDER



1 SECTION- FISH LADDER

PROJECT:

LAKE MAJOR DAM REPLACEMENT

LOCATION:

LAKE MAJOR ROAD
LAKE MAJOR, NOVA SCOTIA

TITLE:

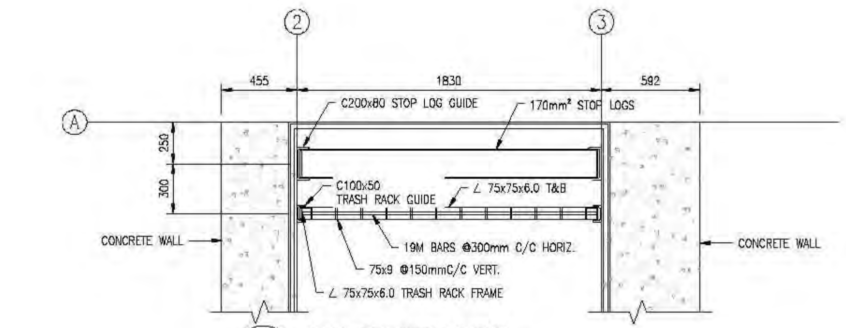
FISH LADDER PLAN AND SECTION

CONSULTANT:

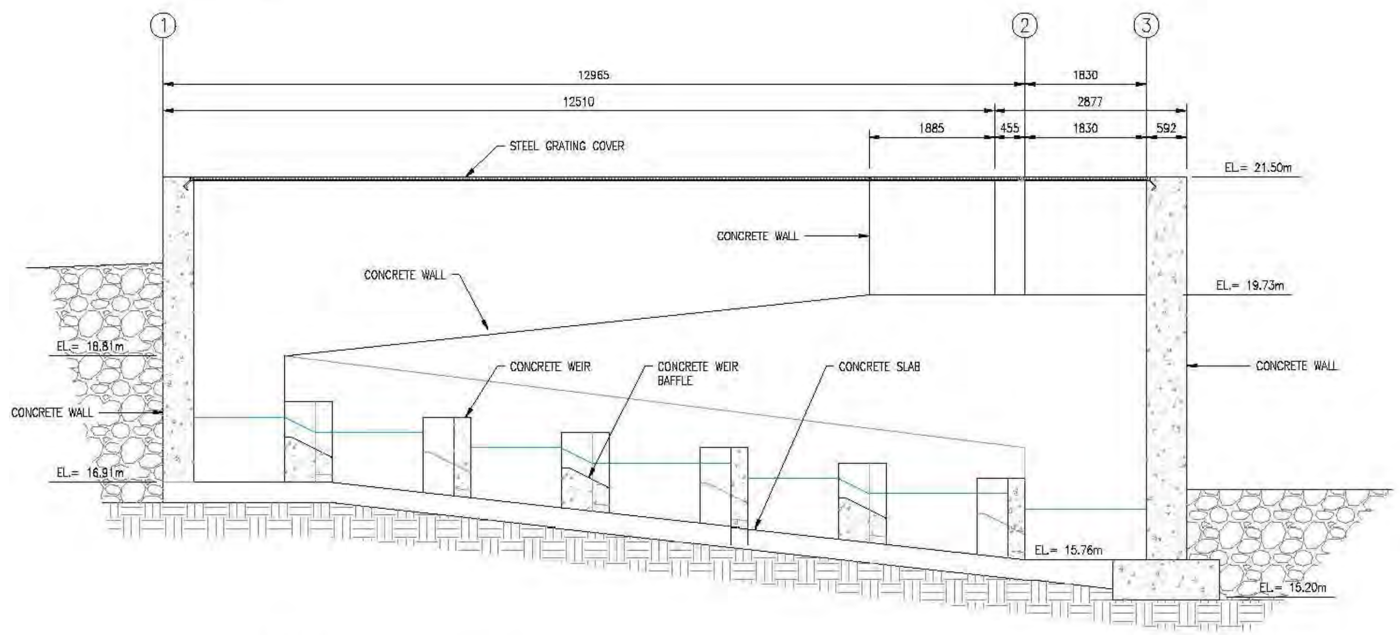
Strum Consulting — 20 Years Taking Charge

Engineering * Surveying * Environmental
Bedford * Antigonish * Moncton * Deer Lake

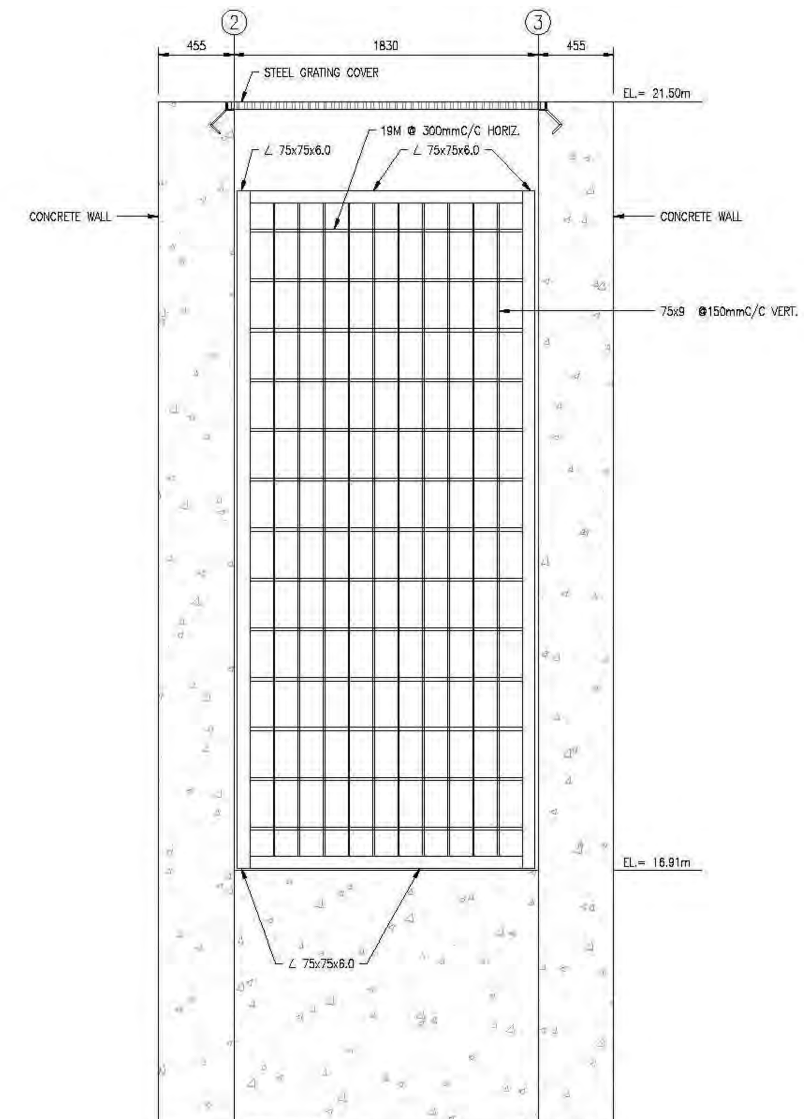
SCALE: H: N.T.S		V: N.T.S
DATE: DECEMBER 2016		DRAWN: MECO
DESIGNED: MECO	CHECKED: H. MOSHER	APPR'D: S. DUNCAN
PROJECT No.: 16-5799		
DRAWING No.: 2.2A		



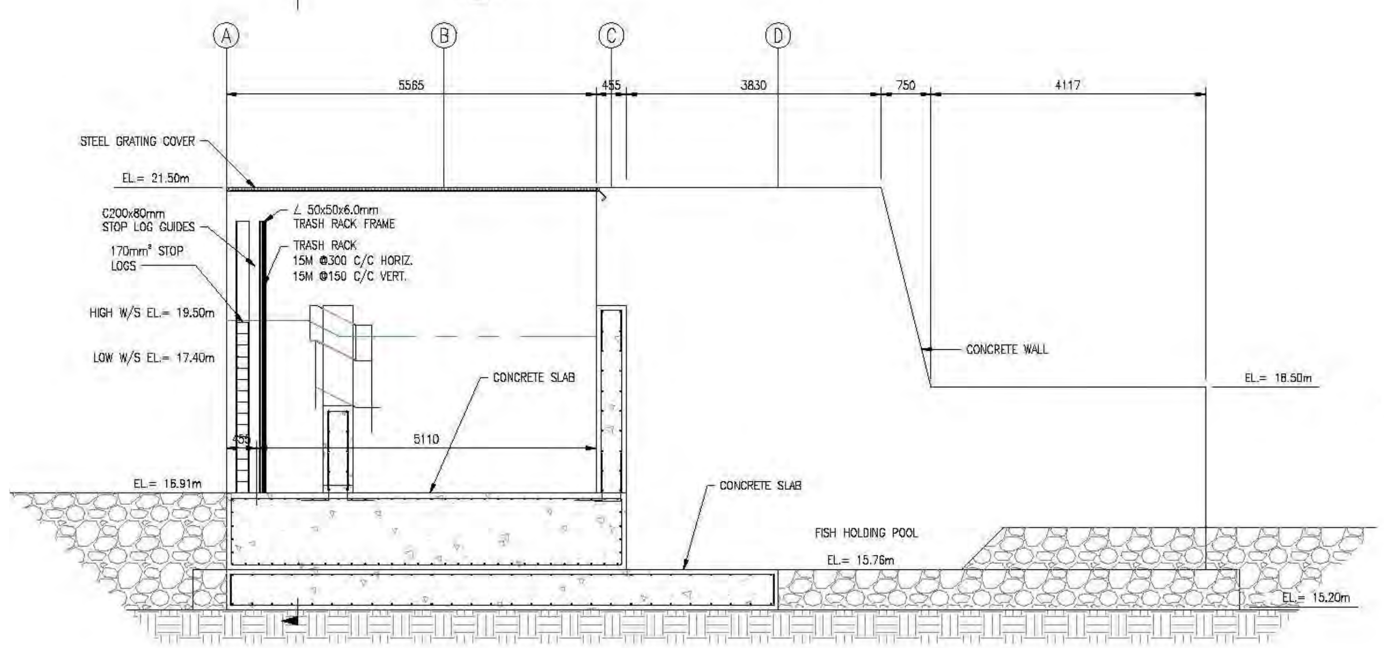
6 C-D10660 DETAIL - FISH LADDER TRASH RACK



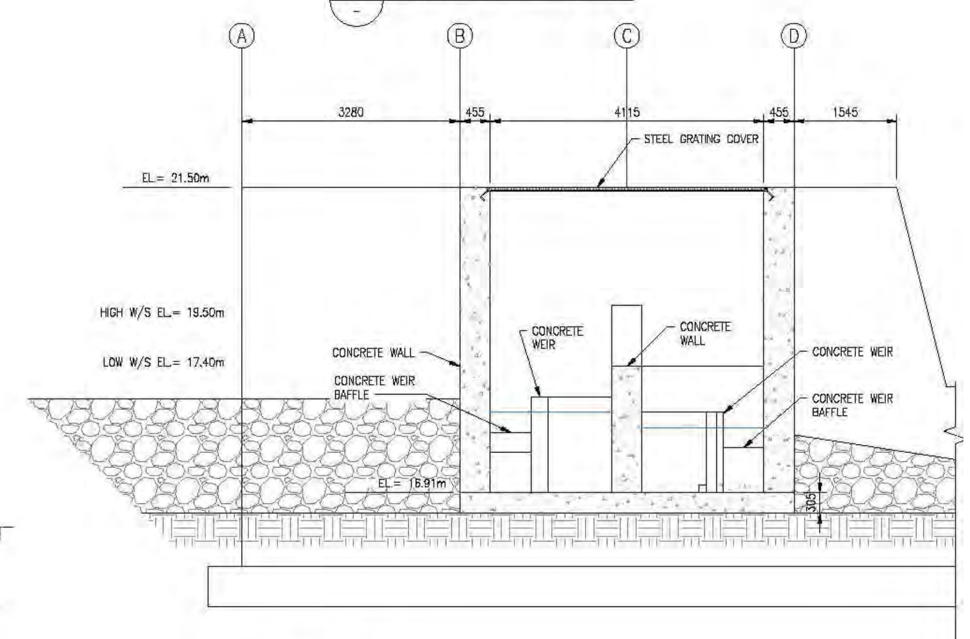
4 C-D10660 SECTION - FISH LADDER



5 DEATAIL - FISH LADDER TRASH RACK



2 C-D10660 SECTION - FISH LADDER



3 C-D10660 SECTION - FISH LADDER

GENERAL NOTES:

1. REFERENCE: DESIGN DRAWINGS SUPPLIED BY MECO ENGINEERING.
2. THIS DRAWING IS A GENERAL PLAN AND SECTION FOR PRESENTATION ONLY AND NOT INTENDED FOR LEGAL USED.

PROJECT:

LAKE MAJOR DAM REPLACEMENT

LOCATION:

LAKE MAJOR ROAD
LAKE MAJOR, NOVA SCOTIA

TITLE:

FISH LADDER SECTIONS AND DETAILS

CONSULTANT:

Strum CONSULTING 20 YEARS Taking Charge

Engineering * Surveying * Environmental
Bedford * Antigonish * Moncton * Deer Lake

SCALE:	
H: N.T.S	V: N.T.S

DATE:		DRAWN:
DECEMBER 2016		MECO
DESIGNED: MECO	CHECKED: H. MOSHER	APPR'D: S. DUNCAN

PROJECT No.: 16-5799

DRAWING No.: **2.2B**

- Phase 3: Once the new dam is completed, the Phase 2 cofferdam will be removed and the new structure will be commissioned. As the water in the area between the new dam and existing dam naturally dewaters over the existing dam, the previously existing watercourse will be restore. Restoration will involve the removal of built-up fine sediment down to existing cobble and the placement of gravel.
- Phase 4: Once the watercourse has been restored, the existing timber dam will be removed and disposed. The existing dam will be decommissioned and removed upon the completion of the new structure. The dam will be removed slowly, in pieces to minimize the disturbance and limit the release of water between the new and old structure. It is intended that the siphons will remain in place during construction to ensure downstream maintenance flow during periods where the dam is not spilling water.

2.2.2 Operations

The new structure will have a length of 51 m, length of 8 m and overall height of 7 m to the top of the spillway. Outside of the of the dam footprint, the fishway will have a length of 8.8 m and a width of 4.8 m. The final footprint will be 450 m^2.

The existing dam maintains a FSL of approximately 19.0 m, increasing to approximately 20.7 m during 1 in 100 year storms. The construction of the new dam will result in a FSL of 19.5 m, an increase of 0.5 m, increasing to approximately 19.7 m during 1 in 100 year storm events. The increased FSL will allow for a greater retention of water during high flow events and better control of downstream flows. By being able to better manage water levels there will be less flooding during peak rain events. To maintain fish habitat, downstream riparian flows will be maintained at 0.17 m^3/s, up from the current permitted maintenance flow of 0.11 m^3/s plus dam leakage.

Water levels within Lake Major will be monitored by the Supply Plant Supervisor and manually released from the lake when required. The Supply Plant Supervisor receives automated severe weather bulletins as part of HRM's emergency management office and uses these alerts to prepare for large precipitation events.

2.2.3 Decommissioning

The proposed Project is expected to have a lifespan extending past 60 years. At this time, the new dam may be replaced if the lake reservoir remains functional as a drinking water source or may be decommissioned if its services are no longer required. Decommissioning of the new dam and its potential environmental effects will be determined at such a time.

2.3 Project Schedule

Table 2.2 presents the Project schedule from EA registration to Project decommissioning.

Table 2.2. Project Schedule

Project Activity	Timeline
EA Registration	December 2016
Clearing	April 2017
Construction	April 2017 – October 2017
Commissioning	November 2017
Operation	December 2017
Decommissioning	60+ years

3.0 ENVIRONMENTAL MANAGEMENT

3.1 Environmental Controls during Dewatering

During the two phases of construction where sand bag cofferdams will be in place, water from the excavation area will be pumped to two connected settling ponds located to the southwest of the construction area. Water from the second pond will be discharged back to Lake Major upstream of the construction areas and within the confines of a floating silt boom. It is expected that the majority of sediment will be removed within the settling ponds, however the silt boom will provide a secondary measure of safety to the lake.

Downstream of the cofferdam a floating silt boom will also be installed to capture any leakage through the cofferdam during construction. This downstream silt boom will be placed to ensure that there will be no impact to fish passage through the area between the existing dam and cofferdam. This arrangement will also allow for the restoration of the riverbed within the cofferdam areas until the new dam is fully functional.

The remainder of the downstream restoration and the removal of the existing dam structure will be completed once the new dam is operational. This phase will include limited and directed flow, with the possibility for no flow, for approximately 2 weeks. This will allow for the removal of the existing dam, regrading of the channel, and restoration of riverbed. This work is expected to occur during the later months of 2017 when fish passage requirements are minimal. However, as it is also a period of wetter weather, construction timing and management of storm events will be a high priority. A downstream silt boom will be in place to capture any materials that may wash out from the work site. It is intended that the majority of the removal and restoration work can take place in the dry using the new dam and, potentially, the southern culvert to control and manage flows from the lake for a short period of time.

3.2 Environmental Protection Plan

An Environmental Protection Plan (EPP) will be developed following EA approval of the Project. The EPP will be approved by NSE prior to start of construction of the Project and will detail best practices and mitigative measures to be employed during construction to minimize potential environmental impacts. The EPP document is the primary mechanism for ensuring that mitigation is implemented, as determined through the EA process, to avoid or mitigate potential adverse environmental effects that might otherwise occur from construction activities, and as required by applicable agencies through permitting processes.

The EPP is a plan for all Project personnel, including contractors, and describes the responsibilities, expectations, and methods for environmental protection associated with Project activities. The EPP will incorporate:

- means to comply with requirements of relevant legislation;
- environmental protection measures identified as part of the EA; and
- environmental commitments made as part of the EA.

A site-specific erosion and sedimentation control plan (ESCP) will be developed for the Project and included in the EPP.

A suggested Table of Contents for the EPP is provided in Appendix C.

4.0 DESCRIPTION OF THE BIOPHYSICAL ENVIRONMENT

4.1 Atmospheric Environment

4.1.1 Climate and Weather

Nova Scotia's climate is quite varied and is largely governed by coastal influences and elevation (Davis and Browne 1996). The Study Area (centered at 44°55'3.86"N, 64° 1'43.58"W) lies along the border of the Rawdon/Wittenburg Hills Ecodistrict and the St. Margaret's Bay Ecodistrict (Neily et al. 2005). With elevations of 180-210 m, the Rawdon/Wittenburg Hills tend to experience cooler temperatures and considerably more moist than the adjacent lowlands. The southern portion of the Study Area lies at the northern extent of the St. Margaret's Bay Ecodistrict which slopes to the south-southeast from an elevation of 150 m at Panuke Lake to sea level along the Atlantic coast (Neily et al. 2005). Forestry is the dominant land use in the area, with agriculture being practised on a small-scale. The typical growing season in the area of the Study Area is 196 days (Webb and Marshall 1999).

Climate norms for a 30-year average were determined from the Shearwater weather station located 9.5 km from the Study Area for average temperature and precipitation, including maximum and minimum values (EC 2016a).

Mean annual precipitation for the area is 1398.5 mm and is calculated by the total rainfall plus the equivalent of snowfall and other forms of frozen precipitation (Table 4.1). Monthly mean precipitation values range from 89.4 mm in August to 138.5 mm in December. The highest monthly mean rainfall levels occurred in October (130.4 mm), with mean monthly snowfall amounts greatest in January (47.8 cm). Rainfall occurs on average every month, however, snowfall does not occur during June, July, August, and September.

Total 4.1. Mean Precipitation Values for 1977-2006

Month	Mean Rainfall (mm)	Mean Snowfall (cm)	Total Precipitation (mm)
January	86.1	**47.8**	127.1
February	67.8	39.3	103.0
March	97.1	29.6	124.2
April	104.4	11.5	116.5
May	112.7	1.8	114.3
June	114.1	0.0	114.1
July	102.7	0.0	102.7
August	89.4	0.0	89.4
September	102.9	0.0	102.9
October	**130.4**	0.2	130.6
November	125.7	10.5	135.1
December	107.8	34.0	**138.5**
Annual Total	**1241.2**	**174.7**	**1398.5**

Source: Environment Canada 1977 – 2006

Annual average daily mean temperature is 11.0°C (Table 4.2). Average daily mean temperatures vary from -4.7°C in January to 18.4°C in August. Average monthly temperatures ranged from -9.0°C in January to 22.6°C in June.

Table 4.2. Mean Temperature Values for 1977-2006

Month	Average Daily Mean (°C)	Average Daily Maximum (°C)	Average Daily Minimum (°C)	Extreme Maximum (°C)	Extreme Minimum (°C)
January	-4.7	-0.3	**-9.0**	14.3	**-26.5**
February	-4.3	0.0	-8.6	16.2	-25.7
March	-0.7	3.3	-4.6	21.8	-20.8
April	4.3	8.3	0.2	22.8	-11.6
May	9.3	13.7	4.9	32.0	-2.3
June	14.2	18.7	9.7	**33.0**	2.0
July	17.9	22.2	13.6	31.8	7.2
August	**18.4**	**22.6**	14.2	32.4	6.2
September	14.9	19.2	10.6	31.2	-0.5
October	9.5	13.5	5.5	24.9	-3.3
November	4.5	8.1	0.8	18.4	-11.4
December	-1.2	2.8	-5.1	14.6	-23.5
Annual	**11.0**	**2.7**	**6.9**	**33.0**	**-26.5**

Source: Environment Canada 1977-2006.

In Atlantic Canada, climate change is expected to bring warmer average temperatures, higher sea levels, more extreme rainfalls and storm flooding, and more frequent and extreme storms (Lemmen et al. 2008). Regional trends in seasonal temperatures for Atlantic Canada show an overall warming of 0.3 °C from 1948 to 2005 (Lewis 1997; Lines et al. 2003). Precipitation increased in Atlantic Canada by approximately 10% between 1948 and 1995 (Lewis 1997), and is anticipated to continue to increase in the future. The Atlantic region is subject to impacts from a wide range of seasonal and interannual events, including winter cyclonic storms, tropical cyclones, and other severe weather events; summer heat and drought; early or late season frost; winter rain and thaw events; and river ice jams and flooding. There is evidence of recent trends toward greater extremes and higher frequencies of such events (Zhang et al. 2001; Beltaos 2002; Bonsal and Prowse 2003; Bruce 2005; Webster et al. 2005).

4.1.2 Air Quality

Nova Scotia monitors air quality at six stations throughout the province. Measured parameters include ground-level ozone (O_3), particulate matter (PM2.5), and nitrogen dioxide (NO_2), and these values are used to calculate a score on the Air Quality Health Index (AQHI) (EC 2016b). The AQHI is a scale from 1-10+, in which scores represent the following health risk categories: Low (1-3), Moderate (4-6), High (7-10), and Very High (10+). An AQHI monitoring station is located at Lake Major. The AQHI at this site is usually low at all times of the year (EC 2016b).

4.2 Geophysical Environment

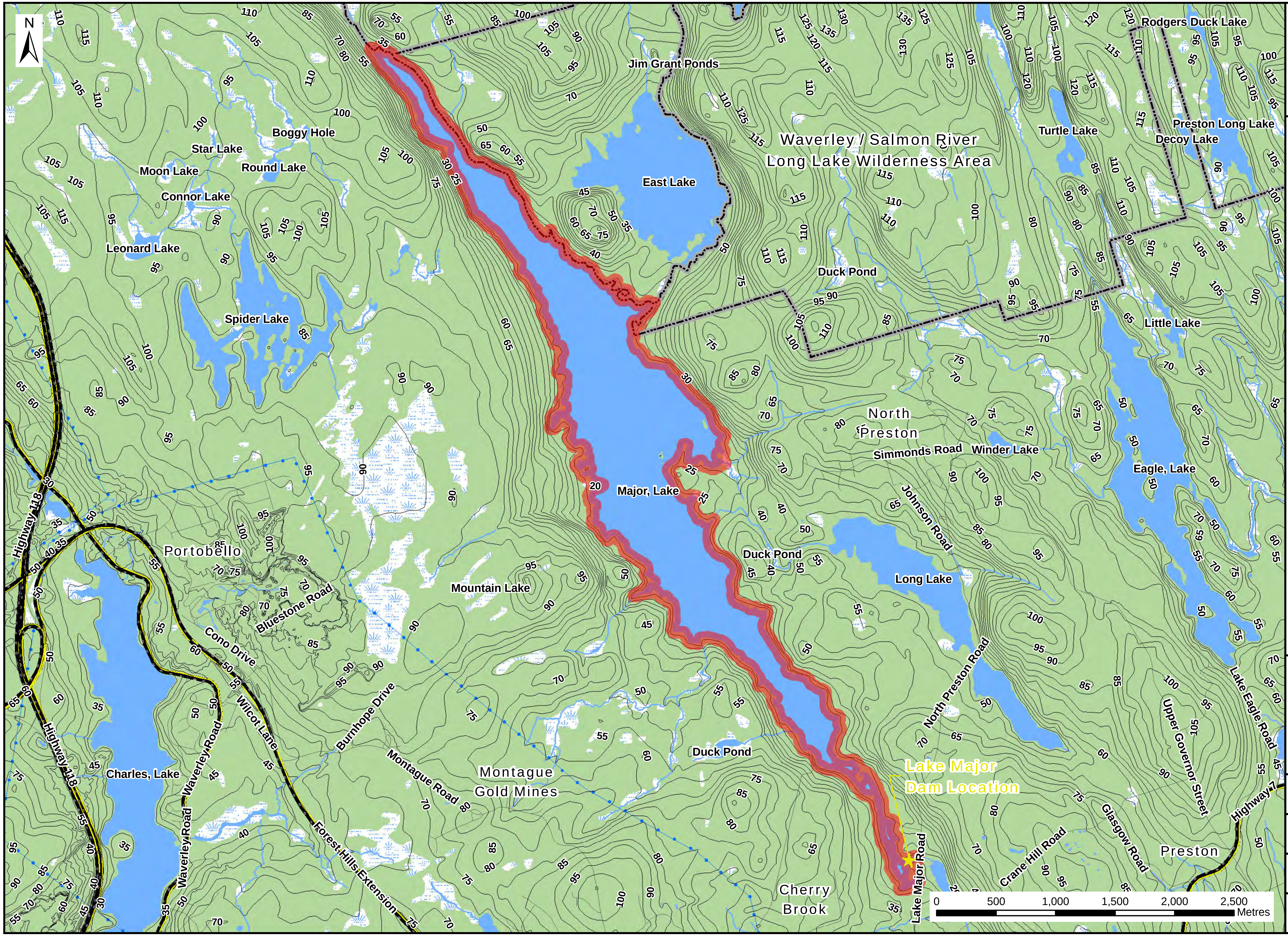
4.2.1 Geology

Physiography and Topography
The Study Area lies within the Eastern Interior Ecodistrict of the Eastern Ecoregion (Neily et al. 2005). This ecodistrict is one of largest in the province extending from Pockwock Lake in the west to the Town of Guysborough in the east. Topography is characterized as ridged throughout the ecodistrict with highly visible bedrock in areas of thin glacial till and thick softwood forests dominant where till is thicker. Nearly 9.3% of the ecodistrict (approximately 343 km^2) has been scraped clean by glaciers exposing large areas of bedrock (Neily et al. 2005).

The land around the lake, within the Study Area is generally steep, running directly towards the lake edge (Drawing 4.1). Elevation in the Study Area ranges from 15 m to 25 m above sea level.

Surficial Geology
Surficial geology of the site consists of stony till plain otherwise referred to as ground moraine and streamlined drift (Drawing 4.2). This unit is further classified as Halifax series soils, characterized as well drained, but typically shallow, stony, and porous. The parent material is olive to yellowish-brown sandy loam to gravelly sandy loam glacial till derived primarily from quartzite (MacDougall *et. al.* 1963). Till thickness in the area ranges from 2 – 20 m, creating a flat to rolling topography with many surface boulders (Stea *et al.* 1992).

A geotechnical assessment was completed in the Study Area during winter 2016. Fill was observed in each borehole, generally consisting of a layer of topsoil 0.05 to 0.20 m thick, underlain by granular soil (i.e. sand and gravel, or silty sand) and often contained roots and other organic material. Sand/sandy silt was observed in 5 of the 11 boreholes and was generally observed below the fill and above the sand and gravel soils. A grain size analysis indicated a composition of 7-8% gravel, 83-86% sand, and 7-9% fines (silt and clay-sized particles). The sand/sandy silt is typically brown, compact to very dense, stratified, dilatant, and was observed in dry and wet moisture conditions.



Notes:

1. Reference: Digital Topogrpahic Mapping by Nova Scotia Geomatics Centre.
2. Projection: NAD83(CSRS), UTM Zone 20 North.
3. Sample Locations are Approximate. This Map is for Presentation Purposes Only & Not Intended for Legal Use.

Legend:

- Study Area
- Contours (m)
- Game Management
- Public Roads
- Major Roads and Highways
- Existing Transmission Lines
- Mapped Stream
- Mapped Wet Areas
- Water Bodies

Lake Major Dam Replacement - Lake Major Topography

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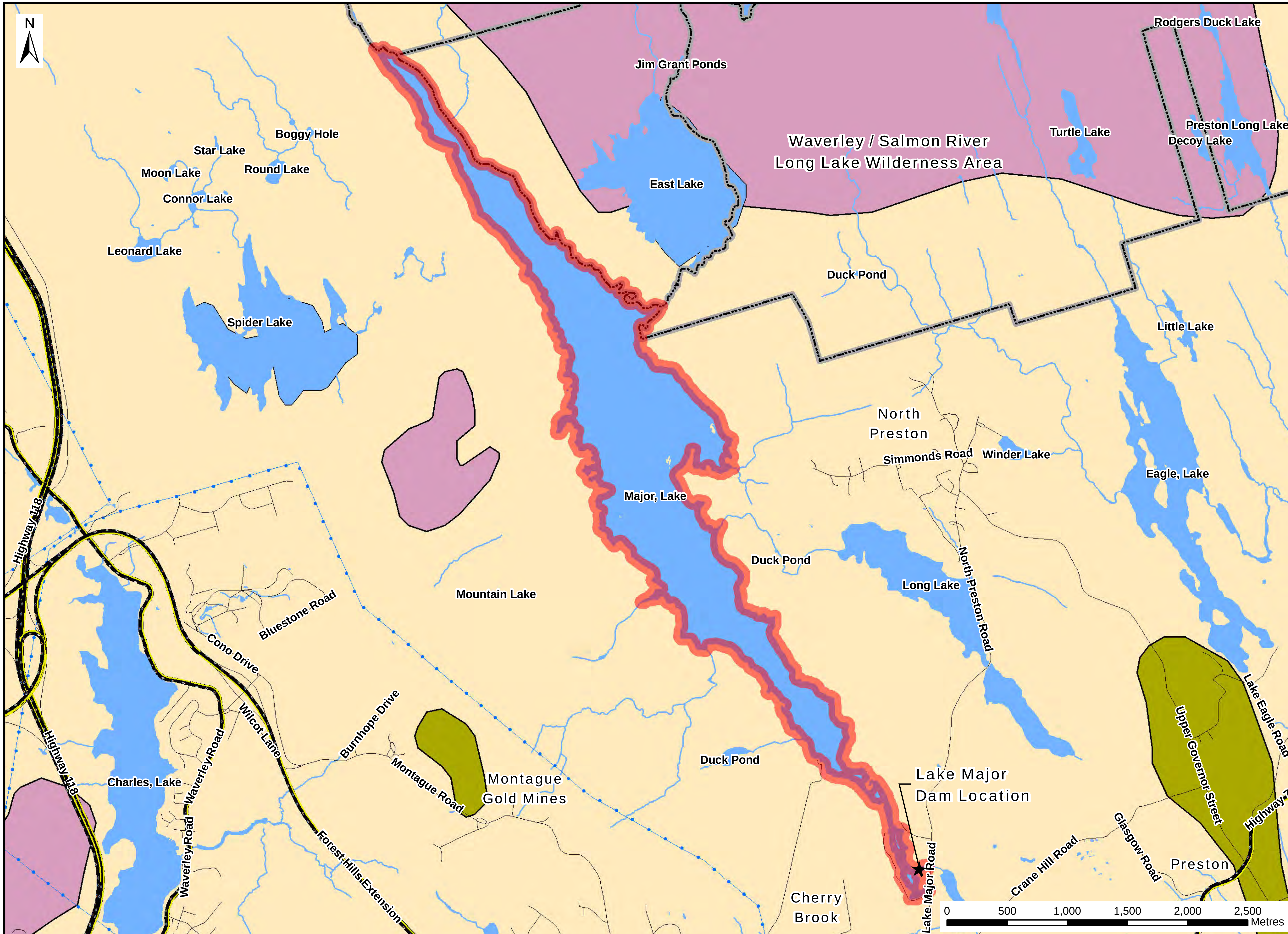
Date:	Project #:
December 2016	16-5799
Scale: 1:30,000	Drawing #: 4.1
Drawn By: H. Serhan	
Checked By: H. Mosher	



Notes:

1. Reference: Digital Topogrpahic Mapping by Nova Scotia Geomatics Centre. DP ME 36, Version 2, 2006, Digital Version of Nova Scotia Department of Natural Resources Map ME 1992-3, Surficial Geology Map of the Province of Nova Scotia, scale 1:500 000, by R. R. Stea, H. Conley and Y. Brown, 1992.
2. Projection: NAD83(CSRS), UTM Zone 20 North

Legend:

- Study Area
- Game Management
- Public Roads
- Major Roads and Highways
- Existing Transmission Lines
- Mapped Stream
- Water Bodies

Surficial Geology By Unit

- Bedrock
- Silty Drumlin
- Stony Till Plain
- Water Bodies

Lake Major Dam Replacement - Surficial Geology

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*Bedford * Antigonish * Moncton * Deer Lake*

Date:	Project #:
December 2016	16-5799
Scale: 1:30,000	Drawing #: 4.2
Drawn By: H. Serhan	
Checked By: H. Mosher	

Sand and gravel (glaciofluvial) was observed in all boreholes generally lying between the sand/sandy silt and the bedrock. Compositions ranged from 19-48% gravel, 39%-66% sand, and 6-23% silt and clay-sized particles. The thickness of the sand and gravel stratum varied from 0.4 m to 10.8 m and is described as brown or grey with frequent cobbles and boulders and in a dry or wet state.

Bedrock Geology
The majority of the Study Area is underlain by Cambrian-Ordovician aged metamorphic rocks of the Goldenville Formation (Keppie 2000) (Drawing 4.3). The Goldenville Formation is typically composed of metasandstone (e.g. quartzite/greywacke), with lesser amounts of interbedded slate and calcareous units. The southern extent of Lake Major is underlain by the Halifax Formation which consists of slates and lesser amounts of metasandstone, metasiltstone, and calcareous units.

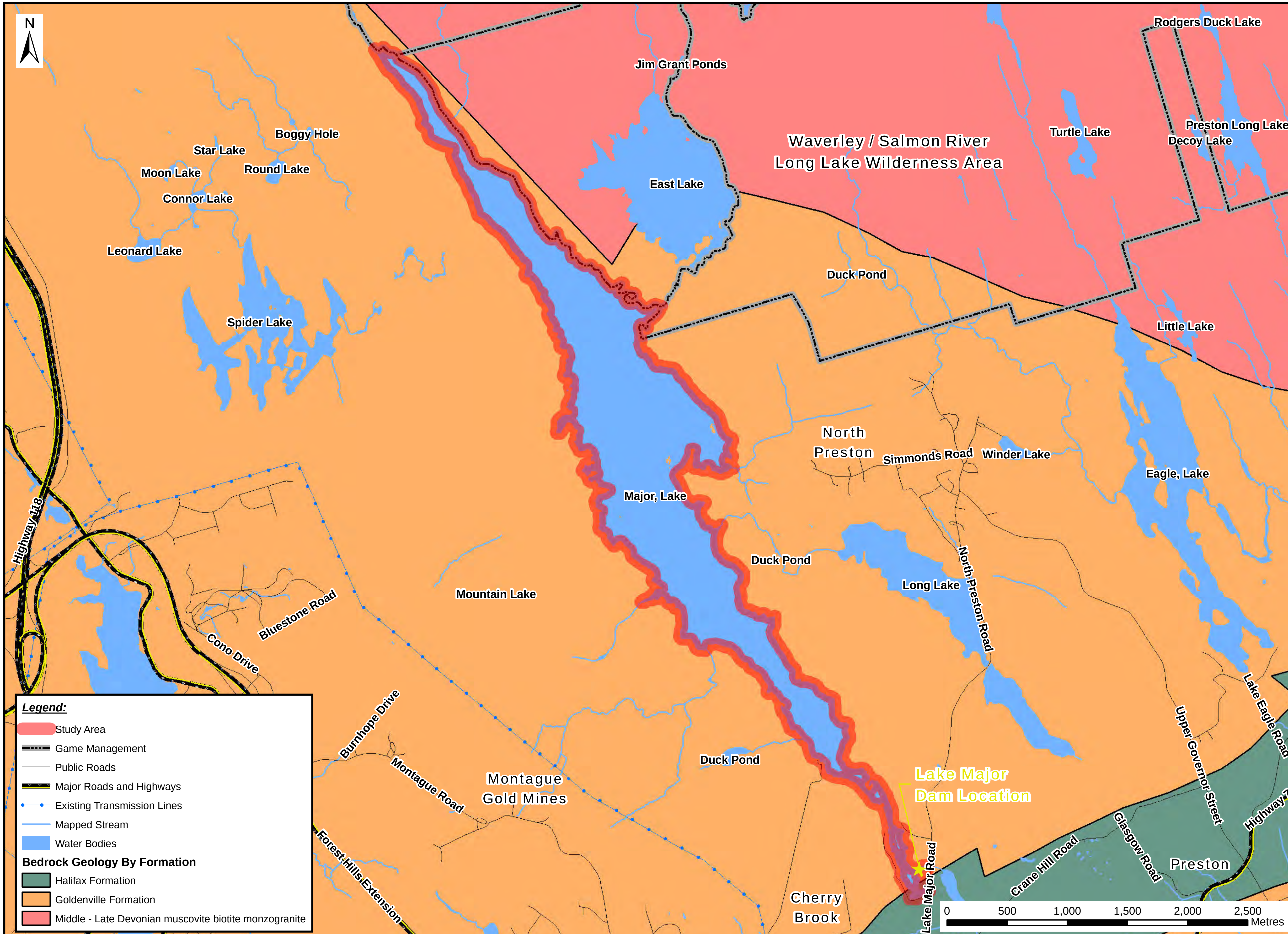
According to the NSE Well Log Database (NSE 2015a), there are 14 wells identified within 500 m of the Study Area, ranging in depths from 20.1 m to 91.4 m. The majority of wells were drilled through slate (10), with quartzite/whinrock (3) and shale/slate (1) also encountered. Surficial material was predominately gravel and/or clay ranging from 0.9 m to 7.6 m in thickness, with stone, mud, and boulders also observed.

Bedrock was encountered in 9 of 11 boreholes. All bedrock encountered during the investigation was identified as slate from the Halifax Formation and is generally described as gray, slightly weathered to fresh with localized weathered/fragmented zones, medium strong to strong, and containing closely-spaced planar fractures dipping at 0-45°. Halifax slate is typically high in sulphide content and associated with acid rock drainage (ARD) during excavation. Based on rock quality designation (RQD) values, the rock quality ranged from very poor (RQD = 0%) to excellent (RQD = 100%), but was generally fair (average RQD = 58%). Core recovery and drill action indicates the bedrock is highly fractured and weathered within the first 0.5 to 1.5 m below the bedrock surface.

Bedrock containing sulphide bearing minerals (*e.g.*, pyrite, pyrrhotite) can potentially generate acid run-off if fresh surfaces are exposed to oxygen and water. The physical disruption of such bedrock leads to oxidation of iron-sulphide minerals and the generation of ARD (Fox *et al*. 1997). Construction activities in the presence of ARD can result in the acidification of surface and groundwater and promote the mobilization and leaching of toxic contaminants into the environment, including heavy metals. The likelihood of ARD to occur will be determined following the results of the geotechnical evaluation.

4.2.2 Hydrogeology and Groundwater

Groundwater Quantity
Water supplies near the Study Area are generally derived from municipal services provided by the Lake Major Water Supply Plant at Lake Major. However, several individually drilled wells were also located within the area. A summary of the pertinent (within 500 m of the Study Area) well properties included in the NSE Well Log Database (NSE 2015a) is presented in Table 4.3.



Notes:

1. Reference: Digital Topogrpahic Mapping by Nova Scotia Geomatics Centre. DP ME 43, Version 2, 2006, Digital Version of Nova Scotia Department of Natural Resources Map ME 2000-1, Geological Map of the Province of Nova Scotia, scale 1:500 000, Compiled by J. D. Keppie, 2000.
2. Projection: NAD83(CSRS), UTM Zone 20 North

Lake Major Dam Replacement - Bedrock Geology

Strum CONSULTING 20 YEARS Taking Charge

*Engineering * Surveying * Environmental*
*Bedford * Antigonish * Moncton * Deer Lake*

Date: December 2016	Project #: 16-5799
Scale: 1:30,000	Drawing #: 4.3
Drawn By: H. Serhan	
Checked By: H. Mosher	

Table 4.3. Summary of Drilled Well Records

	Drilled Date (yr)	Well Depth (m)	Casing Length (m)	Estimated Yield (Lpm)	Water Level (m)	Overburden Thickness (m)	Water Bearing Fractures (m)
Minimum	1967	20.1	5.2	4.5	3.7	0.9	2.4
Maximum	2001	91.4	7.6	45.4	9.1	7.6	91.5
Average	1982	47.1	4.1	15.9	7.3	4.1	34.6
Number of well records	14	14	12	13	5	13	11

Source: NSE 2015a

Based on short term driller's estimates for the wells in Table 4.3, the average yield is approximately 15.9 Lpm (4.2 gpm) and average well depth is approximately 47.1 m (154.5 ft). These measurements represent very short term yields estimated by the driller at the completion of well construction. Fracture depths ranged from 2.4 m (7.9 ft) to 91.5 m (300.1 ft).

NSE maintains the Nova Scotia Groundwater Observation Well Network (NSE 2015b). The nearest observation well to the Study Area is located approximately 4 km south, near Upper Lawrencetown. This well was drilled to a depth of 53 m through quartzite of the Goldenville Formation. The well had been constructed in 1977 as part of a saltwater intrusion investigation. In 2014, the average water elevation was 2.87 m above sea level and the annual water level fluctuation was 1.1 m.

Groundwater Quality

Groundwater in quartzite and slate are usually calcium bicarbonate waters low in dissolved solids and hardness. Groundwater within the metamorphic bedrock of the Goldenville and Halifax Formations are often slightly acidic and sometimes contain iron, manganese, and occasionally arsenic (Trescott 1969).

4.3 Freshwater Environment

4.3.1 Watershed

The Lake Major Watershed provides water to Dartmouth, Cole Harbour, Eastern Passage, Westphal, Cherry Brook, North Preston, and Montague Gold Mines (HRM 2015a). The watershed is a protected area with portions of it falling in the Waverly-Salmon River Long Lake Wilderness Area. The Lake Major Watershed Protected Water Area contains 6197 hectares of primarily forested land and 800 hectares of water for a total area of 6997 hectares.

The land within the watershed consists of a combination of Crown land (41.0%), Privately-owned land (17.0%) and land owned by Halifax Water (41.0%). Portions of five communities, Montague, Cherry Brook, Lake Major, East Preston, and North Preston are located within the watershed area (Drawing 4.4).

There are 32 lakes within the designated area (Table 4.4).