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2017 Baseline Aquatic Environmental Technical Report

Atlantic Gold
A St Barbara Ltd Company

Stantec

Touquoy Mine: 2017 Baseline Aquatic Environment Technical Report

April 30, 2018 (Revised February 12, 2020)

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EXECUTIVE SUMMARY

Atlantic Gold Mining Corporation (Atlantic Gold) operates the Touquoy Gold Mine (the Mine), located in Moose River Gold Mines, approximately 110 km northeast of Halifax, NS. The Project includes an open-pit mine and processing to extract gold on site. It is currently planned that the Project will discharge effluent from a polishing pond into Scraggy Lake, NS, with discharge beginning in 2019.

Stantec Consulting Ltd. (Stantec) was contracted by Atlantic Gold to undertake baseline aquatic monitoring in 2017. This report provides background information on the mine and the future aquatic receiving environment and provides the results of a baseline aquatic sampling program conducted in 2017. The baseline program was designed to establish existing conditions in Scraggy Lake prior to effluent discharge to set the stage for the future environmental effects monitoring (EEM) program, which will be required when the Project becomes subject to the Metal Mining Effluent Regulations (MMER), under the federal Fisheries Act, anticipated in 2019.

The baseline program was designed to mirror the requirements for EEM under MMER. A multiple control-impact design was selected, with controls (i.e., references to reflect background) in nearby lakes unaffected by current mining activities, and impact (i.e., future effluent exposure) locations in Scraggy Lake. The focus was on shallow lake habitat (littoral zone) which is a dominant habitat type in the area lakes.

The baseline program design included the following components:

- Adult fish survey (including a fish habitat assessment);
- Benthic invertebrate community (BIC) survey; and
- Supporting environmental variables (water and sediment quality).

The baseline program also included fish tissue analysis for metals, which is not required under MMER, but will establish conditions prior to the release of mine effluent to Scraggy Lake. Due to time restrictions and level of effort, baseline sampling was conducted in Scraggy Lake only, with limited reconnaissance work in one of the two potential nearby reference lakes.

The following summary points document the main findings of the baseline study:

- Sampling Locations:
  - Scraggy Lake:
    - sampling locations were confirmed: nearfield (close to the future effluent final discharge point), farfield (near the outlet of Scraggy Lake to Fish River)
    - baseline sampling was completed for fish, benthic invertebrates, and supporting environmental variables (water, sediment), and fish tissues (metals, mercury)
  - Reference Lakes - potential:
    - Long Lake to the northwest of Scraggy Lake - similar fish habitat in the littoral zone, same watershed and surrounding land use, similar water quality (based on reconnaissance survey sampling); potential limitations include lack of confirmation of presence of white sucker and yellow perch (although habitat seems to be suitable), and lack of information on sediment quality

        - Alma Lake to the east of Scraggy Lake – similar habitat and size to Scraggy Lake based on desktop analysis; no reconnaissance of baseline sampling has been conducted to confirm its suitability as a reference
- Adult fish survey in Scraggy Lake:
    - white sucker and yellow perch were targeted for EEM endpoints
    - sufficient numbers of male and females were obtained for each species; baseline data were collected
    - these fish species are broadly used for EEM purposes across Canada and are suitable for this purpose
    - provided information for power analysis for the Cycle 1 EEM study design to detect a difference between sites for the key EEM endpoints
    - fish tissue baseline data were collected for metals and mercury
        - there was an increasing concentration of total mercury with fish length in white sucker and yellow perch, which is a typical pattern for bioaccumulation with increasing age, based on length of fish
- Benthic invertebrate community survey in Scraggy Lake
    - challenging to sample because of substrate with boulders and limited amounts of finer sediment
    - qualitative kick-net sampling approach was used which does not allow for calculation of standard EEM endpoints, but did provide valuable qualitative information for future reference
- Supporting environmental variables (water and sediment quality) were collected to establish baseline conditions in Scraggy Lake and Long Lake
    - waters were soft, contained low concentrations of dissolved minerals (i.e., hardness) and had low pH
    - water was generally clear and with low nutrient levels.
    - trace metal concentrations of key parameters and general chemistry were similar among samples and between lakes, except for iron and aluminum which showed increased concentrations in some samples.
    - a thermocline was not apparent in depths less than 4 m for Scraggy Lake or Long Lake
    - increased aluminum and iron concentrations in sediment from Scraggy Lake were noted

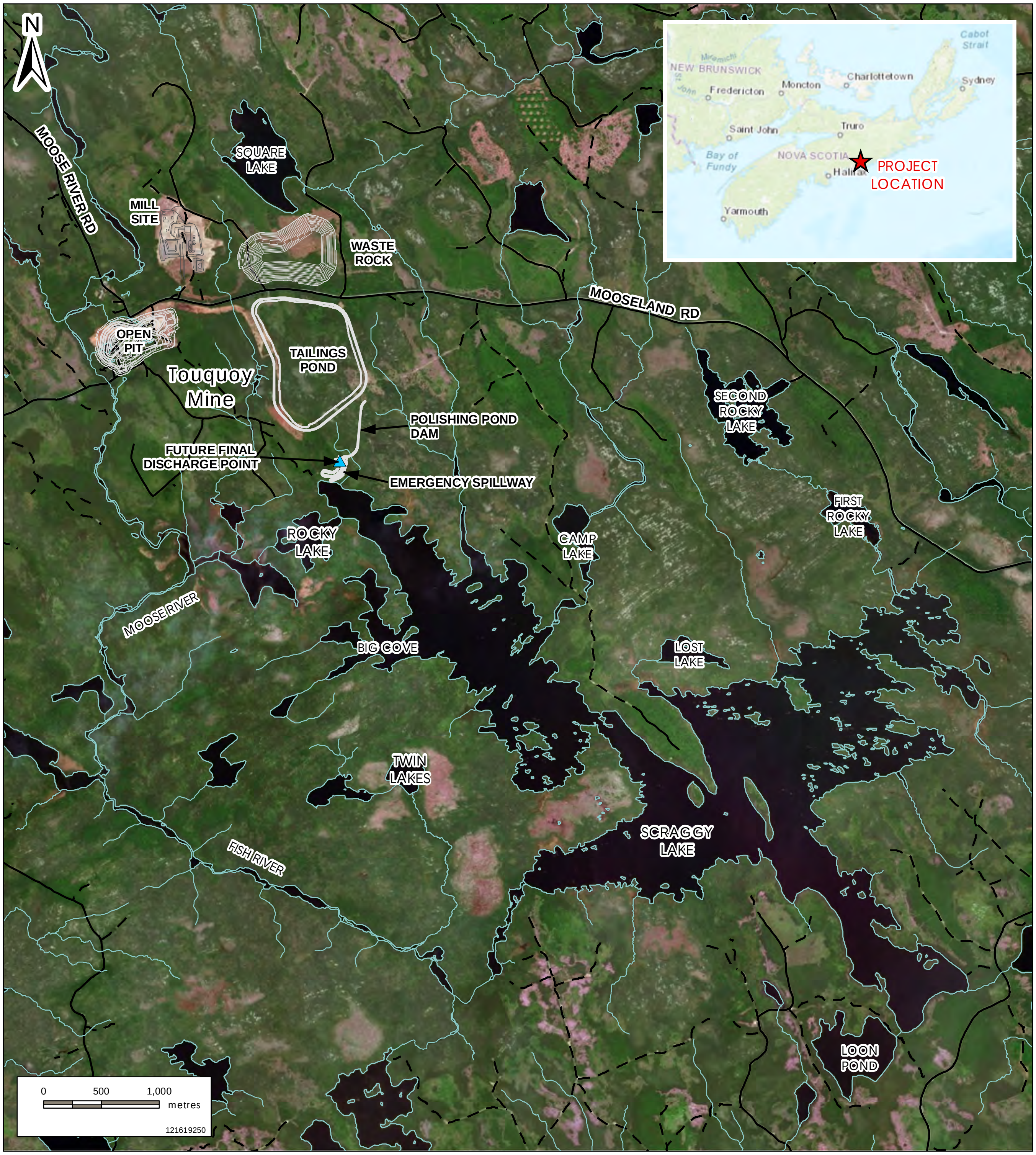
The baseline study in 2017 established the existing conditions in Scraggy Lake prior to effluent discharge from the Mine for the fish community, benthic invertebrate community, water and sediment quality, and metals and mercury in fish tissues. These results will be used to inform EEM design and to provide context for interpretation of results from the future EEM program.

1.0 INTRODUCTION

Atlantic Gold Mining Corporation (Atlantic Gold) operates the Touquoy Gold Mine (the Mine), located in Moose River Gold Mines, approximately 110 km northeast of Halifax, NS (Photo 1, Figure 1.1). The Project includes open-pit mine and processing for gold on site. It is currently planned that the Project will discharge effluent from a polishing pond into Scraggy Lake, NS, anticipated to begin in 2019.

Stantec Consulting Ltd. (Stantec) was contracted by Atlantic Gold to undertake baseline aquatic monitoring in 2017. This report provides background information on the mine and the future aquatic receiving environment and provides the results of a baseline sampling program conducted in 2017. The baseline program was designed to establish existing conditions in Scraggy Lake prior to effluent discharge to set the stage for the future environmental effects monitoring (EEM) program, which will be required when the Project becomes subject to the *Metal Mining Effluent Regulations* (MMER), under the federal *Fisheries Act*, anticipated in 2019.

Photo 1 Touquoy Gold Mine in Moose River Gold Mines, NS. (Photo source: Atlantic Gold 2014)



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Notes
1. Coordinate System: NAD 1983 CSRS UTM Zone 20N
2. Baedata Source: Government of Nova Scotia
3. Imagery Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong),

Client/Project

ATLANTIC GOLD CORPORATION
TOUQUOY GOLD PROJECT

Figure No.
1.1

Title
LOCATION OF TOUQUOY GOLD MINE IN MOOSE RIVER GOLD MINES, NS

1.1 MINE BACKGROUND

The Mine is in an area of historic gold mining activity. Gold production from Moose River Gold Mines, near the Mine site, commenced around 1877 and continued intermittently until the First World War. An estimated 21,500 ounces of gold were produced. Most gold was recovered from underground operations from quartz veins in bedded leads with lesser amounts from shallow quarries working both bedrock and eluvia deposits (Ausenco, 2015).

An attempt to re-open the underground workings was made in 1935/36 ending in a mine collapse on Easter Sunday 1936 with the subsequent highly publicized mine rescue event. The site then became dormant (Ausenco, 2015).

Modern exploration commenced in 1983 by Seabright Explorations Inc. (Seabright); Seabright staked the property and focused activities on aggressive exploratory drilling. In 1987, Westminer took over Seabright and continued the drilling program. By the end of 1989, a 57,000 tonne bulk sample had been taken from the north-western end of the deposit and processed by flotation at the Gays River Mill, 40 km from Moose River Gold Mines (Ausenco, 2015).

After multiple changes in ownership over the next decade, in May 2003, Atlantic Gold NL (then known as Diamond Ventures NL) and its wholly owned by Atlantic Mining NS Corp., entered into an option agreement with Moose River Resources Inc. In August 2014, a merger between Atlantic Gold Corporation and Atlantic Gold NL was completed.

In 2016, the detailed design of the tailings management facility (TMF) was completed and submitted to Nova Scotia Environment (NSE) for Industrial Approval. Approval was given on February 24, 2017 (NS 2017). The Touquoy Gold Mine was officially opened on October 11, 2017 with commercial production achieved in March 2018 with an anticipated life of Mine of five years.

The major project components related to water management at Touquoy are the mill, tailings pond, process water treatment plant and the polishing pond (Photo 1). Process water is primarily sourced from the TMF area and supplemented by make-up water from Scraggy Lake, where withdrawal began in 2017. All waste water and surface runoff are directed to the TMF for treatment. Excess tailings water will be treated by adding ferric sulphate to the effluent to precipitate arsenic, hydrated lime to adjust pH, and coagulant polymer to facilitate the removal of colloidal sized suspended matter. The treated effluent will then be directed into the polishing pond where additional settling will occur before being released into an engineered wetland for subsequent discharge into the northwestern end of Scraggy Lake. Effluent discharge is anticipated to begin in 2018 (Stantec 2017).

1.2 LOCAL GEOLOGY

The description of local geology herein is summarized from information provided in Ausenco (2015). At Touquoy gold mineralization broadly conforms to bedding over a strike length of approximately 700 m. Most gold occurs within the 25-180 m thick Touquoy Argillite, which is part of the lowermost unit of the Goldenville Formation, the Moose River Member. Gold is mostly disseminated within the Touquoy Argillite close to, and on both limbs of, the Moose- River-Beaver Dam-Fifteen Mile Stream Anticline, but also occurs within thin bedding-parallel quartz veins within the Touquoy Argillite. Subordinate gold mineralization in the adjacent greywackes is mostly restricted to more typical “Meguma-style”, narrow quartz vein hosted gold mineralization. At the small, Meguma-style Higgins & Lawlor and Stillwater deposits at the western end of the Property gold mineralization is hosted entirely in mostly bedding-parallel quartz veins.

Sulphide minerals accompanying the gold mineralization are pyrrhotite (1-2%), usually aligned along the sub-vertical axial plane cleavage within the argillite, arsenopyrite (1%), often as coarse porphyroblasts and pyrite (<1%). Other sulphides are rare. At a macro scale there is poor correlation between arsenic and gold content. Distinctive carbonate (ankerite) alteration accompanies the mineralization.

Gold occurs as native gold and has been observed in hand specimen and microscopic settings, mostly along fractures and grain boundaries or as disseminations within sulphides (mostly arsenopyrite), and as isolated grains along cleavage planes or within quartz veins. Gold grain size, as indicated by petrographic studies varies, from one micron to greater than one millimetre and gold grains up to 1.5 mm in size have been observed.

1.3 BACKGROUND ON ENVIRONMENTAL EFFECTS MONITORING AND THE AQUATIC RECEIVING ENVIRONMENT

With the start of production and tailings deposition in the TMF, it is anticipated that the Mine will trigger the MMER in 2018 when effluent discharge from the Mine exceeds a flow rate of 50 m^3 per day into the receiving environment, Scraggy Lake. Environment and Climate Change Canada (ECCC) administers the MMER, for which the basic requirements include reporting on effluent characterization, sublethal toxicity testing, water quality monitoring in the receiving environment, and a cyclical EEM program to evaluate the potential for effluent effects to fish and fish habitat. The present baseline program will establish existing conditions in the receiving environment prior to the discharge of mine effluent for interpretation of EEM results once the Mine is subject to MMER.

Scraggy Lake is part of the Moose River watershed which is 41 km^2 in areal extent. Scraggy Lake has an area of 6.4 km^2 (Alexander et al. 1986) and forms two major basins which are separated by a variety of islands and peninsulas. Water flows into Scraggy Lake from approximately twenty-two inlets consisting of mapped watercourses or adjacent waterbodies. Water flows out of Scraggy Lake over the Fish River Dam and into the Fish River. The Fish River Dam is a wooden plank structure which forms a water level control structure for the lake. The dam is in poor condition and a considerable amount of seepage occurs through the structure although it appears to be a partial barrier to fish passage during low flow conditions. Habitat within the Fish River consists of wetlands, former beaver impoundments and natural deep pools.

2.0 BASELINE AQUATIC ENVIRONMENT STUDY DESIGN

The baseline program was conducted to establish existing conditions in the future aquatic receiving environment for effluent in Scraggy Lake. It was designed to mirror the requirements for EEM under MMER to support interpretation of future EEM results when Mine becomes subject to MMER. The Metal

Mining Technical Guidance for Environmental Effects Monitoring (Technical Guidance; Environment Canada 2012) was used to inform for design and methods.

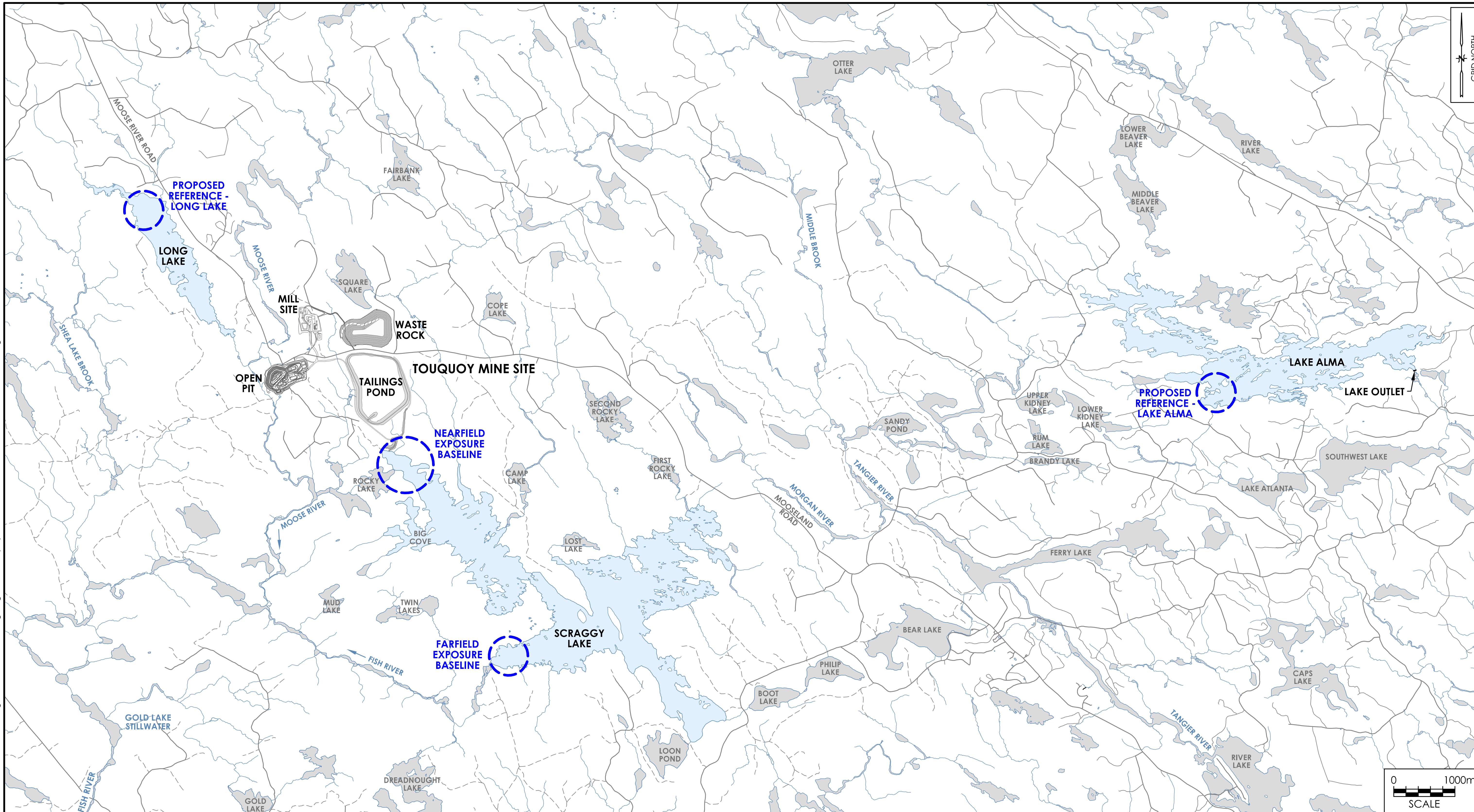
A multiple control-impact design was selected, with controls in nearby reference lakes and impact locations in Scraggy Lake. The focus was on shallow lake habitat (littoral zone) which is a dominant habitat type in the area lakes.

In accordance with EEM program components under MMER, the baseline program design included the following components:

- Adult fish survey (including a fish habitat assessment);
- Benthic invertebrate community (BIC) survey; and
- Supporting environmental variables (water and sediment quality).

The baseline program also included fish tissue analysis for metals, which is not required under MMER, but will establish conditions prior to the release of Mine effluent to Scraggy Lake.

To inform the baseline study design, a reconnaissance survey was conducted in August 2017 to identify suitable study locations, potential sentinel fish species, and potential nearby reference lakes. The survey included site visits and limited sampling. Information from this survey was used to develop a baseline study design which was implemented in early October 2017. Nearfield and farfield exposure locations were identified in Scraggy Lake, with the nearfield station at the north end of the lake close to the future effluent discharge, and the farfield station near the outlet of the lake to Fish River. Long Lake was visited and identified as a suitable reference lake based on similar habitat and land use to Scraggy Lake. Alma Lake was not visited during the reconnaissance survey or baseline EEM sampling and has been identified as an additional potential reference lake based on similar size and adjacent land use as Scraggy Lake. These locations are shown in Figure 2.1.



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LEGEND
- EXISTING ROAD - PAVED
- EXISTING ROAD - DIRT
- EXISTING WATERCOURSE
- EXISTING WATERBODY - OTHER
- EXISTING WATERBODY - STUDY AREA

Client/Project
ATLANTIC GOLD CORPORATION
2017 BASELINE AQUATIC ENVIRONMENT TECHNICAL REPORT

Project No.
121619250

Title
BASELINE ENVIRONMENTAL EFFECTS MONITORING STUDY LOCATIONS

Revision	Date
REV-0	2018.04.09
Reference Sheet	Figure No.
-	2.1

3.0 BASELINE AQUATIC ENVIRONMENT METHODOLOGY

Stantec conducted the reconnaissance survey from August 22 to 25, 2017 and the baseline EEM survey from October 2 to 5, 2017. This section describes the methods used for the adult fish survey, benthic invertebrate community survey, and supporting environmental variables.

3.1 ADULT FISH SURVEY

3.1.1 Reconnaissance Survey

3.1.1.1 Fish Habitat Assessment

For planning purposes, bathymetric information for Scraggy Lake was obtained from Atlantic Gold, which was based on work conducted by GHD (GHD, 2017). This information was verified during the reconnaissance using a handheld depth sounder (HawkEye Boating & Fishing Electronics Model #H22PX, Orlando, Florida, USA) and a fish finder (Humminbird Model #535, Eufaula, Alabama, USA). A limited field bathymetric survey for Long Lake was conducted to identify deeper areas of the lake, using the hand held sounder and the fish finder.

Habitat characteristics for shoreline and aquatic habitat were documented using a GPS unit, photographic records, and a handheld depth sounder as well as a boat mounted fish finder/depth sounder.

3.1.1.2 Fish Survey

A fish community reconnaissance survey was undertaken in Scraggy Lake and Long Lake to determine potential sentinel species for the subsequent baseline EEM program. Four minnow traps were set in the near-field area of Scraggy Lake (Figure 3.1) and near the boat launch of Long Lake (Figure 3.2).

3.1.2 Baseline Survey

During the October baseline sampling program, fish habitat assessments were carried out at the near-field and far-field locations and included substrate type, aquatic vegetation, and water depth. Locations were taken using GPS and photos were taken. Four days of field sampling effort were assigned for the baseline program and priority was given to sampling Scraggy Lake to establish conditions prior to effluent discharge, likely to begin in 2018. Due to level of effort applied Scraggy Lake, there was no remaining field time available for baseline sampling in Long Lake or in Alma Lake; priority was given to collect baseline data from Scraggy Lake prior to effluent discharge from the Mine.

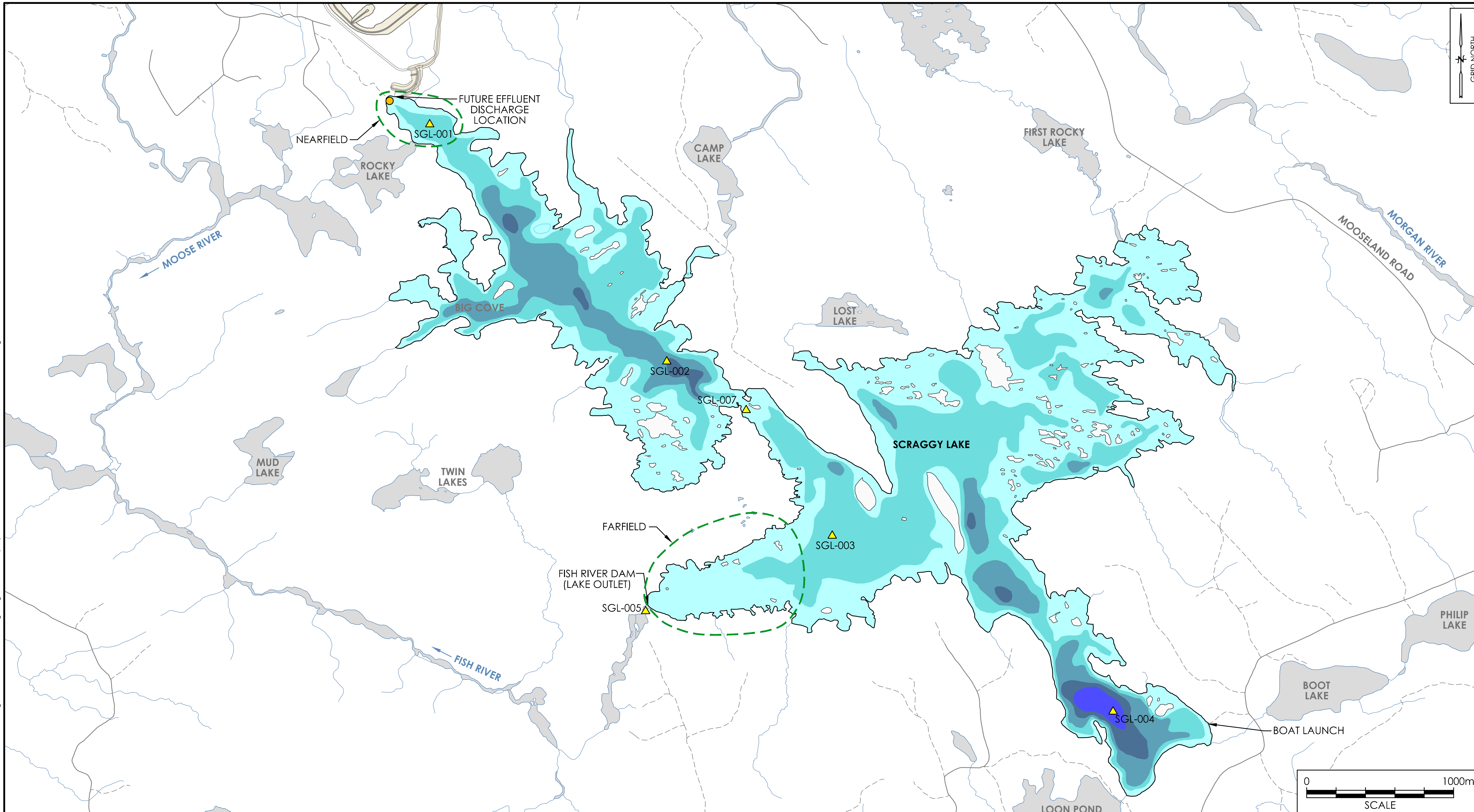
Results of the reconnaissance survey suggested that yellow perch (*Perca flavescens*) and banded killfish (*Fundulus diaphanous*) would be suitable for use as sentinel species for the baseline sampling. However, baseline sampling using various capture methods determined it would be difficult to obtain sufficient numbers and sizes of banded killifish and therefore white sucker was selected as the second sentinel species along with yellow perch. Mature yellow perch and white sucker (*Catostomus commersonii*) were abundant in nearfield and far-field locations in Scraggy Lake and are considered likely to be present in the reference lakes based on habitat.

Overnight sets of gill nets were the primary method used to catch yellow perch and white sucker. Mesh size ranged from 13 mm to 64 mm and nets were 30.5 m in length and 1.82 m in height. Gill nets were set late in the day and checked early in the morning to reduce soak times and potential for bycatch. Fyke nets and minnow traps baited with small quantities of cat food were also used to catch fish. Location and effort for all gear was recorded.

Following the Technical Guidance (EC 2012), approximately 45 fish of each species were targeted per location, consisting of a minimum of 20 males and 20 females, with an additional five fish of varying sizes retained for fish tissue analysis. Mature white sucker and yellow perch were euthanized by a blow to the head and stored immediately on ice in labelled bags. Non-target species were identified, counted and released. Non-target species or immature yellow perch and white sucker were measured as time permitted taking care to measure the smallest and largest fish to assess the size range of species within the lake.

Mature males were considered those with opaque white gonads and mature females were considered as those with opaque orange gonads where developing eggs were visible. Mature white sucker and yellow perch were processed for length, weight, liver weight, and gonad weight EEM endpoints. White sucker and yellow perch with GSI less than 1% were considered as immature and not included in the analysis and is described in the Technical Guidance (EC 2012). Fish were measured to the nearest millimeter. Body weight were measured using a A&D® balance (EJ-300) accurate to 0.01 grams. Gonad and liver weights were measured using an A&D® Precision Balance (FZ-120iWP) accurate to 0.001 grams. Age structures were also retained for determination of age. The first pectoral ray and scales were retained for white sucker and the third dorsal spine and scales were retained for yellow perch. The pectoral ray and dorsal spines were used as the primary aging structure with the scales used as back up as needed to verify or confirm fish ages. Age analysis was conducted by Bob Irwin in Maynooth, Ontario.

The remaining five fish of each species were retained for whole body analysis, which is described in more detail below.



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2. BATHYMETRY DATA PROVIDED BY GHD.

LEGEND
- EXISTING ROAD - PAVED
- EXISTING ROAD - DIRT
- EXISTING WATERCOURSE
- EXISTING WATERBODY - OTHER
- WATER SAMPLE LOCATION
- MINNOW TRAPS

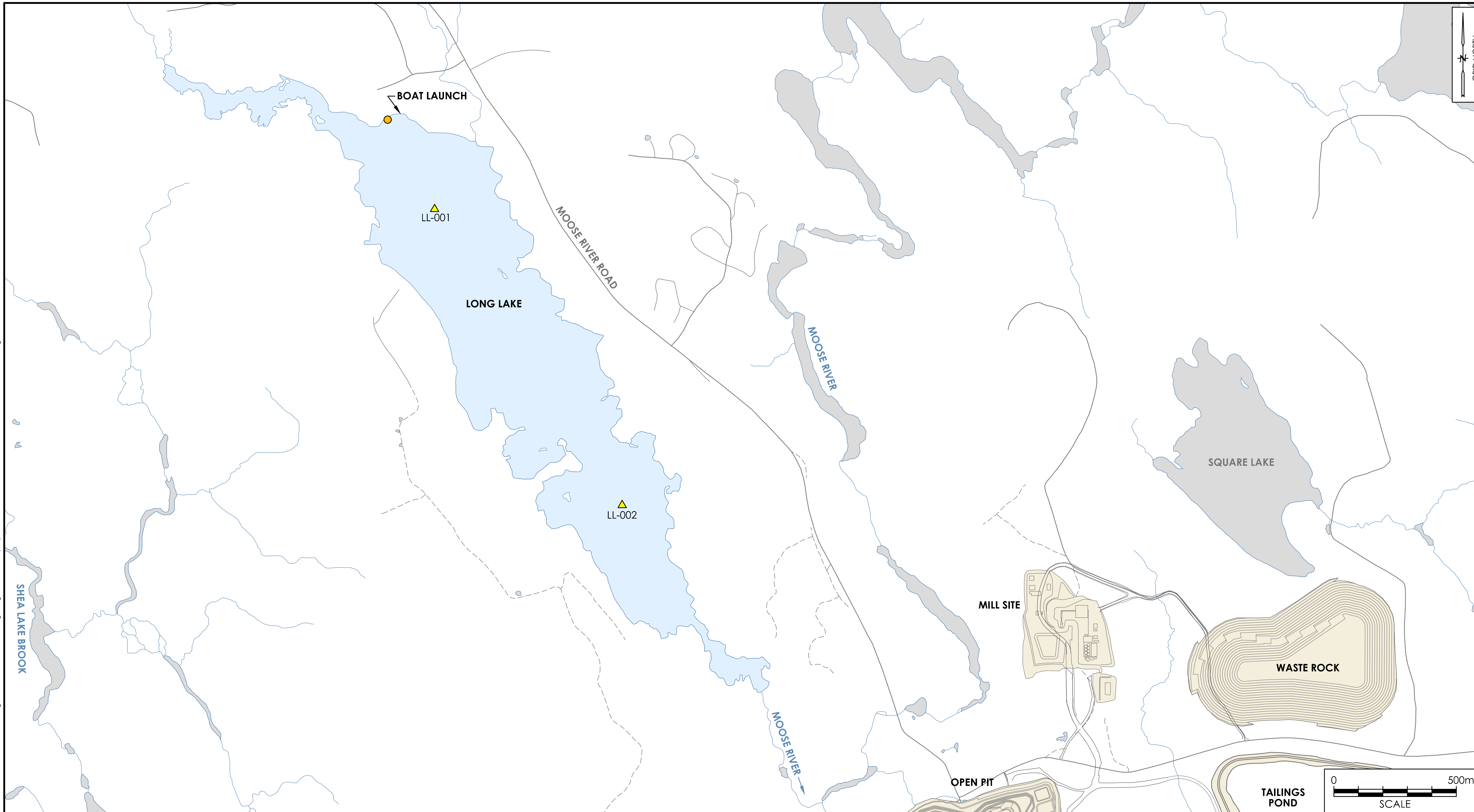
BATHYMETRY
- 0 - 3 m DEPTH
- 3 - 6 m DEPTH
- 6 - 9 m DEPTH
- 9 - 12 m DEPTH
- > 12 m DEPTH

Client/Project
ATLANTIC GOLD CORPORATION
2017 BASELINE AQUATIC ENVIRONMENT TECHNICAL REPORT

Project No.
121619250

Title
LOCATIONS OF RECONNAISSANCE AND BASELINE AQUATIC EEM SAMPLING ON SCRAGGY LAKE

Revision	Date
REV-0	2018.04.09
Reference Sheet	Figure No.
-	3.1



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LEGEND
- EXISTING ROAD - PAVED
- EXISTING ROAD - DIRT
- EXISTING WATERCOURSE
- EXISTING WATERBODY - OTHER
- EXISTING WATERBODY - STUDY AREA
- WATER SAMPLE LOCATION
- MINNOW TRAPS

Client/Project
ATLANTIC GOLD CORPORATION
2017 BASELINE AQUATIC ENVIRONMENT TECHNICAL REPORT

Project No.
121619250

Title
LOCATIONS OF RECONNAISSANCE SAMPLING ON LONG LAKE

Revision
REV-0

Date
2018.04.29

Reference Sheet
-

Figure No.
3.2

3.1.2.1 Data Analysis

Descriptive metrics were calculated for sentinel species following the procedures outlined in the Technical Guidance (EC 2012). Condition factor (K), gonadosomatic index (GSI) and liver somatic index (LSI) were completed on sentinel species (mature white sucker and yellow perch) using the following equations:

- Condition Factor (K) = (fish weight/fork length^3) x 100
- Gonadosomatic Index (GSI) = (gonad weight/fish weight) x 100
- Liver Somatic Index (GSI) = (liver weight/fish weight) x 100

Mean, median, standard deviation, standard error, minimum and maximum values were calculated for each descriptive metric and can be found in Section 4.1.

3.1.3 Fish Tissue Analysis for Metals

Fish selected for tissue analysis for metals were transferred on ice in clean plastic bags from the collection site to a field laboratory. Dissecting tools (e.g., scalpel, forceps, cutting board) were rinsed with tap water, followed by de-ionized water between samples, to prevent cross-contamination. Nitrile gloves were worn during dissections and were changed between samples to prevent cross contamination.

Five white sucker and five yellow perch were retained and transferred into Whirl-Pak® bags or large Ziploc® bags, depending on fish size. Samples were labelled with a unique sample number and placed immediately into a freezer for storage prior to being submitted to Maxxam Analytics in Bedford, NS, for analysis of whole body mercury and metals.

Fish tissue samples were analyzed for several parameters, including a complete scan for metals, using Inductively Coupled Plasma Mass Spectrometry (ICP-MS), and for mercury, using Cold Vapour Atomic Absorption (CVAA). Results are presented on a wet weight basis.

3.1.4 Data Analysis

Mean, minimum, maximum, standard deviation and standard error were calculated for each tissue parameter by fish species and location captured. Several metals were selected for detailed analysis, including aluminum, arsenic, cadmium, copper, iron, lead, mercury, and zinc based on concentrations of these parameters in surface water quality data (Stantec 2017). The results of fish tissue analysis were compared to applicable federal consumption guidelines for mercury and can be found in Section 4.2.

The Health Canada fish consumption guideline for human consumption for mercury is 0.5 mg/kg (Health Canada 2007). As there are no provincially specific guidelines for Nova Scotia, the Ontario Ministry of Environment (MOE) guidelines for fish muscle tissue were used for comparison. The MOE (2013) has established a complete restriction consumption guideline level of 0.52 mg/kg total mercury in fish muscle tissue (fillets), and a partial restriction of 0.26 mg/kg, for women of child bearing age and children under the age of 15 years old; a complete restriction consumption guideline of 1.84 mg/kg has also been established for the general population MOE (2013). The data presented in the report are for whole fish, whereas the guidelines are for fish muscle tissue (e.g., fillet).

3.2 BENTHIC INVERTEBRATE COMMUNITY ASSESSMENT

Five samples were collected for BIC assessment within the littoral areas of the nearfield and farfield locations of Scraggy lake in October 2017. As noted earlier, no benthic invertebrate samples were collected from Long Lake or Alma Lake due to a lack of available field time; priority was given to collecting baseline data from Scraggly Lake prior to effluent discharge from the Mine.

Initially benthic samples were to be collected by an Eckman grab which would allow a defined area to be sampled within the littoral zone, however due to the presence of boulders, rocky shoreline and general low quantity of fine material, the Eckman grab was not suitable for use in the littoral area of the lake. Benthic samples were instead collected by kick sampling as described below.

Each benthic invertebrate sample was collected from within a general area of similar substrate type and consisted of three sub-samples collected at least 10 m apart. Samples were taken at water depths of less than one meter and the three sub-samples were composited to form one sample. Kick samples were collected using a standard D-frame kick net with 500 µm mesh size, in accordance with the Technical Guidance (EC 2012). Kick samples were collected by placing the bottom of the D-frame net firmly in contact with the substrate and then systematically kicking and turning over the substrate within the area in front of the net while moving in a forward at the same rate for each sample. A standard time of one minute of sampling effort was applied for each subsample. This method was relatively qualitative as a result of the uneven and large substrate available for kicking.

Samples collected in the D-frame net were transferred to a sorting box and sieved in the field through a 500 µm mesh sieve to remove excess sediment, using site water to rinse the sample. Samples were fixed in the field with 95% denatured alcohol diluted to 75% (Fisher Scientific HC1300) and labelled on the inside and outside of each sample container. Samples were switched over to 95% denatured alcohol within 48 hours of collection for longer-term preservation.

Benthic invertebrates were sorted and identified to the lowest practical level by a qualified taxonomist at Envirosphere Consultants Limited in Windsor, NS. Eight of the ten samples were sub-sorted to allow for consistent processing times and adequate numbers of organisms for analysis. Depending on the sample volume and the expected number of specimens present, samples designated for sub-sampling were manually divided into specific fractions of the original sample (e.g., ½ or ¼). All fractions produced during sub-sampling were weighed and verified to be equivalent (i.e., within 0.5 to 1.0 g). Final counts for the sub-samples were extrapolated to 100%, based on the sub-sample percentage.

A reference collection was retained in archive for potential future taxonomic verification and calculations of sorting efficiency and sub-sampling error were provided.

3.2.1 Data Analysis

BIC data were analyzed using four effect endpoints: total invertebrate density, taxa richness, Simpson's Evenness Index, Simpson's Diversity Index and biomass. Total invertebrate density, taxa richness, Simpson's Evenness Index and Bray-Curtis Dissimilarity Index are required endpoints in the Technical

Guidance (EC 2012), however the Bray-Curtis Dissimilarity Index was not calculated as per the Technical Guidance (EC 2012) because it requires a reference location for comparison.

BIC invertebrate density (number of organisms per m^2) could not be calculated quantitatively as a result of the uneven substrate and difficulty finding suitable substrate for kick netting, therefore a measure of abundance (# of individuals per three minutes of kick netting) was used.

Data were summarized at the family level since there were several taxa with a low number of individuals (e.g., one or two), as per the Technical Guidance (EC 2012).

The EEM benthic invertebrate community endpoints and descriptors are defined below.

- Mean invertebrate abundance: # of individuals per three minutes of kick-netting
- Mean taxa richness: mean number of taxa (family-level)
- Mean Simpson's Evenness Index (E): a measure of the distribution of individuals among sampled taxa (range: 0 to 1) and calculated at the family level; a more equitable distribution (values approaching 1) indicates how evenly the individual species in the community are distributed. The evenness value for such a community would be 1.
- Mean Simpson's Diversity Index (D): the probability that two organisms, selected at random, are from a different taxonomic group (range: 0 to 1, with larger values indicative of more diverse communities); this index is influenced by the numerically dominant taxa and calculated at the family level.
- Biomass: a measure of the total weight of all organisms per sample; integrated measure of growth and survival; can be used to quantify productivity / energy flow within food chains.

Simpson's Evenness (E) was calculated using the formula:

$$E = \frac{1}{\frac{\sum_{i=1}^{S}(p_i)^2}{S}}$$

where 'p_i' is the proportion of individuals of the 'i^{th}' taxon in a community of 'S' taxa:

($_i$ = 1 to S).

Simpson's Diversity was calculated using the formula:

$$D = 1 - \sum (p_i)^2$$

where 'p_i' is the proportion of individuals of the 'i^{th}' taxon in a community of 'S' taxa
(i = 1 to S).

3.3 WATER AND SEDIMENT QUALITY ASSESSMENT

Two water sampling campaigns were completed in 2017. During the reconnaissance survey in August, near-field, mid-field, and far-field sampling locations were established in Scraggy Lake based on distance from the future effluent final discharge point and water depth (Figure 3.1). Two additional sampling locations were established in nearby Long Lake to serve as a potential reference to Scraggy Lake (Figure 3.2). During the September baseline study, one additional sampling site (SGL-007) located between the two main basins of Scraggy Lake was added at the proponent's request (Figure 3.1).

As noted earlier, for the baseline program, no sediment sampling was conducted in Long Lake or Alma Lake due to lack of available field time; priority was given to Scraggy Lake to obtain baseline information prior to effluent discharge from the Mine.

3.3.1 Water Sampling

During the August reconnaissance visit, two samples (near surface, near bottom) were collected at each location on Scraggy Lake and Long Lake for laboratory analysis which included general chemistry, dissolved metals, total metals and chlorophyll a. Surface samples were grab samples, while the near bottom samples were collected using a food-grade battery-powered pump with food grade tubing. Prior to use on each lake, the pump and associated tubing was rinsed with a 5% hydrochloric acid solution as per USGS (2004). Prior to each sample collection, the pump was rinsed for several minutes with lake water from the sampling location. Samples were collected using the appropriate containers as defined by the accredited laboratory. Trace metals samples were field filtered using disposable 45 µm syringe filters. Samples submitted for chlorophyll *a* analysis were collected using amber glass bottles covered with foil paper to further limit light penetration. Water samples were immediately placed in coolers and stored at 4°C for transport to the laboratory.

In-situ temperature, dissolved oxygen, and conductivity profiles were collected at each sampling location using a YSI Multi-Meter (Model Pro2030, Ohio, USA). Readings were done at 0.5 m intervals from the surface to the bottom and again from bottom to surface. Measurements for turbidity at surface and near bottom were taken using a turbidity meter (Hach 2100Q turbidimeter, Ontario, Canada). In addition, *in-situ* pH was measured at each location using a Hanna Instruments pH meter (Model HI98127, Quebec, Canada).

3.3.2 Sediment Sampling

One composite sediment sample was collected by hand/jar at each of the benthic invertebrate sampling stations (SGL-001 and SGL-003) where a composite of five subsamples were collected at each station for laboratory analysis of total organic carbon, particle size and total metals, and *in-situ* measurement for redox using a Hanna redox meter (Model HI98120, Quebec, Canada).

3.3.3 Data Analysis

Surface and near bottom water quality were compared to the Canadian Environmental Quality Guidelines for water for the protection of aquatic life (CEQG-Water; CCME 2018). Sediment quality was compared with the Interim Sediment Quality Guidelines (ISQG) and with Probable Effects Levels (PEL) guidelines (CCME 2018).

3.4 QUALITY ASSURANCE AND QUALITY CONTROL

A QA/QC program was implemented to confirm that data produced would be of acceptable and of verifiable quantity and meet the data quality objectives in support of future EEM requirements under MMER. For the field component of the study, the program included a field plan, standard operating procedures for sampling, consistent sampling techniques, and the use of standardized field data collection sheets. The field sampling was conducted by a team of four experienced staff, including two biologists who have conducted lethal fish, benthic invertebrate community, water and sediment sampling for EEM for metal mining projects.

Each fish was weighed using a calibrated digital scale (± 0.01 g) and measured using a measuring board (± 1 mm). Where possible all efforts were made to increase accuracy; fish were weighed in an enclosed room or container to minimize the effects of wind on the balance, the balance was tared prior to weighing between fish, and efforts were made to reduce the residual amounts of water on fish. A subset of 10% of the fish that were lethally sampled were remeasured and reweighed for quality assurance and quality control as described in the Technical Guidance (EC 2012).

For statistical analysis of data from the fish survey, Section 4.2.3 outlines data QA/QC and identification of outliers.

The benthic invertebrate samples were sorted and identified by a qualified taxonomist and in accordance with the Technical Guidance (EC 2012). A reference collection of representative benthic invertebrate taxa was retained for future verification (if warranted) and estimates of sorting efficiency were performed as described in the Technical Guidance (EC 2012) and were confirmed to be within 10% criterion for acceptability.

All water and sediment sampling equipment were checked to confirm normal operation prior to using. QA/QC measures included the pre-labelling of sampling bottles, eliminating the need to label samples under field conditions. All sample locations were identified and assigned either a name or number identifier prior to starting the field surveys. Pertinent sample identification information was recorded on a data sheet and/or field book. Samples were packaged in coolers containing well-sealed ice packs, issued chain-of-custody forms, and stored at the appropriate temperature until shipped.

Field blanks were used to check contamination from all potential sources of contamination of the sample (e.g., contaminated sample bottles, caps, equipment, atmospheric contamination, sampling techniques, analysis). Duplicate field samples were collected to verify analytical results, equipment reliance, the homogeneity of the site, and the reproducibility of the sampling approach.

For water quality sampling, field duplicates were collected for approximately 10% of the samples as well as using field and trip blanks throughout the field program. No field duplicates were conducted for the sediment sampling as only two samples were taken.

4.0 RESULTS

4.1 ADULT FISH SURVEY

4.1.1 Habitat Assessment

Scraggy and Long Lake are in the Moose River Watershed. Both lakes are surrounded by forested land and wetlands. There is a small amount of development on each lake (e.g., cottages) and the lakes provides opportunities for recreational users though a boat launch on each lake. In addition, Scraggy Lake mining-related activities at the northwestern end.

4.1.1.1 Scraggy Lake

Scraggy Lake was characterized by two large basins (Figure 3.1). The basin closest to the future effluent discharge point was approximately 3 km in length and 1 km in width. Water depths were generally shallow (<6 m), however a deeper area (6-11.2 m) runs approximately 75% of the length of the basin. Maximum depth in this basin was 11.2 m.

The basin farthest from the future effluent discharge point was approximately 4 km in length and a maximum of 4 km in width. Similarly, water depths were generally shallow (<6 m), however a deeper area (>12 m) was found near the boat launch (Figure 3.1). Maximum depth in this basin was 14.0 m.

Fish habitat in Scraggy Lake was comprised principally of shallow water rocky habitats (<6 m water depth) with sparse amounts of emergent vegetation near the shoreline (e.g., water lilies). Substrate was a mix of cobble, rock, and some sand in littoral areas. Rock outcrops and large boulders were prevalent in Scraggy Lake. The profundal zone of the lake was characterized by rich organic flocculent/mucky substrate, which was observed during reconnaissance sampling in August 2017. The fish habitat in Scraggy Lake is good for species which prefer shallow (<3 m) rocky substrate and structure.

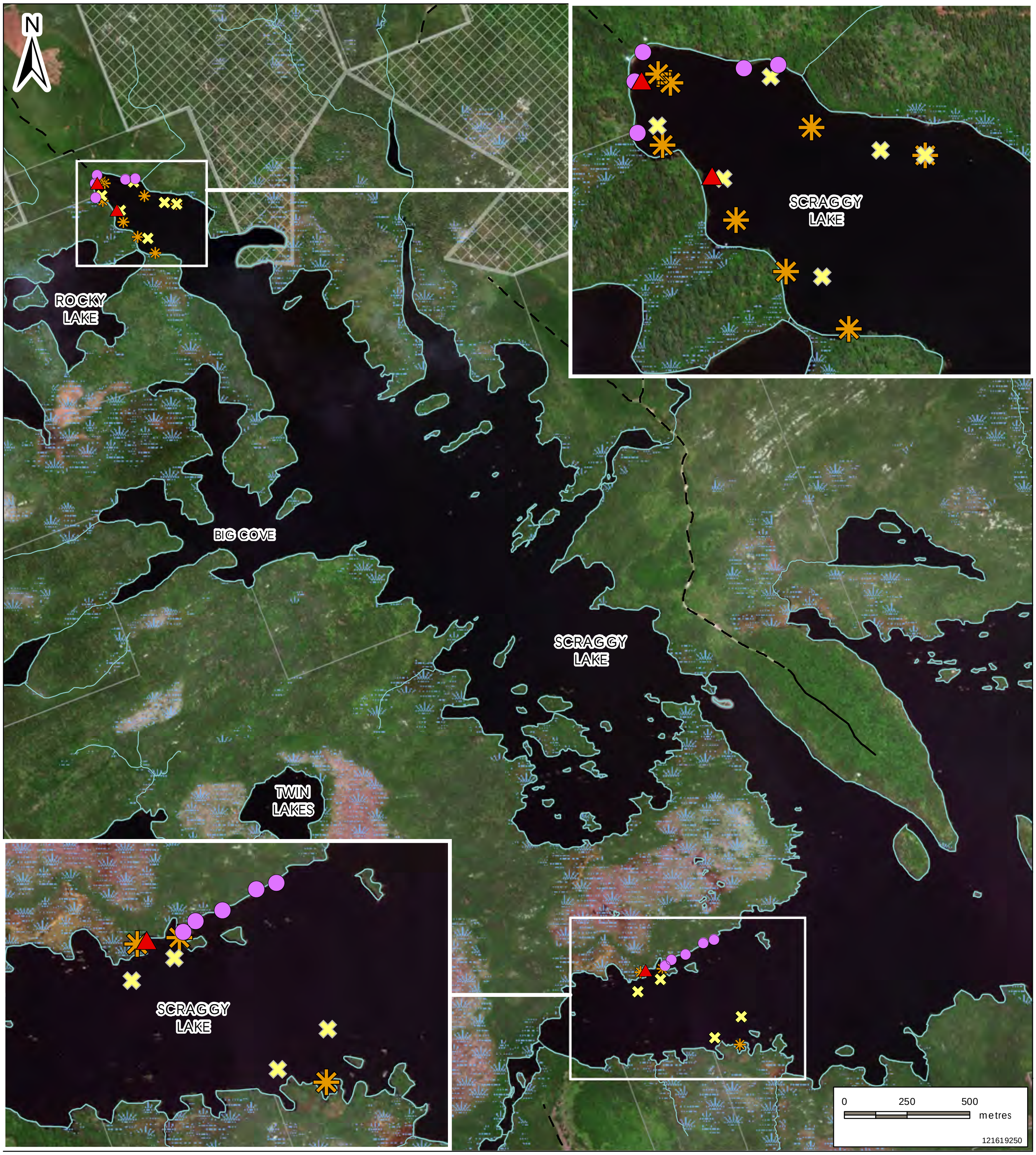
Photos in Appendix A show the representative shoreline habitat for Scraggy Lake and Fish River.

4.1.1.2 Long Lake

Long Lake is in the Moose River Watershed. Long Lake was characterized by one long basin (Figure 3.2) which was approximately 3 km in length and 0.5 km in width. Water depths were generally shallow (<3 m) with a maximum depth in this basin of 3.0 m. Unlike Scraggy Lake, no deeper basin was identified in the field.

Fish habitat in Long Lake was comprised principally of shallow water rocky habitats (<3 m water depth) with sparse amounts of emergent vegetation near the shoreline. Substrate was a mix of cobble, rock, and some sand in littoral areas. The profundal zone of the lake was characterized by rich organic flocculent/mud substrate. The fish habitat in Long Lake is good for species which prefer shallow (<3 m) rocky substrate.

Photos in Appendix A show the shoreline habitat for Long Lake.



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Stantec

Legend

- BENTHIC
- FYKE NET
- GILL NET
- MINNOW TRAP
- ROAD
- TRACK
- WATERCOURSE
- WATERBODY
- WETLAND
- CROWN LAND

102 - 40 Highfield Park Drive
Dartmouth NS
www.stantec.com

Notes

1. Coordinate System: NAD 1983 CSRS UTM Zone 20N
2. Baedata Source: Government of Nova Scotia
3. Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Client/Project

ATLANTIC GOLD CORPORATION
TOUQUOY GOLD PROJECT

Figure No.
4.1

Title
FISH AND BENTHIC INVERTEBRATE COMMUNITY SAMPLING LOCATIONS FOR SCRAGGY LAKE, NS

4.1.2 Fish Community Assessment

The fish community assessment was divided into two surveys; a fish community reconnaissance survey (August 2017) was used to select suitable species for the subsequent baseline survey (October 2017). The fish surveys were conducted in accordance with Scientific Collection Licence #321156. Locations of various fyke net, gill net, and minnow trap gear sets used for the baseline survey are shown in Figure 4.1. Raw data are provided in Appendix B.

4.1.2.1 Reconnaissance Survey

During the reconnaissance survey in August 2017, the fish community was assessed using minnow traps. Four minnow traps were each set in Scraggy Lake for 48 hours and set in Long Lake for three hours. In Scraggy Lake, four yellow perch ranging in fork length from 7.2 to 8.0 cm and one brown bullhead (*Ameiurus nebulosus*) (4.3 cm) were captured. In Long Lake, five banded killifish were captured ranging from 6.4 to 8.3 cm in length. Catch per unit effort (CPUE) for Scraggy Lake was three fish per day and for Long Lake was 40 fish per day.

4.1.2.2 Baseline Survey

Over a four-day period of intensive effort in October 2017, more than 1,000 fish were collected from Scraggy Lake, representing twelve different species from nine different families (Table 4.1). As noted earlier, baseline sampling was not conducted in Long Lake or Alma Lake due to lack of available field time; priority was given to collecting baseline data from Scraggy Lake prior to the discharge of effluent from the Mine. The dominant fish species by relative abundance sampled from Scraggy Lake were yellow perch (56%), alewife (13%), and white sucker (13%). Minimum and maximum lengths of the fish sampled are shown in Table 4.2.

Gill nets were used as the primary collection method in lakes (Table 4.3). Nets consisting of 38, 51 and 64 mm mesh sizes were the most successful. Fyke nets and minnow traps were successful for capturing small yellow perch.

Table 4.1 Total Number of Fish Captured from Nearfield and Farfield Locations in Scraggy Lake, NS for EEM Fish Survey.

Species	Nearfield (SGL-001)	Farfield (SGL-003)	Grand Total
Alewife (*Alosa pseudoharengus*)	137	9	146
American eel (*Anguilla rostrata*)	8	0	8
Atlantic salmon (*Salmo salar*)	0	2	2
Banded Killifish (*Fundulus diaphanus*)	34	3	37
Brown Bullhead (*Ameiurus nebulosus*)	45	42	87
Brook Trout (*Salvelinus fontinalis*)	4	6	10

Table 4.1 Total Number of Fish Captured from Nearfield and Farfield Locations in Scraggy Lake, NS for EEM Fish Survey.

Species	Nearfield (SGL-001)	Farfield (SGL-003)	Grand Total
Golden Shiner (*Notemigonus crysoleucas*)	5	3	8
Lake Chub (*Couesius plumbeus*)	19	0	19
White Perch (*Morone americana*)	2	6	8
White Sucker (*Catostomus commersonii*)	91	64	155
Yellow Perch (*Perca flavescens*)	485	126	611
Grand Total	**830**	**261**	**1091**

Table 4.2 Minimum and Maximum Fork Length Ranges of the Fish Species Collected in Scraggy Lake, NS

Species	Number (n)	Minimum Fork Length (mm)	Maximum Fork Length (mm)
Alewife	34	6.2	28
American eel	7	30[a]	62
Atlantic salmon	2	23.2	24.7
Banded killifish	32	4.8	8.2
Brown bullhead	11	5.9	25.5
Brook trout	9	16.9	32.9
Golden shiner	4	12.3	15
Lake chub	7	7.1	12.5
White perch	6	26	34
White sucker	138	15.3	33.7
Yellow perch	124	4.4	23.2
Note: [a] length was estimated visually			

Table 4.3 Summary of Catch Per Unit Effort (CPUE) by Fishing Method in Scraggy Lake

Waterbody name	Gill Nets			Minnow Traps			Fyke Nets		
	Total Effort (net[a] hours)	Total Catch	CPUE (fish / net[a] / day)	Total Effort (trap hours)	Total Catch	CPUE (fish / trap / day)	Total Effort (trap hours)	Total Catch	CPUE (fish / trap / day)
Nearfield, Scraggy Lake	137.8	220	38.3	184.4	335	43.6	84.8	275	77.8
Farfield Scraggy Lake	106.1	172	38.9	71.3	34	11.4	23.2	55	57

Note: [a]1 net is equivalent to a 30.5 m (100 ft) gill net

4.1.2.3 Lethal Sampling for Endpoints

Two species, white sucker and yellow perch were targeted as the sentinel species for the lethal baseline program. Both species are routinely used in EEM programs in Canada (EC 2012).

Yellow perch spawn once per year, in spring, typically in late April to early May (Scott and Crossman 1973). Adults migrate to the shallows of the lake or may spawn in river tributaries. Spawning takes place on rooted vegetation, submerged brush, fallen trees, or occasionally over sand or gravel (Scott and Crossman 1973). The best time to sample yellow perch for EEM is during the late fall, approximately 6 months prior to spawning (EC 2012).

As noted in Section 3, length, weight, condition, GSI, LSI, and age data were obtained. Other than descriptive statistics (e.g., count, mean, median, minimum, maximum, standard deviation, standard error), no comparative analyses were conducted because this is a baseline program to set existing conditions. Resulting data will be used to support interpretation of future EEM results when the Mine becomes subject to EEM under MMER.

White Sucker

In total, 155 white sucker were captured as part of the lethal baseline survey in Scraggy Lake. White sucker ranged in fork length from 15 to 34 cm. One white sucker was identified as immature based on a GSI of less than 1% as described in the Technical Guidance (EC 2012) (Appendix B). Of these, 44 male and 36 female mature white sucker were selected for the lethal survey endpoints. No abnormalities were found on any of the white sucker captured, however several fish had parasites within their body cavity or on internal organs (i.e., encysted nematodes, other unknown parasites). The descriptive statistics for each of the sampling groups is presented in Table 4.4.

Table 4.4 Descriptive Statistics for Weight, Length, Condition, GSI, LSI and Age for White Sucker Captured in October 2017, Atlantic Gold, Touquoy Mine

Statistic	Length (cm)	Weight (g)	Condition	GSI	LSI	Age
Male White Sucker - Nearfield						
Count	22	22	22	20	20	22
Mean	23.4	156.8	1.2	5.0	0.87	4.2
Median	23.1	149.9	1.2	5.2	0.84	4.0
Minimum	21.5	113.5	1.0	3.5	0.64	2.0
Maximum	28.6	293.8	1.3	6.1	1.29	7.0
Standard Deviation	1.6	38.8	0.1	0.7	0.18	1.22
Standard Error	0.35	8.27	0.02	0.16	0.04	0.26
Male White Sucker - Farfield						
Count	22	22	22	21	21	22
Mean	25.2	195.4	1.2	4.8	0.89	4.95
Median	25.1	196.6	1.2	5.1	0.86	5.0
Minimum	20.3	94.6	0.8	3.6	0.62	3.0
Maximum	30.8	340	1.2	5.6	1.46	8.0
Standard Deviation	2.5	58.0	0.1	0.6	0.20	1.46
Standard Error	0.53	12.36	0.02	0.14	0.04	0.31
Female White Sucker - Nearfield						
Count	18	18	18	17	17	17
Mean	27.7	258.3	1.6	3.5	1.25	5.9
Median	27.2	237.8	1.6	3.6	1.21	5.5
Minimum	22.7	135.5	1.0	1.5	0.92	3.0
Maximum	33.7	460.0	1.3	4.5	1.64	11.0
Standard Deviation	3.3	96.6	0.1	0.7	0.22	2.08
Standard Error	0.78	22.76	0.01	0.05	0.05	0.49
Female White Sucker - Farfield						
Count	18	18	18	18	18	18
Mean	27.3	237.6	1.2	3.4	1.24	5.1
Median	28.0	249.6	1.2	3.4	1.10	5.0
Minimum	23.8	153.0	1.0	2.8	0.91	4.0
Maximum	29.1	275.6	1.2	4.3	1.74	8.0
Standard Deviation	1.6	36.2	0.1	0.4	0.25	1.1
Standard Error	0.38	8.53	0.02	0.09	0.06	0.26

Female white sucker in the nearfield and farfield locations in Scraggy Lake appeared to be slightly longer (Figure 4.2) and heavier (Figure 4.3) than male white suckers. There did not appear to be obvious differences in the length or weight of male or female white sucker when comparing the nearfield to farfield locations.

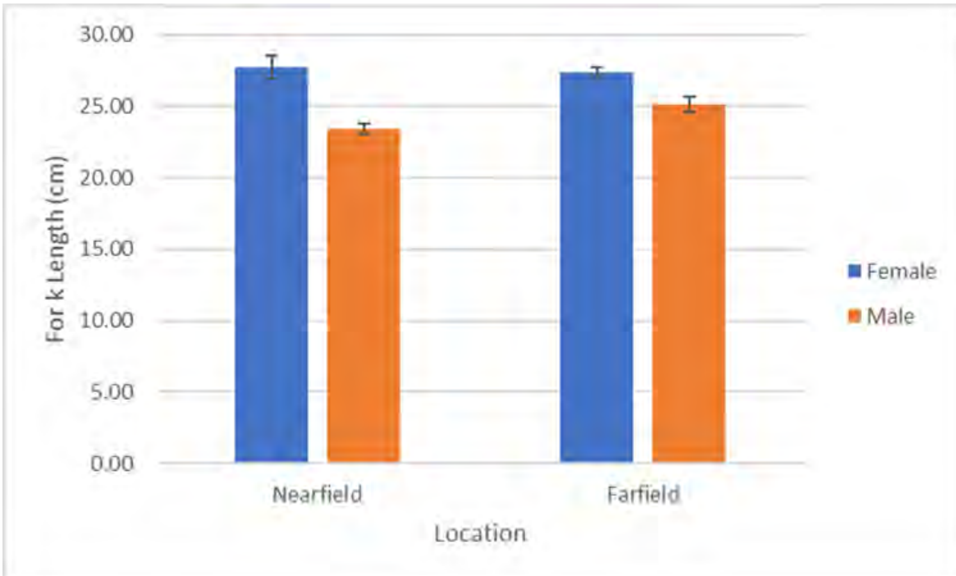


Figure 4.2 Average Male and Female White Sucker Length ± Standard Error in Scraggy Lake; October 2017, Atlantic Gold, Touquoy Mine

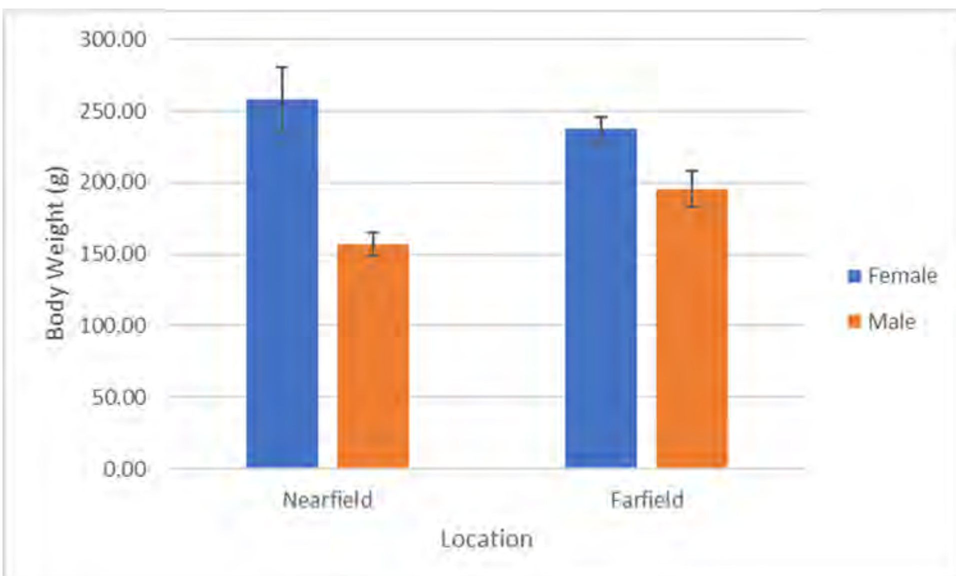


Figure 4.3 Average Male and Female White Sucker Weight ± Standard Error in Scraggy Lake; October 2017, Atlantic Gold, Touquoy Mine

Female white suckers in the nearfield and farfield locations in Scraggy Lake appeared to be have lower condition than male white suckers (Figure 4.4). There did not appear to be obvious differences in the condition of males or females when comparing between the nearfield to farfield locations.

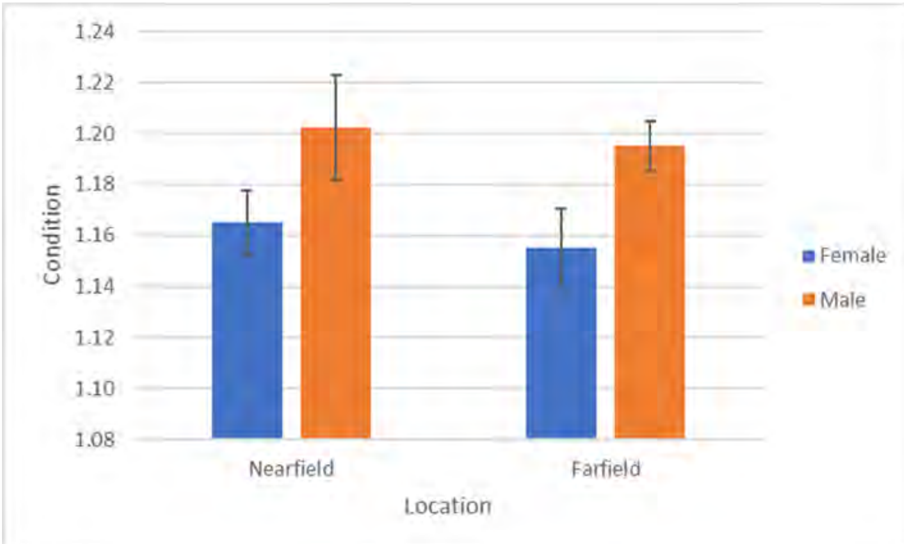


Figure 4.4 Average Male and Female White Sucker Condition ± Standard Error in Scraggy Lake; October 2017, Atlantic Gold, Touquoy Mine

Female white suckers in the nearfield and farfield locations in Scraggy Lake appeared to be have lower GSI and LSI than male white suckers (Figure 4.5; Figure 4.6). There did not appear to be obvious differences in the GSI or LSI for males or females when comparing between the nearfield to farfield locations.

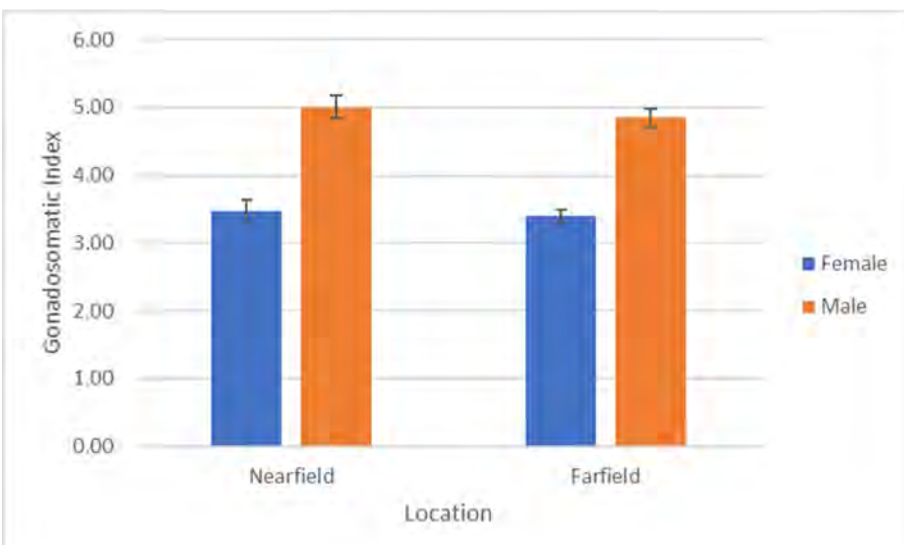


Figure 4.5 Average Male and Female White Sucker GSI ± Standard Error in Scraggy Lake; October 2017, Atlantic Gold, Touquoy Mine

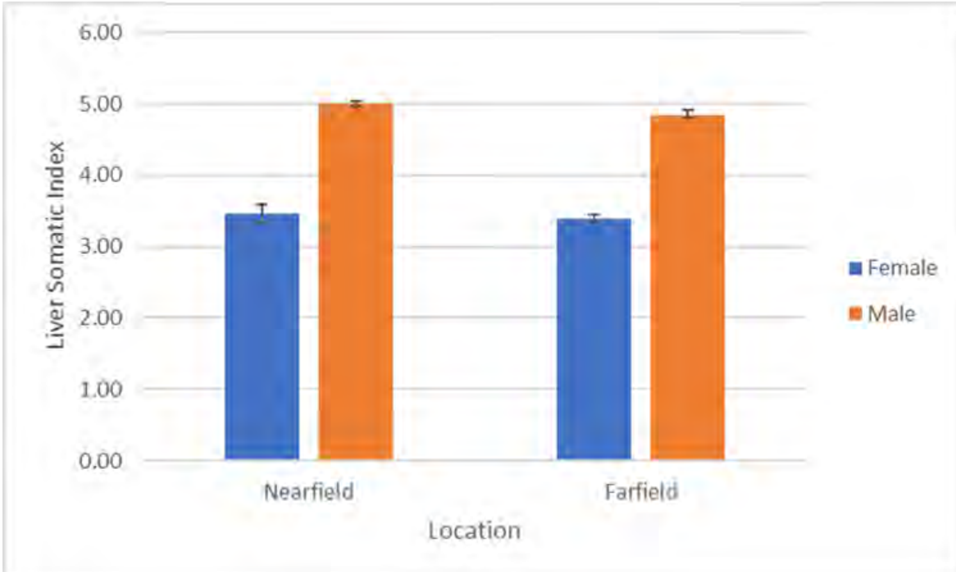


Figure 4.6 Average Male and Female White Sucker LSI ± Standard Error in Scraggy Lake; October 2017, Atlantic Gold, Touquoy Mine

Nearfield female white sucker appeared slightly older than farfield female white sucker, whereas male white sucker in the nearfield were slightly younger than the in the farfield. Male white sucker in the nearfield were younger than females, whereas in the farfield they were similar ages (Figure 4.7).

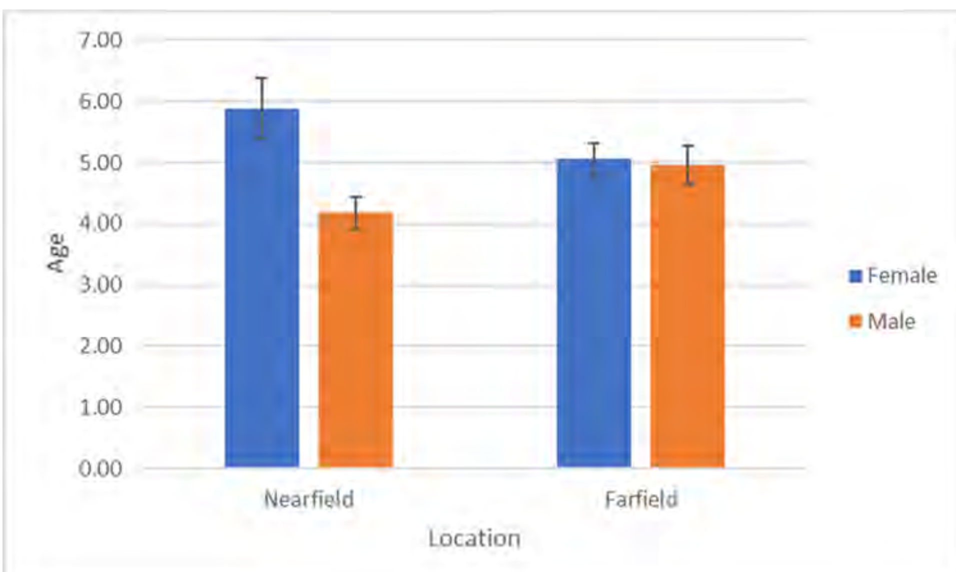


Figure 4.7 Average Male and Female White Sucker Age ± Standard Error in Scraggy Lake; October 2017, Atlantic Gold, Touquoy Mine

Yellow Perch

In total, 611 yellow perch were captured as part of the lethal EEM survey in Scraggy Lake. Yellow perch ranged in length from 4 to 23 cm. One yellow perch was identified as immature based on a GSI of less than 1% as described in the Technical Guidance (EC 2012) (Appendix B). Of these, 40 male and 43 female mature yellow perch were selected for the lethal survey endpoints. One male yellow perch was removed from the lethal fish survey data set as the gonads were not opaque indicating it was likely immature and would be reaching maturity for the upcoming spring season. An abnormality (e.g., bent spine) was observed on one of the yellow perch captured. The descriptive statistics for each of the sampling groups is presented in Table 4.5.

Table 4.5 Descriptive Statistics for Weight, Length, Condition, GSI, LSI and Age for Yellow Perch Captured in October 2017, Atlantic Gold, Touquoy Mine

Statistic	Length (cm)	Weight (g)	Condition	GSI	LSI	Age
Male Yellow Perch - Nearfield						
Count	21	21	21	21	21	21
Mean	9.67	11.35	1.12	6.28	0.87	2.62
Median	9.00	8.35	1.12	6.18	0.84	2.00
Minimum	8.00	5.89	0.95	1.93	0.65	2.00
Maximum	16.00	47.94	1.27	9.08	1.28	6.00
Standard Deviation	1.90	9.53	0.09	1.93	0.17	1.07
Standard Error	0.41	2.08	0.02	0.44	0.04	0.23
Male Yellow Perch - Farfield						
Count	19	19	19	19	19	19
Mean	9.02	8.95	1.14	7.03	1.05	1.84
Median	8.90	8.02	1.15	6.79	1.03	2.00
Minimum	7.60	4.86	1.07	5.47	0.55	1.00
Maximum	13.70	29.23	1.22	10.68	1.84	5.00
Standard Deviation	1.29	5.19	0.04	1.26	0.27	0.90
Standard Error	0.30	1.19	0.01	0.29	0.06	0.21
Female Yellow Perch - Nearfield						
Count	21.00	21.00	21.00	20.00	20.00	21.00
Mean	13.75	31.27	1.12	2.57	1.16	3.90
Median	13.00	27.30	1.12	2.59	1.04	4.00
Minimum	11.00	15.61	1.01	0.89	0.62	2.00
Maximum	17.50	64.63	1.25	3.73	3.41	7.00
Standard Deviation	2.10	15.15	0.07	0.62	0.56	1.22
Standard Error	0.46	3.31	0.02	0.14	0.12	0.27
Female Yellow Perch - Farfield						

Table 4.5 Descriptive Statistics for Weight, Length, Condition, GSI, LSI and Age for Yellow Perch Captured in October 2017, Atlantic Gold, Touquoy Mine

Statistic	Length (cm)	Weight (g)	Condition	GSI	LSI	Age
Count	22.00	22.00	22.00	21.00	21.00	22.00
Mean	15.02	43.98	1.24	1.17	1.17	4.14
Median	14.50	35.52	1.21	1.18	1.18	4.00
Minimum	10.50	13.80	1.06	0.80	0.80	3.00
Maximum	18.50	87.94	1.45	1.56	1.56	6.00
Standard Deviation	1.90	17.89	0.10	0.19	0.19	0.99
Standard Error	0.41	3.81	0.02	0.04	0.04	0.21
Count	22	22	22	21	21	22

Female yellow perch in the nearfield and farfield locations in Scraggy Lake appeared to be slightly longer and heavier than male yellow perch (Figure 4.8; Figure 4.9). There did not appear to be obvious differences in the length or weight of males or females when comparing the nearfield to farfield locations.

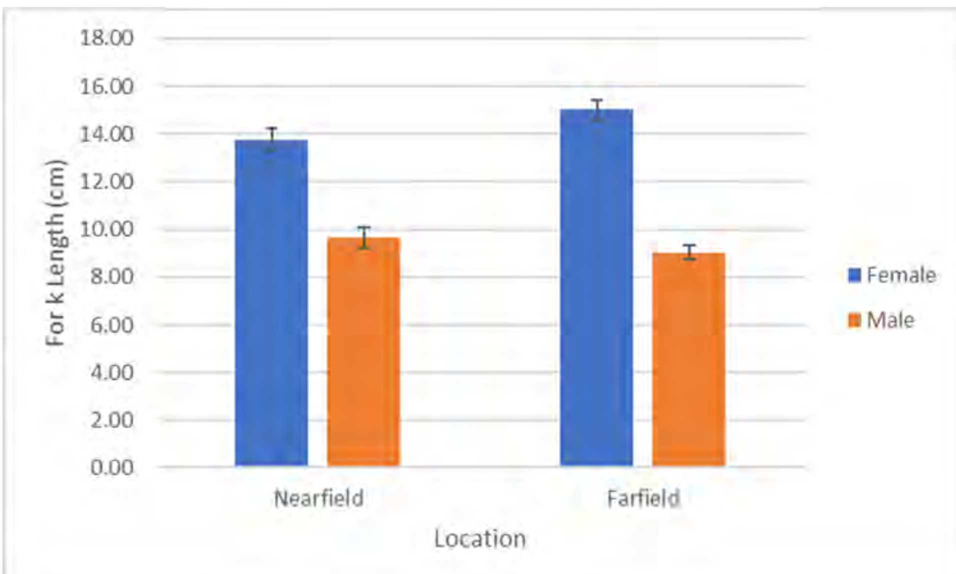


Figure 4.8 Average Male and Female Yellow Perch Length ± Standard Error in Scraggy Lake; October 2017, Atlantic Gold, Touquoy Mine

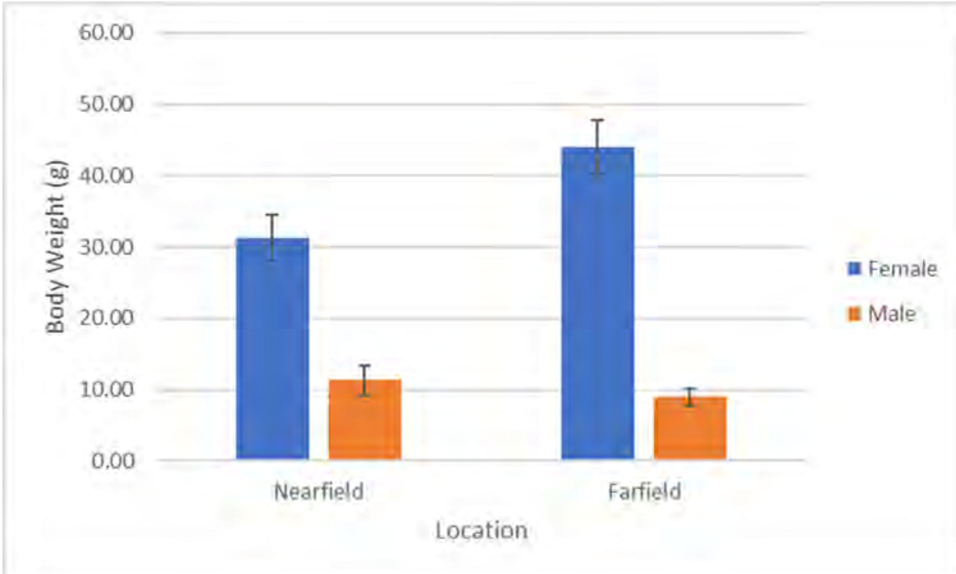


Figure 4.9 Average Male and Female Yellow Perch Weight ± Standard Error in Scraggy Lake; October 2017, Atlantic Gold, Touquoy Mine

Only female yellow perch in the farfield location in Scraggy Lake appeared to have higher condition than male yellow perch in the nearfield and farfield locations, and compared to females in the nearfield location (Figure 4.10). There did not appear to be obvious differences in the condition of males when comparing the nearfield to farfield locations.

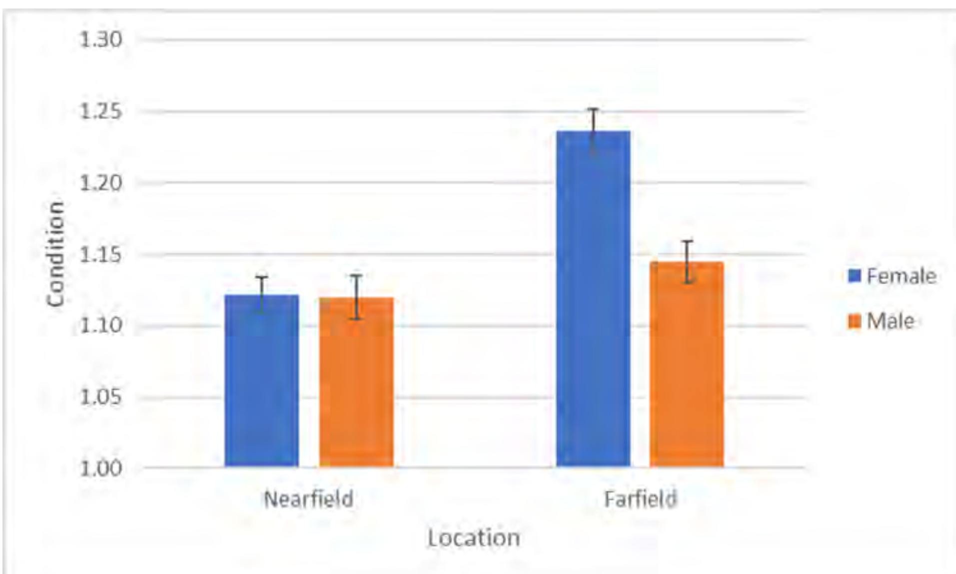


Figure 4.10 Average Male and Female Yellow Perch Condition ± Standard Error in Scraggy Lake; October 2017, Atlantic Gold, Touquoy Mine

Female yellow perch in the nearfield and farfield locations in Scraggy Lake appeared to be have lower GSI than male yellow perch as the ovaries were still developing in preparation for spring, whereas male gonads appeared to be quite developed (Figure 4.11). There did not appear to be obvious differences in the GSI between males when comparing the nearfield and farfield locations, however females in the farfield appeared to have lower GSI than females in the nearfield location of Scraggy Lake.

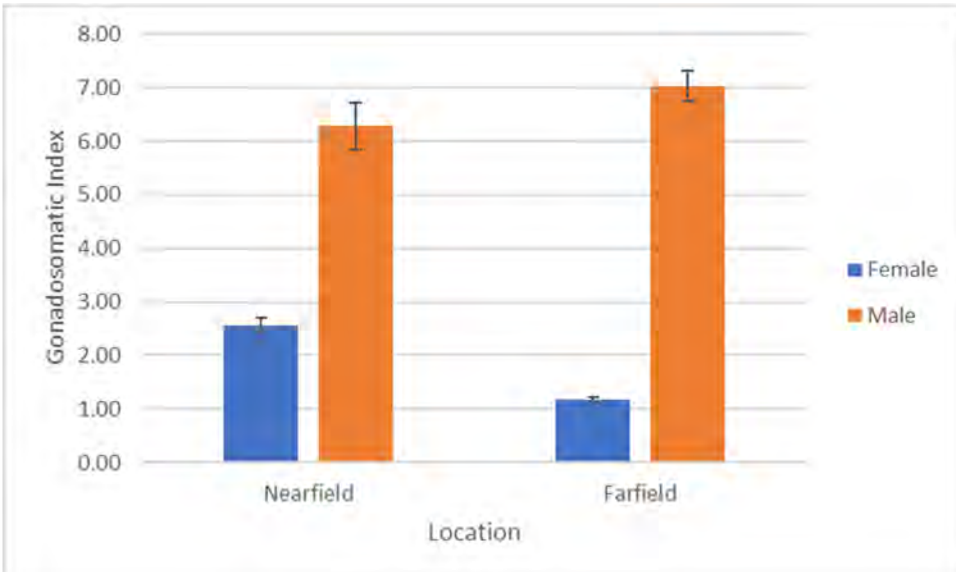


Figure 4.11 Average Male and Female Yellow Perch GSI ± Standard Error in Scraggy Lake; October 2017, Atlantic Gold, Touquoy Mine

Female yellow perch in the nearfield and farfield locations in Scraggy Lake appeared to have higher LSI than male yellow perch in the nearfield and farfield areas (Figure 4.12). There did not appear to be obvious differences in the LSI of for males when comparing yellow perch the nearfield and farfield locations or for females when comparing yellow perch the nearfield and farfield locations.

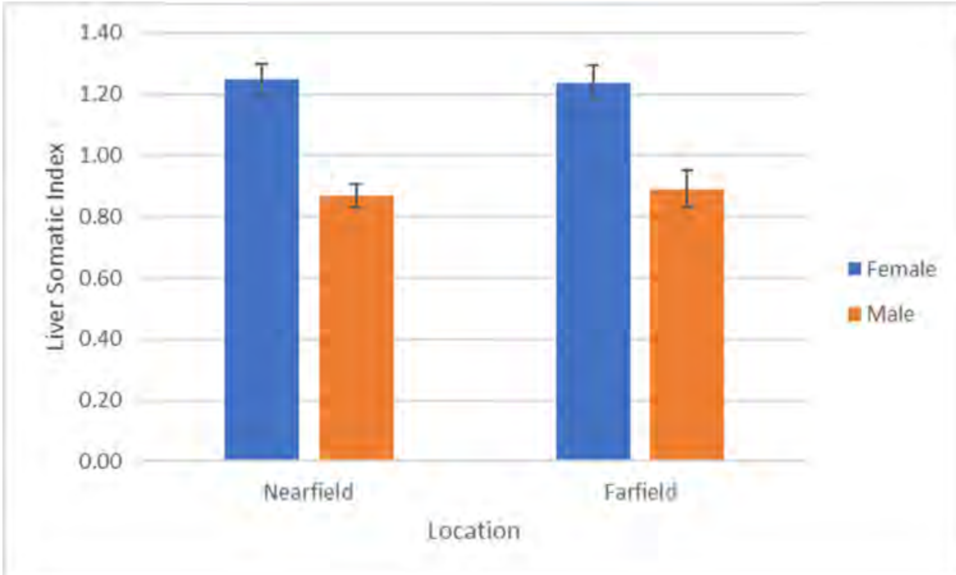


Figure 4.12 Average Male and Female Yellow Perch Liver Somatic Index ± Standard Error in Scraggy Lake; October 2017, Atlantic Gold, Touquoy Mine

In general, male and female yellow perch in the farfield locations had similar ages, whereas females in the nearfield location were slightly older, and males in the nearfield slightly younger (Figure 4.13).

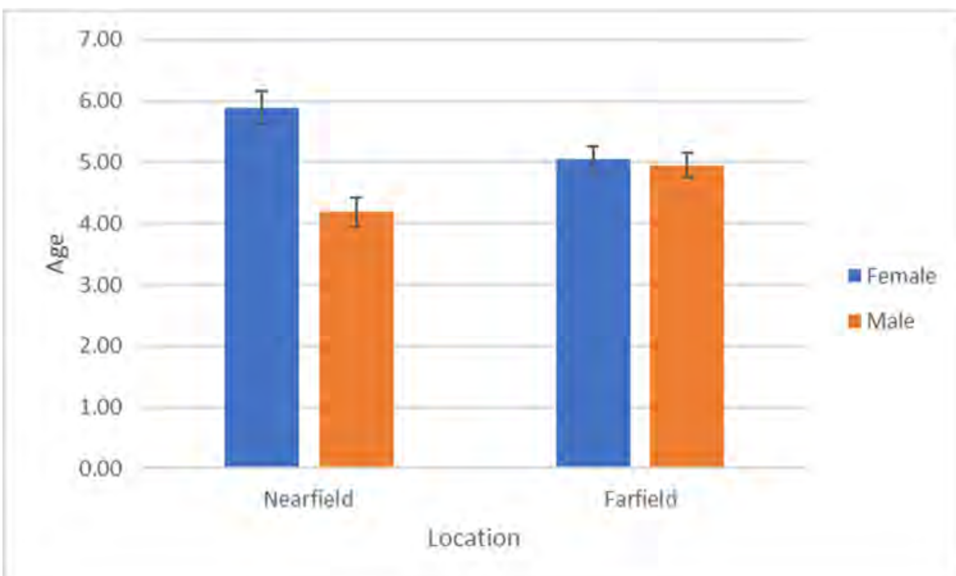


Figure 4.13 Average Male and Female Yellow Perch Age ± Standard Error in Scraggy Lake; October 2017, Atlantic Gold, Touquoy Mine

4.1.3 Quality Assurance and Quality Control

Sixteen out of 164 lethally sampled fish were remeasured and reweighed for quality assurance and quality control. There was a maximum of 3% or less relative percent difference (RPD) in the length of fish measured and a maximum of 1% or less RPD in the weight of fish, which is less than the 10% recommended in the Technical Guidance (EC 2012). Results are shown in Appendix B.

4.2 FISH TISSUE ANALYSIS FOR METALS

A total of nine whole body fish samples were collected from white sucker and ten whole body fish samples were collected from yellow perch, in roughly equal proportions from the nearfield and farfield locations in Scraggy Lake in 2017.

Measured concentrations of several trace metals in whole fish were routinely below levels that could be detected by the analytical laboratory. There were no whole-body detections of arsenic or nickel for yellow perch and white sucker, and no detections of lead for yellow perch (Table 4.6). There were some detections of aluminum, cadmium, copper and iron in yellow perch and white sucker. Mercury and zinc were detected in all white sucker and yellow perch samples submitted. As the analysis was conducted on the whole body of fish, the concentrations in the muscle tissue are anticipated to be less (Goldstein et al. 1996).

Table 4.6 Minimum, Maximum, and Count for Trace Metal Parameters of Concern for Whole-Body Analysis

Parameter	Reportable Detection Limit	Nearfield White Sucker (n=4)			Farfield White Sucker (n=5)		
		Detections	Min	Max	Detections	Min	Max
Aluminum (mg/kg)	2.5	4	4.4	18	5	4.8	13
Arsenic (mg/kg)	0.5	0	-	-	0	-	-
Cadmium (mg/kg)	0.05	2	<0.05	0.065	1	0.03 [a]	0.07
Copper (mg/kg)	0.5	4	0.59	0.81	4	0.25[a]	0.58
Iron (mg/kg)	15	4	23	69	5	19	42
Lead (mg/kg)	0.18	3	<0.18	0.34	2	0.09 [a]	0.33
Mercury (mg/kg)	0.01	4	0.15	2	5	0.061	0.2
Nickel (mg/kg)	0.5	0	-	-	0	-	-
Zinc (mg/kg)	1.5	4	17	23	5	17	30

Parameter	Reportable Detection Limit	Nearfield Yellow Perch (n=5)			Farfield Yellow Perch (n=5)		
		Detections	Min	Max	Detections	Min	Max
Aluminum (mg/kg)	2.5	2	<2.5	7.9	3	1.25[a]	8
Arsenic (mg/kg)	0.5	0	-	-	0	-	-
Cadmium (mg/kg)	0.05	1	<0.05	0.15	0	-	-

Table 4.6 Minimum, Maximum, and Count for Trace Metal Parameters of Concern for Whole-Body Analysis

Parameter	Reportable Detection Limit	Nearfield White Sucker (n=4)			Farfield White Sucker (n=5)		
		Detections	Min	Max	Detections	Min	Max
Copper (mg/kg)	0.5	0	-	-	2	0.25[a]	0.81
Iron (mg/kg)	15	3	<15	23	3	7.5[a]	42
Lead (mg/kg)	0.18	0	-	-	0	-	-
Mercury (mg/kg)	0.01	5	0.18	0.59	5	0.12	0.28
Nickel (mg/kg)	0.5	0	-	-	0	-	-
Zinc (mg/kg)	1.5	5	16	25	5	18	29

Yellow perch and white sucker from Scraggy Lake show an increasing trend in mercury concentration with fish length (Figure 4.14). This trend is not surprising given that methylmercury is easily absorbed by aquatic organisms and becomes concentrated further up the aquatic food web (CCME 2003). Methylmercury is accumulated almost exclusively by diet with the highest concentrations occurring in large, older predatory fish (CCME 2003). Notably, the longest of the ten yellow perch samples had a whole-body tissue concentration of mercury that exceeded the muscle fillet total restriction guideline of 0.52 mg/kg for women of childbearing age and children under 15, four samples had concentrations above the muscle fillet partial restriction guideline for human consumption (0.26 mg/kg), and all samples were below total restriction guideline of 1.84 mg/kg (MOE 2013). For white sucker, none of the whole-body samples exceeded the guidelines for human consumption for muscle fillets.

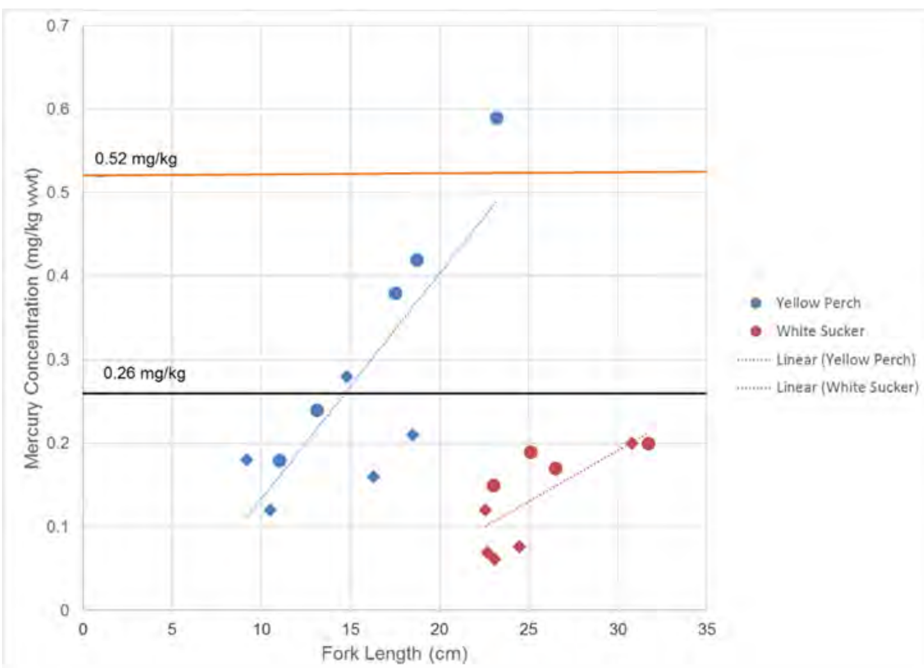


Figure 4.14 Yellow Perch and White Sucker Whole Body Mercury Concentration in Relation to Fork Length (Circles represent nearfield, diamonds represent farfield)

4.3 BENTHIC INVERTEBRATE COMMUNITY ASSESSMENT

Five samples from each of the nearfield and farfield locations were sampled in Scraggy Lake. Benthic invertebrate sampling was not conducted in Long Lake or Alma Lake due to lack field time; priority was given to sampling Scraggy Lake to obtain baseline data prior to discharge of Mine effluent.

4.3.1 Community Structure

In total over 40 different species consisting of 31 family taxa were identified from the samples. The predominant major benthic invertebrate taxa included:

- Diptera (e.g., Chironomidae)
- Crustacea (e.g., Amphipoda)
- Ephemeroptera (e.g., Caenidae)
- Tricoptera (e.g., Leptoceridae)
- Coleoptera (e.g., Elmidae)

The other category was made up of Neuroptera, Molluscs, Oligochaetes, Platyhelminthes, Hirudinea and Odonata, which made up 4% of the benthic invertebrate community at the nearfield location on Scraggy Lake and 8% of the benthic invertebrate community at the farfield location, as shown in Figure 4.15.

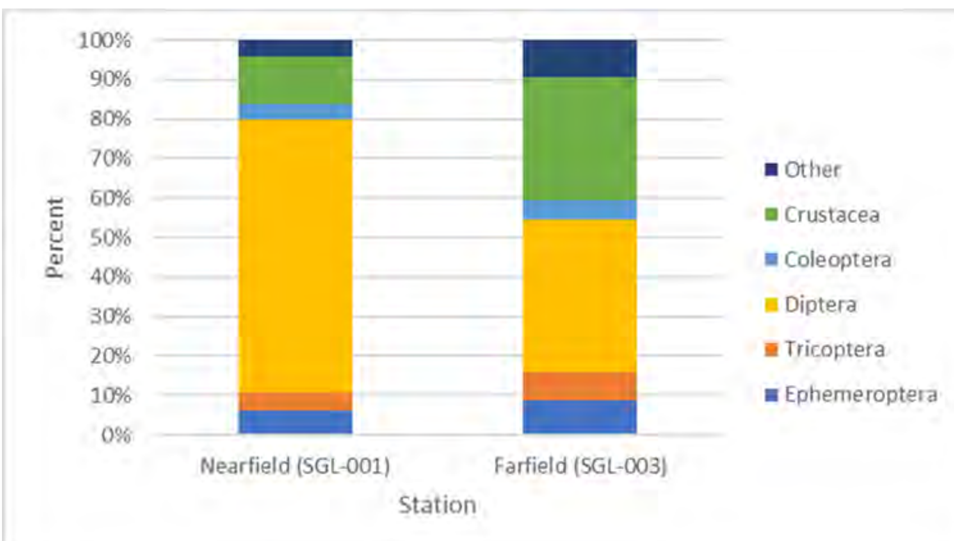


Figure 4.15 Taxonomic Composition of Benthic Invertebrate Community by Location

4.3.2 Benthic Invertebrate Community Endpoints

The summary statistics for the effect endpoints required by the Technical Guidance (EC 2012) are shown in Table 4.7 and include density (i.e., abundance), taxa richness (at family level), Simpson's Evenness

Index, as well as Simpson's Diversity Index and biomass per sample. The benthic invertebrate community raw and indices values are presented in Appendix D.

Table 4.7 Benthic Invertebrate Community Summary Statistics for Abundance, Taxa Richness, Simpson's Diversity Index and Simpson's Evenness Index

Parameter	Nearfield (SGL-001)	Farfield (SGL-003)	Parameter	Nearfield (SGL-001)	Farfield (SGL-003)
N of Cases	5	5	**N of Cases**	5	5
Abundance			**Simpson's Evenness Index**		
Mean	471.4	195.8	**Mean**	0.23	0.50
Median	472	182	**Median**	0.17	0.52
Standard Error	79.7	30.6	**Standard Error**	0.05	0.05
Standard Deviation	178.1	68.4	**Standard Deviation**	0.11	0.11
Minimum	255	97	**Minimum**	0.15	0.35
Maximum	654	272	**Maximum**	0.40	0.64
Taxa Richness			**Simpson's Diversity Index**		
Mean	10.2	12.4	**Mean**	0.50	0.82
Median	11	11	**Median**	0.45	0.83
Standard Error	0.9	1.9	**Standard Error**	0.07	0.03
Standard Deviation	1.9	4.3	**Standard Deviation**	0.16	0.08
Minimum	7	10	**Minimum**	0.38	0.71
Maximum	12	20	**Maximum**	0.77	0.92
Biomass					
Mean	0.39	0.07			
Median	0.31	0.05			
Standard Error	0.14	0.03			
Standard Deviation	0.30	0.06			
Minimum	0.16	0.04			
Maximum	0.90	0.18			

The abundance of organisms in the benthic invertebrate community was higher at the nearfield (mean = 471 individuals per three minutes of sampling time) than the farfield sampling location (mean = 196 individuals per three minutes of sampling time) (Figure 4.16).

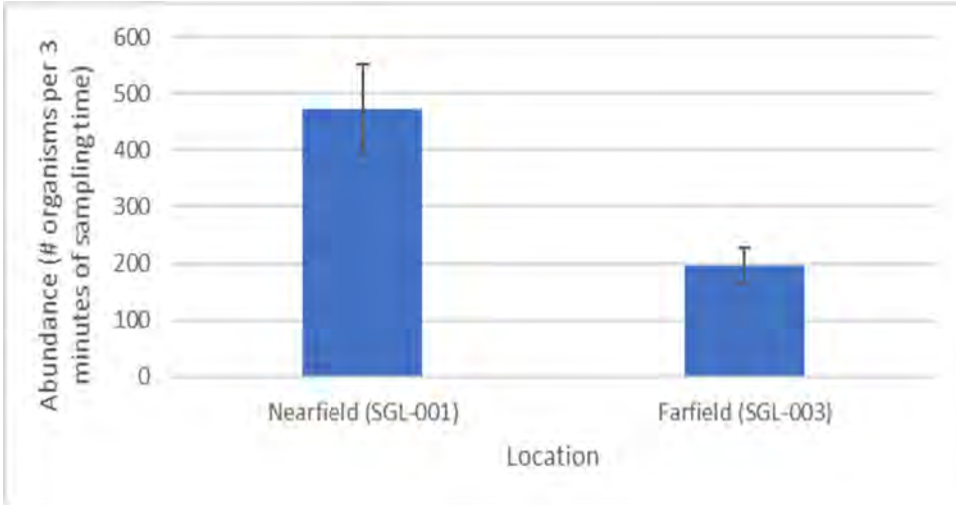


Figure 4.16 Benthic Invertebrate Community: Average Abundance ± Standard Error

Taxa richness was similar in the nearfield (11 taxa) compared to the farfield sampling location (13 taxa) (Figure 4.17).

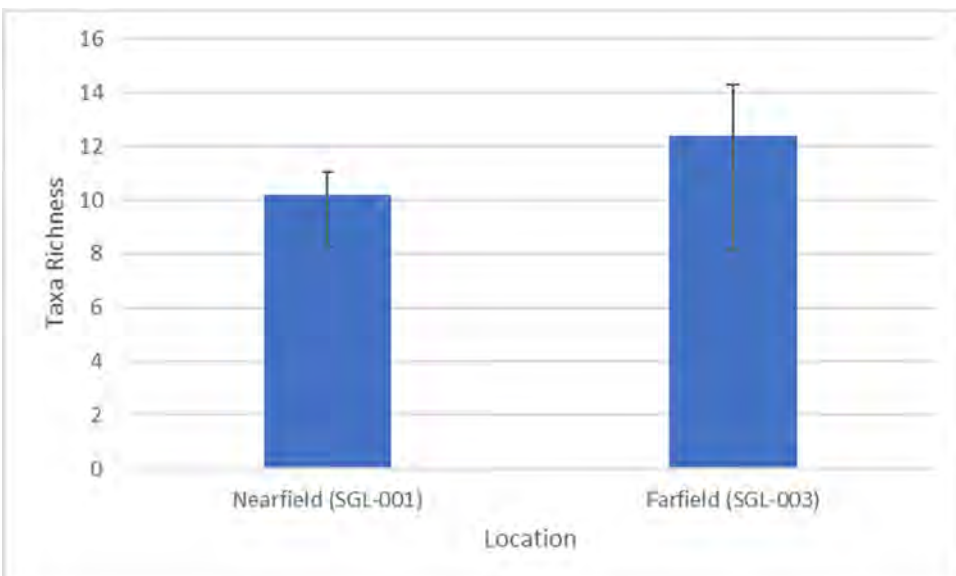


Figure 4.17 Benthic Invertebrate Community: Average Taxa Richness ± Standard Error

Simpson's Evenness Index was higher at the farfield sampling location (0.21) than the nearfield sampling location (0.43) (Figure 4.18).

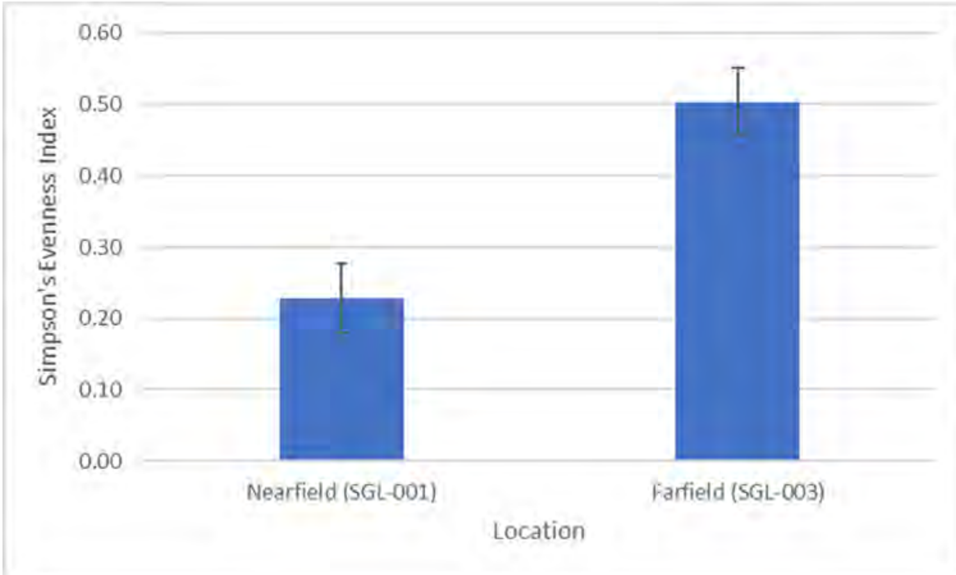


Figure 4.18 Benthic Invertebrate Community: Simpson's Evenness Index ± Standard Error

Similarly, Simpson's Diversity Index was higher at the farfield sampling location (0.81) than the nearfield sampling location (0.50) (Figure 4.19).

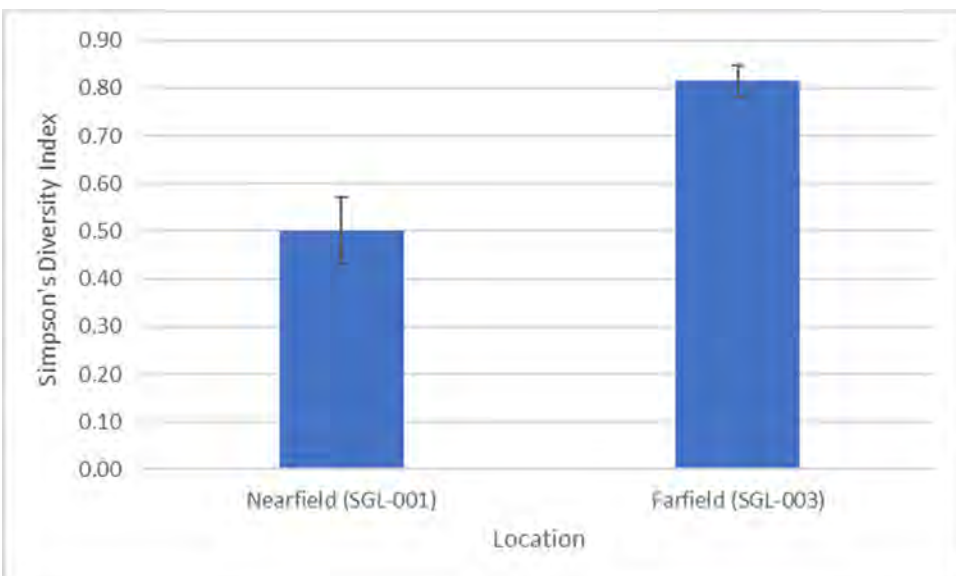


Figure 4.19 Benthic Invertebrate Community: Simpson's Diversity Index ± Standard Error

The wetted biomass of organisms in the benthic invertebrate community was higher at the nearfield (mean = 0.4 g) than the farfield sampling location (mean = 0.1 g) (Figure 4.20). The wet biomass of organisms reflected the trends observed in abundance inferring that the biomass was likely made up of the most predominant organisms.

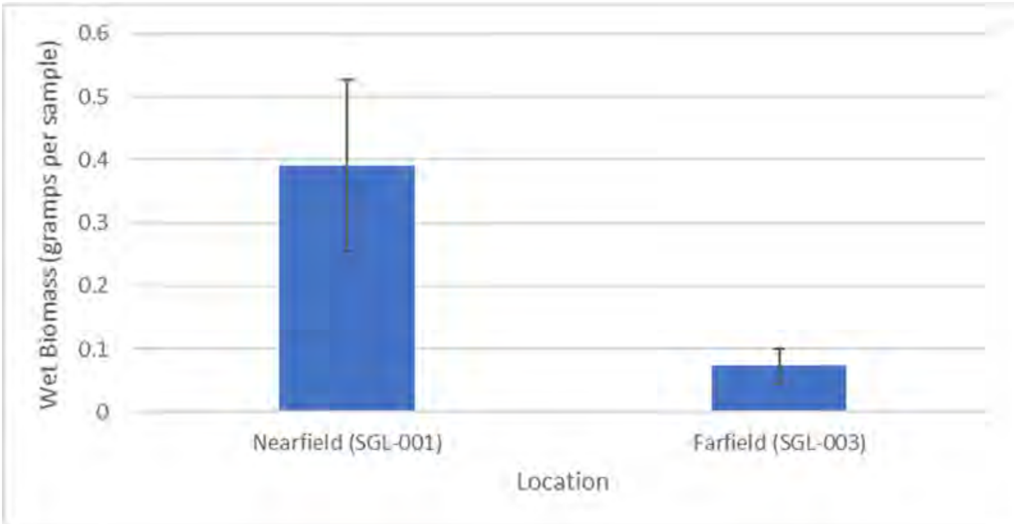


Figure 4.20 Benthic Invertebrate Community: Wet Biomass (g per sample) ± Standard Error

Overall, the differences observed in the benthic invertebrate community may have been partially attributable to the substrate which made sampling difficult in Scraggy Lake. Particularly in the farfield location, large substrates dominated (i.e., boulders) and it was difficult to find smaller substrates (e.g., cobble, gravel) that were more suitable for kick sampling with a D-net.

4.3.3 Quality Assurance and Quality Control

Ten percent (1 of 10) of samples submitted for benthic invertebrate analysis were re-sorted. These re-sorts showed that 98% of the benthic invertebrates were recovered in the original sort (Appendix D). These recovery rates were deemed to be acceptable.

4.4 WATER AND SEDIMENT QUALITY ASSESSMENT

Water and sediment quality information was collected as supporting environmental data to support interpretation of the results of baseline fish and benthic invertebrate community surveys.

4.4.1 Surface Water

In-situ surface water was collected from Scraggy Lake, Long Lake and Fish River, immediately downstream from the outlet from Scraggy Lake. Surface water samples from Scraggy Lake (August and October) and Long Lake (August reconnaissance only) were submitted for laboratory analyses. As noted previously, no sampling was conducted at Alma Lake due to lack of field time in October for the baseline survey. Additional information can be found in Appendix E.

4.4.1.1 Scraggy Lake

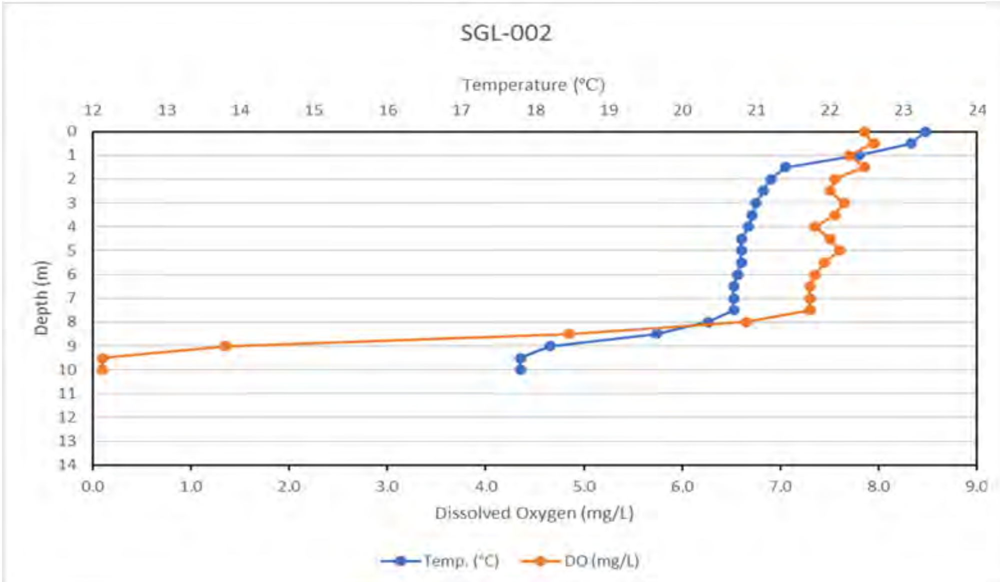
Reconnaissance Survey – August 2017

A thermocline was apparent in Scraggy Lake in August 2017 at SGL-002 and SGL-004, but not at SGL-001 and SGL-003 (Appendix E; Figure E.1). SGL-001 and SGL-003 are shallow basins (<4 m) which appear to not have sufficient depth for the formation of a thermocline. The location of the thermocline at SGL-002 was between 7.5 and 9.5 m and between 5 and 9 m at SGL-004. Water temperature above the thermocline was typically between 20-24°C with warmer temperatures found near surface. Below the thermocline, temperatures are varied between locations.

Temperatures were less than 18°C at SGL-002 and less than 13°C at SGL-004 (Figure 4.21). Similarly, dissolved oxygen concentrations for Scraggy Lake above the thermocline were above 7.0 mg/L with the highest concentrations observed near surface suggesting well oxygenized waters. Dissolved oxygen levels below the thermocline was approximately 2 mg/L with the lowest concentrations observed in the deeper sections of the lake. This difference in depth of the thermocline between basins may be a result of individual basins mixing differently because of their physical characteristics (e.g., fetch, flow direction in relation to the outlet).

Conductivity levels for Scraggy Lake in August 2017 varied between 19-26 μs/cm with higher conductivity levels found near SGL-001 and SGL-002 varying from 24-26 μs/cm. The values for pH were found to vary between the near-field and far-field locations with 6.20 at SGL-001 and 7.10 at SGL-004.

Surface turbidity readings in August 2017 were generally low, varying between 0.74 NTU at SGL-004 and 1.41 NTU at SGL-003. Turbidity levels near bottom tend to be higher and range between 3.15 NTU at SGL-004 (10.5 m) and up to 6.50 NTU at SGL-002 (10.5 m). Secchi disk measurements varied from 2.4 metres at SGL-001 to 3.5 metres at SGL-004.



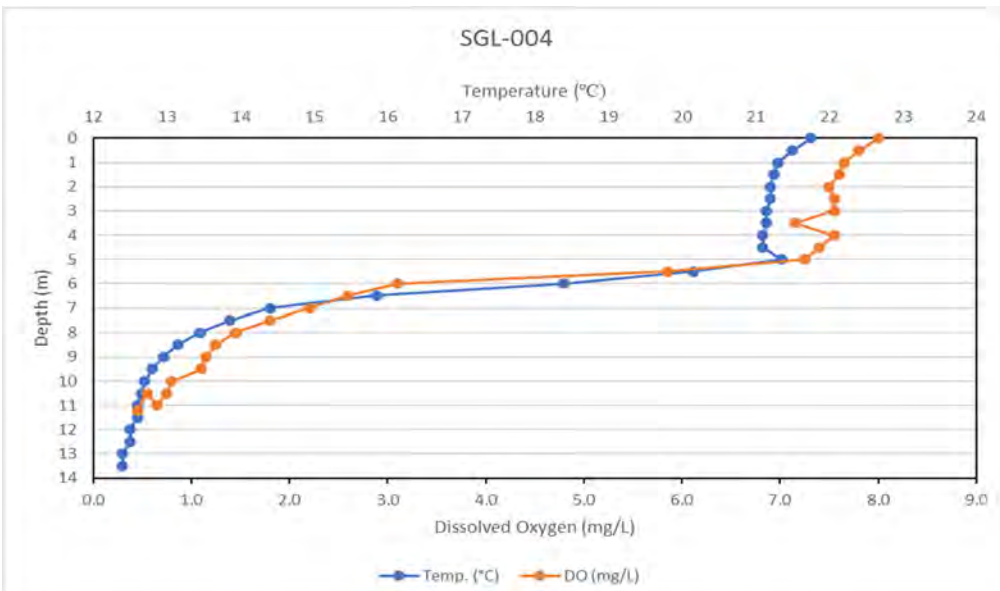


Figure 4.21 Dissolved Oxygen and Temperature Profiles for SGL-002 and SGL-004, August 2017, Scraggy Lake, NS

Baseline Survey – October 2017

By October 2017, the water column in Scraggy Lake at SGL-001 and SGL-003 appeared to be well mixed indicating fall turnover had likely occurred (

Figure 4.22). In fall, water temperature profiles at the near-field and far-field locations remained uniform at 16°C and 15°C respectively. In fall, dissolved oxygen was noted to be lower in the near-field (SGL-001) ranging from 8.4-8.7 mg/L than the far-field location where DO concentrations were between 9.6-9.7 mg/L.

In October 2017, conductivity trends remained consistent with what was observed in August where conductivity was slightly higher in the near-field location (25 µs/cm) than at the far-field location (20 µs/cm). Levels of pH were different between the near and far-field locations in October. An acidic in-situ pH of 4.90 was observed at the near-field location (SGL-001) while a pH of 6.60 was noted at the far-field (SGL-003). The pH at the mid-field (SGL-007) location was also noted to be on the acidic side at 5.10. The pH results appear to be valid because the pH meters were calibrated prior to use and the acidic sample pH values were confirmed at site. Additional sampling in 2018 would determine if this is reflective of normal conditions.

Near surface turbidity was found to be similar for all locations at 1.3 NTU during the fall sampling. Secchi depth was found to be similar at the near and far-field with 2.65 metres and 2.40 metres observed, respectively.

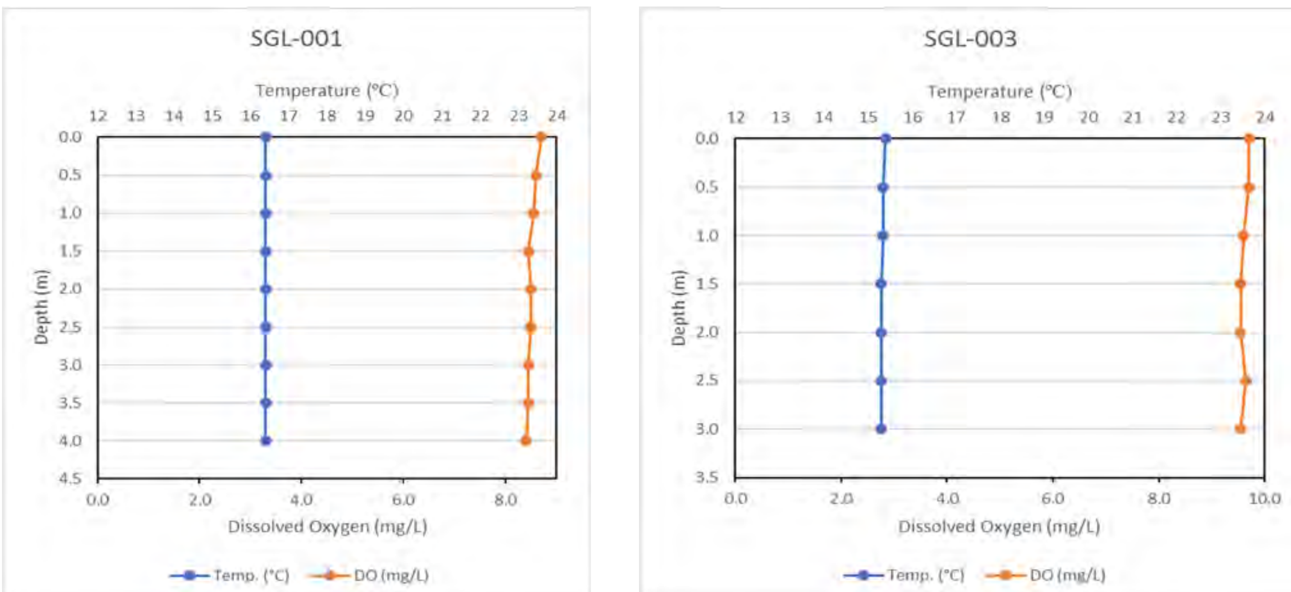


Figure 4.22 Dissolved Oxygen and Temperature Profiles in October 2017, Scraggy Lake, NS

Analytical results for Scraggy Lake were compared to the CCME FAL guidelines and key parameters are summarized in Table 4.8. Tables with the analytical results are included in Appendix E.

In general, the surface water quality in the study area are soft, containing low concentrations of dissolved minerals (i.e., hardness) and having low pH. The pH values from the laboratory were different than in the field (e.g., in-situ pH at SGL-007 of 5.1 and laboratory pH of 5.9). This is understandable given that the pH of very soft waters is prone to drift during holding time prior to analysis at the laboratory. As a result, field measured pH values are considered to be more reliable than the laboratory measured values. Alkalinity values were non-detectable, hardness ranged from 2.8 to 4.5 mg/L (as $CaCO_3$), and conductivity ranged from 18 to 26 µS/cm; all of these low values indicate very soft water conditions in Scraggy Lake. The other major cations contributing to hardness (e.g., calcium, magnesium, sodium, potassium) were also found to be at low concentration. Total organic carbon ranged from 4.4 to 6.2 mg/L.

The major ion analyses reflect the generally thin soils and high resistance of underlying bedrock to weathering.

Water was typically clear, as indicated by generally low total suspended solids (<3) and low turbidity (<2 NTU), and this was consistent with field measurements taken in August 2017.

Nutrient concentrations in surface water in Scraggy Lake were generally low, given the relatively undeveloped nature of Scraggy Lake and surrounding land. Total phosphorus values were generally non-detectable in the August samples and less than 350 µg/L in fall samples. Ortho-phosphate was non-detectable in all samples. Total ammonia, a source of nitrogen, was generally non-detectable (14 out of 16 samples), and nitrate + nitrite was detected in only one sample out of 16 samples. Reactive silica concentrations were also low (<0.5 to 2.9 mg/L). Chlorophyll a ranged from 0.46 to 0.84 µg/L indicating low productivity. The water clarity and low nutrient concentrations of Scraggy Lake indicate an oligo-mesotrophic lake status.

Water quality results for many parameters in Scraggy Lake were generally found to be below the reportable detection limit (RDL) (e.g., chromium, copper, molybdenum, nickel, selenium). All parameters were within the CCME-FAL guidelines, with the exceptions noted below.

The following exceedances of CCME FAL guidelines were noted for Scraggy Lake:

- Total aluminum concentrations ranged between 97-320 µg/L and exceeded the guideline (5 to 100 µg/L; total aluminum) at all sampling stations except SGL-003-0m.
- Total arsenic concentrations ranged between <1 and 13 µg/L and exceeded the guideline (5 µg/L; total arsenic) at one location, SGL-002-10.5 m (13 µg/L); see Figure 4.25.
- Total iron concentrations ranged between 120 to 6000 µg/L and exceeded the guideline (300 µg/L; total lead) in several samples (SGL-001-3.5m - 350 µg/L; SGL-002-10.5 m - 6000 µg/L; SGL-004-10.5 m - 1300 µg/L); note that iron concentrations in Long Lake also exceeded the guideline in several samples (LL-001-0m - 470 µg/L; LL-001-2.5m - 470 µg/L; LL-002-0m - 440 µg/L; LL-002-3.0m - 470 µg/L; see Figure 4.26.
- Total lead was detected in only two of 16 samples and exceeded the guideline (1 µg/L; total lead) at SGL-002-10.5m (1.6 µg/L).
- The laboratory-analyzed pH ranged from 5.8 to 6.7 for 14 of the 16 samples and was below the recommended guideline (6.5).
- Total suspended solids were generally below 3 mg/L for most of the samples collected.

While not exceeding the CCME FAL guidelines, mercury, total organic carbon, nitrogen, total suspended solids and turbidity were all noted to be elevated at SGL-002-10.5 m compared to other sites, which may indicate that the sample accidentally contained some flocculent matter from the sediment.

Table 4.8 Descriptive Statistics for General Chemistry and Trace Metals in Surface Water Samples for Scraggy Lake for all Sites and Depths

Parameter	UNITS	RDL	CCME -FAL	Min.	Max.	Mean	Standard Deviation	Standard Error	Exceedances of CCME FAL-Guidelines (out of n = 16)
Total Aluminum (Al)	ug/L	5	5-100[a]	97.0	320.0	136.6	55.0	13.7	15
Total Arsenic (As)	ug/L	1	5	<1	13.00	1.61	3.06	0.77	1
Total Calcium (Ca)	ug/L	100		590.0	1100.0	833.1	199.4	49.8	NA
Total Iron (Fe)	ug/L	50	300	120.0	6000.0	674.4	1445.9	361.5	7
Total Lead (Pb)	ug/L	0.5	1[b]	<1	1.60	0.38	0.37	0.09	1
Total Magnesium (Mg)	ug/L	100		320.0	480.0	382.5	54.8	13.7	NA
Total Manganese (Mn)	ug/L	2		30.0	410.0	68.0	95.0	23.7	NA
Total Phosphorus (P)	ug/L	100		50.0	350.0	140.0	124.5	31.1	NA
Total Silver (Ag)	ug/L	0.1	0.25	<0.1	<0.1	<0.1	0.0	0.0	0
Total Thallium (Tl)	ug/L	0.1	0.8	<0.1	<0.1	<0.1	0.0	0.0	0
pH				5.94	6.68	6.28	0.22	0.07	NA
Hardness				2.80	4.50	3.44	0.74	0.23	NA
Chlorophyll a (Acidification Technique)	ug/L	NA		0.46	2.84	1.74	0.92	0.33	NA
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	1		<1	<1	<1	0.00	0.00	NA
Cation Sum	me/L	N/A		0.15	0.42	0.19	0.07	0.02	NA
Hardness (CaCO3)	mg/L	1		2.80	4.50	3.58	0.71	0.18	NA
Nitrate (N)	mg/L	0.05	2.9	<0.05	0.16	0.03	0.03	0.01	0
Total Alkalinity (Total as CaCO3)	mg/L	5		<5	<5	<5	0.00	0.00	NA

Table 4.8 Descriptive Statistics for General Chemistry and Trace Metals in Surface Water Samples for Scraggy Lake for all Sites and Depths

Parameter	UNITS	RDL	CCME -FAL	Min.	Max.	Mean	Standard Deviation	Standard Error	Exceedances of CCME FAL-Guidelines (out of n = 16)
Colour	TCU	5		24.0	45.0	34.3	9.2	2.4	NA
Nitrate + Nitrite (N)	mg/L	0.05		<0.05	0.16	0.03	0.03	0.01	NA
Nitrite (N)	mg/L	0.01	0.06	<0.01	0.01	0.01	0.00	0.00	0
Nitrogen (Ammonia Nitrogen)	mg/L	0.05	4[c]	<0.05	0.34	0.05	0.08	0.02	0
Total Organic Carbon (C)	mg/L	0.5		4.40	6.20	5.24	0.64	0.18	NA
Orthophosphate (P)	mg/L	0.01		<0.01	<0.01	<0.01	0.00	0.00	NA
pH	pH	N/A	6.5-9.0	5.84	6.68	6.20	0.26	0.06	14
Reactive Silica (SiO2)	mg/L	0.5		<0.5	2.90	0.78	0.69	0.17	NA
Total Suspended Solids	mg/L	1		<1	20.0	3.5	4.8	1.2	NA
Turbidity	NTU	0.1		0.69	14.00	2.10	3.21	0.80	NA
Conductivity	uS/cm	1		18.0	26.0	21.0	2.6	0.7	NA

Note: NA = not applicable

RDL = Reportable Detection Limit; note: "<" denotes that the value was lower than the RDL for that parameter.

Canadian Environmental Quality Guidelines (CEQG) – Canadian Council of Ministers of the Environment (CCME) Freshwater Aquatic Life (FAL) - CCME (2018)

[a] guideline varies based on pH

[b] guideline varies based on hardness

[c] guideline varies based on temperature and pH

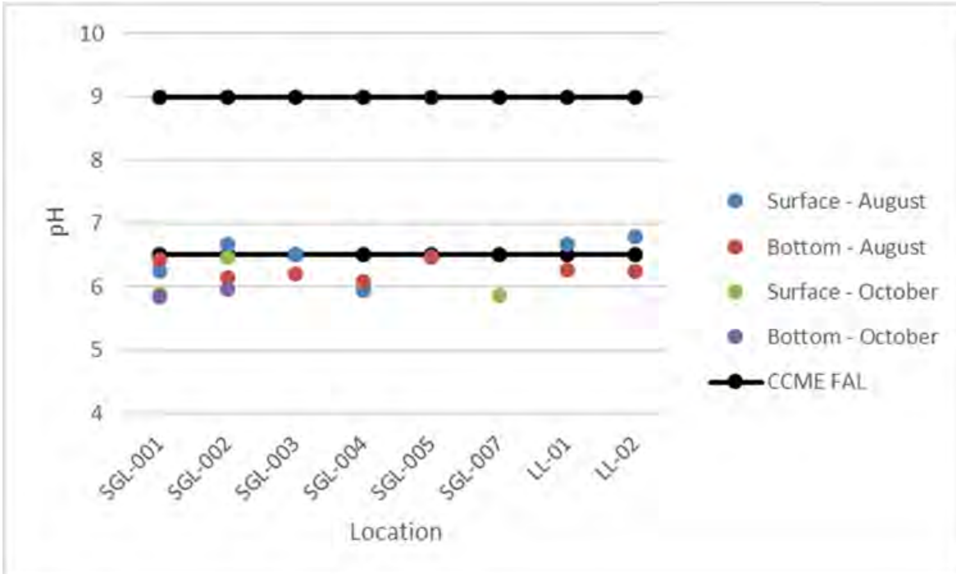


Figure 4.23 Plot of Individual Data Points for Surface Water pH in Scraggy Lake and Long Lake, NS

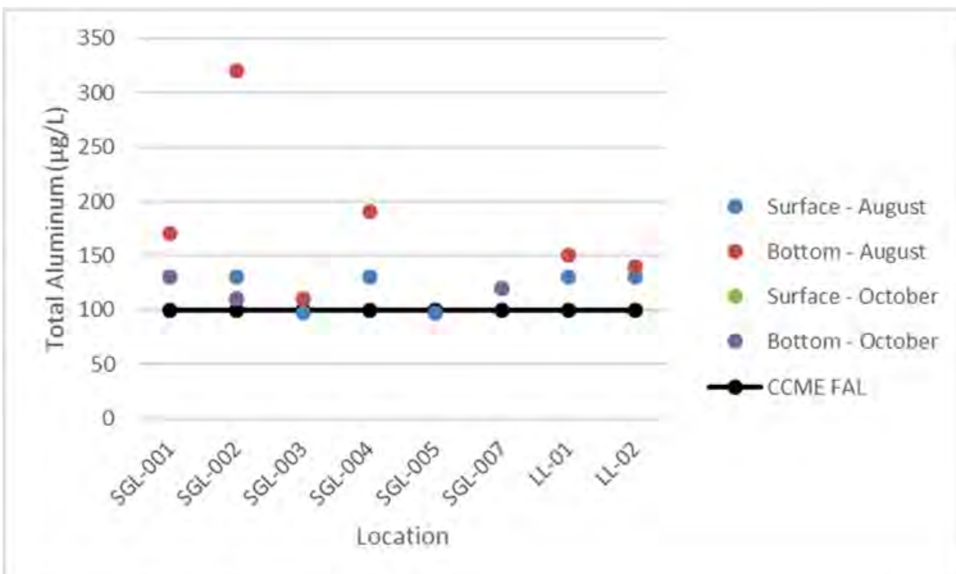


Figure 4.24 Plot of Individual Data Points for Total Aluminum in Surface Water in Scraggy Lake and Long Lake, NS

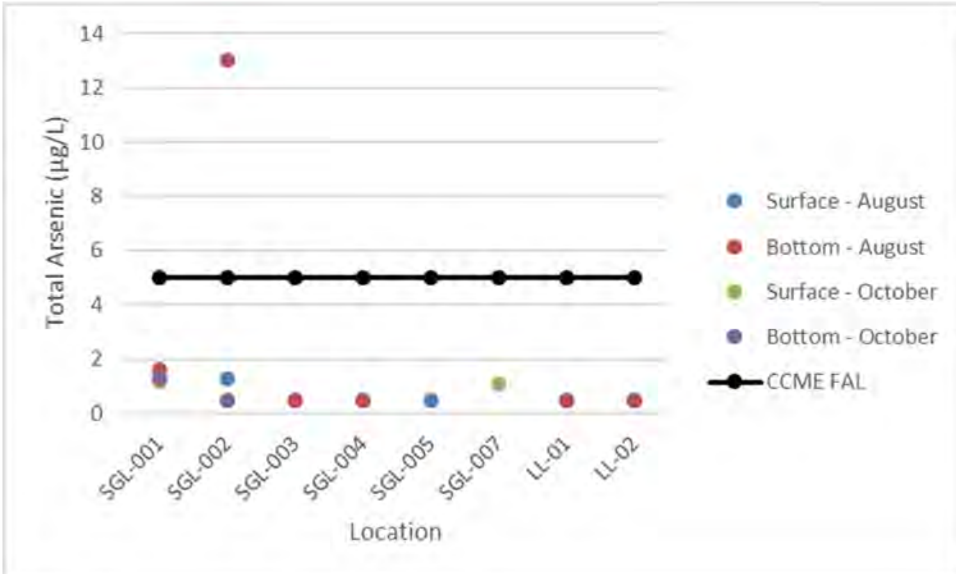


Figure 4.25 Plot of Individual Data Points for Total Arsenic in Surface Water in Scraggy Lake and Long Lake, NS

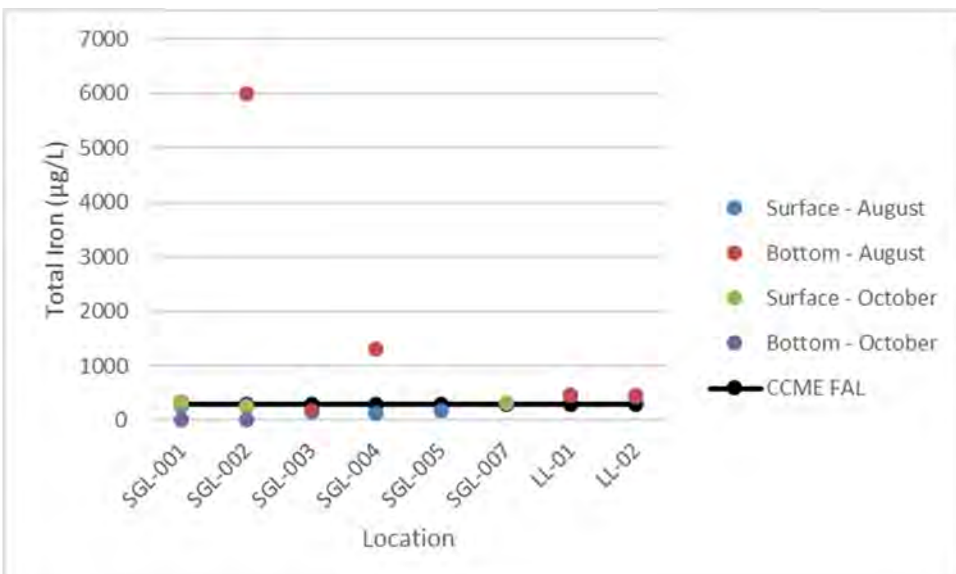


Figure 4.26 Plot of Individual Data Points for Total Iron in Surface Water in Scraggy Lake and Long Lake, NS

4.4.1.2 Long Lake

Analytical results for Long Lake were compared to the CCME FAL guidelines and key parameters are summarized in Table 4.9. Tables with the analytical results are included in Appendix E.

Water quality parameters measured in the field were similar between both sampling stations (LL-001 and LL-002). Dissolved oxygen in Long Lake ranged from 6.7 to 7.8 mg/L and water temperature ranged from 22.4°C near surface to 21.3°C near bottom (Appendix E, Table E.3). No thermal stratification (e.g., thermocline) was apparent in Long Lake likely because of its shallow depth (Appendix E; Figure E.2). Conductivity levels were uniform throughout Long Lake ranging between 29.3-29.9 μs/cm. Near surface and near bottom turbidity readings were similar, ranging from 2.10-2.76 NTU. Secchi disk measurements at both sampling locations varied between 2.48 metres (LL-001) and 2.38 metres (LL-002).

Similar to Scraggy Lake, the surface water quality in Long Lake is very soft, containing low concentrations of dissolved minerals and having low pH. Alkalinity values were non-detectable, hardness ranged from 4.3 to 4.5 mg/L (as $CaCO_3$), and conductivity ranged from 27 to 28 µS/cm and were very low. The other major cations contributing to hardness were also found to be low (e.g., calcium, magnesium, sodium, potassium. Total organic carbon ranged from 5.9 to 6.0 mg/L. Similar to Scraggy Lake, the major ion analyses reflect the generally thin soils and high resistance of underlying bedrock to weathering.

Water was typically clear, as indicated by generally low total suspended solids (<3) and low turbidity (<2.1 NTU) measured in the laboratory, which is consistent with field measurements.

Nutrient concentrations in surface water were generally low, given the relatively undeveloped nature of Long Lake. Total phosphorus and ortho-phosphate values were non-detectable. Total ammonia, a source of nitrogen, was generally non-detectable (3 out of 4 samples), and nitrate + nitrite was not detected. Reactive silica concentrations were also not detected (<0.5 mg/L). Chlorophyll a ranged from 1.5 to 2.2 µg/L indicating low productivity.

Water quality results for many parameters in Long Lake were generally found to be below the RDL (e.g., total chromium, total copper, total molybdenum, total nickel, total selenium). All total metal parameters were within the CCME FAL guidelines, with the following exceptions:

- Total aluminum concentrations ranged between 130-150 μg/L. Total aluminum exceeded the CEQG-Water guideline at all the sampling stations.
- Total iron concentrations ranged between 280 to 300 μg/L. Total iron exceeded the CEQG-Water guideline of 300 μg/L at all the sampling stations.
- The laboratory analyzed pH ranged from 6.2 to 6.8. For half of the samples analyzed pH was below the recommended CEQG-Water guideline of 6.5.

Overall, water quality in Scraggy Lake was similar to Long Lake. The waters in Scraggy Lake and Long Lake were soft, contain low concentrations of dissolved minerals (i.e., hardness) and had low pH. Water was generally clear and with low nutrient levels. Trace metal concentrations of key parameters and general chemistry was similar. A thermocline was not apparent in Long Lake and the shallower areas of Scraggy Lake with depths less than 4 m, which was is characteristic of the nearfield and farfield locations. Long Lake is a suitable reference lake for Scraggy Lake.

Table 4.9 Descriptive Statistics for General Chemistry and Trace Metals in Surface Water Samples for Long Lake

Parameter	UNITS	RDL	CCME FAL Guideline	Minimum	Maximum	Mean	Standard Deviation	Standard Error	CCME FAL Guideline Exceedances (out of n = 4)
Total Aluminum (Al)	ug/L	5	5-100[a]	130.0	150.0	137.5	9.6	4.8	4
Total Arsenic (As)	ug/L	1	5	<1	<1	<1	0.00	0.00	0
Total Calcium (Ca)	ug/L	100		960.0	1000.0	990.0	20.0	10.0	NA
Total Iron (Fe)	ug/L	50	300	440.0	470.0	462.5	15.0	7.5	4
Total Lead (Pb)	ug/L	0.5	1[b]	<0.5	<0.5	<0.5	0.00	0.00	0
Total Magnesium (Mg)	ug/L	100		400.0	430.0	412.5	12.6	6.3	NA
Total Manganese (Mn)	ug/L	2		44.0	58.0	50.8	6.1	3.0	NA
Total Phosphorus (P)	ug/L	100		50.0	50.0	50.0	0.0	0.0	NA
Total Potassium (K)	ug/L	100		130.00	160.00	142.50	12.58	6.29	NA
Total Silver (Ag)	ug/L	0.1	0.25	<0.1	<0.1	<0.1	0.00	0.00	0
Total Sodium (Na)	ug/L	100		3200.00	3300.00	3275.00	50.00	25.00	NA
Total Thallium (Tl)	ug/L	0.1	0.8	<0.1	<0.1	<0.1	0.00	0.00	0
pH				6.24	6.79	6.49	0.28	0.14	NA
Hardess				4.30	4.50	4.40	0.08	0.04	NA
Chlorophyll a (Acidification Technique)	ug/L	NA		1.30	2.22	1.78	0.47	0.24	NA
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	1		<1	<1	<1	0.00	0.00	NA
Cation Sum	me/L	N/A		0.24	0.25	0.25	0.01	0.00	NA
Hardness (CaCO3)	mg/L	1		4.30	4.50	4.40	0.08	0.04	NA
Nitrate (N)	mg/L	0.05	2.9	<0.05	<0.05	<0.05	0.00	0.00	0
Total Alkalinity (Total as CaCO3)	mg/L	5		<5	<5	<5	0.00	0.00	NA

Table 4.9 Descriptive Statistics for General Chemistry and Trace Metals in Surface Water Samples for Long Lake

Parameter	UNITS	RDL	CCME FAL Guideline	Minimum	Maximum	Mean	Standard Deviation	Standard Error	CCME FAL Guideline Exceedances (out of n = 4)
Colour	TCU	5		35.0	36.0	35.5	0.6	0.3	NA
Nitrate + Nitrite (N)	mg/L	0.05		<0.05	<0.05	<0.05	0.00	0.00	NA
Nitrite (N)	mg/L	0.01	0.06	<0.01	<0.01	<0.01	0.00	0.00	0
Nitrogen (Ammonia Nitrogen)	mg/L	0.05	8[c]	<0.05	0.06	0.03	0.02	0.01	0
Total Organic Carbon (C)	mg/L	0.5		5.90	6.00	5.93	0.06	0.03	NA
Orthophosphate (P)	mg/L	0.01		<0.01	<0.01	<0.01	0.00	0.00	NA
pH	pH	N/A	6.5-9.0	6.24	6.79	6.49	0.28	0.14	2
Reactive Silica (SiO2)	mg/L	0.5		<0.5	<0.5	<0.5	0.00	0.00	NA
Total Suspended Solids	mg/L	1		2.2	3.0	2.6	0.3	0.2	NA
Turbidity	NTU	0.1		1.60	2.10	1.73	0.25	0.13	NA
Conductivity	uS/cm	1		27.0	28.0	27.5	0.6	0.3	NA

Note: NA = not applicable

RDL = Reportable Detection Limit; note: "<" denotes that the value was lower than the RDL for that parameter.

Canadian Environmental Quality Guidelines (CEQG) – Canadian Council of Ministers of the Environment (CCME) Freshwater Aquatic Life (FAL) - CCME (2018)

[a] guideline varies based on pH

[b] guideline varies based on hardness

[c] guideline varies based on temperature and pH

4.4.1.3 Quality Assurance and Quality Control Results

Overall, field duplicate results agreed closely with their corresponding samples and confirmed the representativeness of sampling procedures (Appendix E, Table E.6). For water, relative percent differences (RPD) from the mean for individual parameters were below 20% (personal communication, M. Comeau, Maxxam Analytics). Higher RPDs were typically observed when analyte concentrations were very low (i.e., close to their respective laboratory detection limit). In general, field blank results also showed non-detect confirming that no outside contamination affected the results.

4.4.2 Sediment

4.4.2.1 Analytical Results

Concentrations of metals were compared to two CEQG for the protection of aquatic life: interim sediment quality guideline (ISQG; below which effects are considered unlikely to occur); and probable effects level (PEL; above which effects are considered probable to occur) (CCME 2018). The results are compiled in Table E.7 in Appendix E. No exceedances of the ISQG or PEL were identified. Higher concentrations of aluminum and iron were observed in the nearfield location SGL-001 compared to the farfield location based on the two samples collected (Figure 4.27, Figure 4.28).

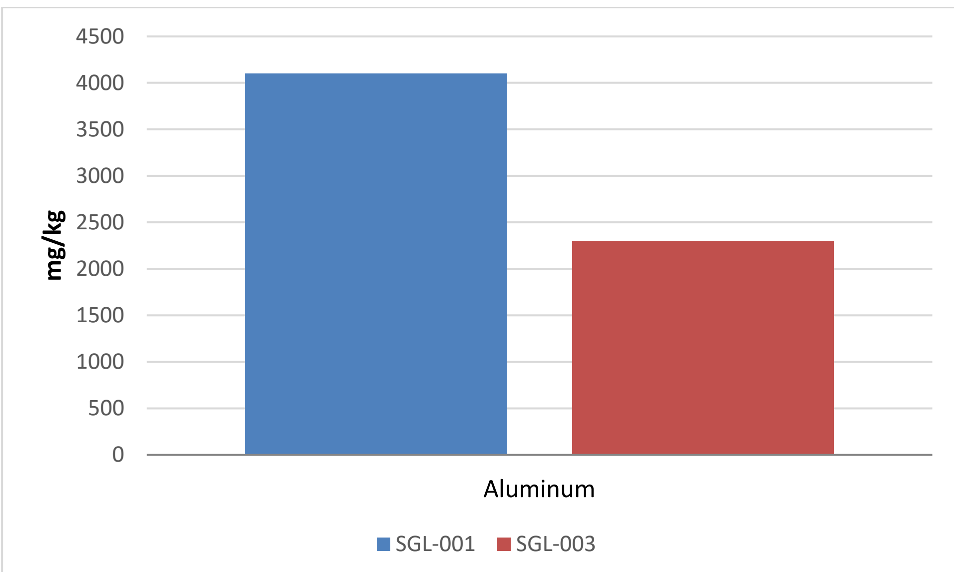


Figure 4.27 Acid Extractable Aluminum in Sediment Samples October 2017, Scraggy Lake, NS

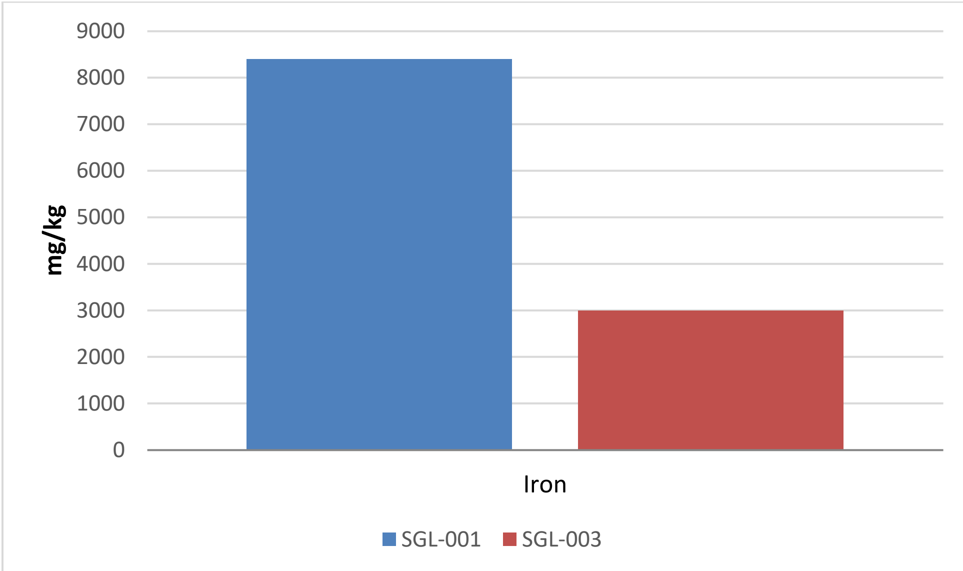


Figure 4.28 Acid Extractable Iron, in Sediment Samples October 2017, Scraggy Lake, NS

Other metals found in relatively higher concentrations at the near-field Exposure Area SGL-001 included arsenic, barium, chromium, copper, lead, lithium, nickel, uranium, vanadium, and zinc. In most cases, the concentrations were found to have decreased at the far-field location (SGL-003).

Grain size distribution between the nearfield and farfield locations showed that sand was the dominant feature with 58% and 68% respectively followed by gravel, sand and clay (Figure 4.29).

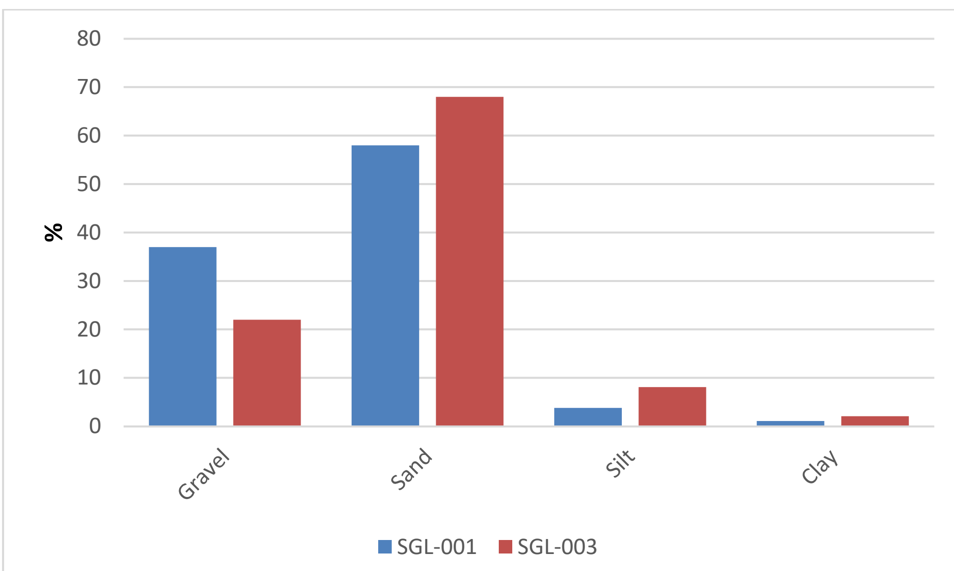


Figure 4.29 Particle Size Distribution in Sediment Samples October 2017, Scraggy Lake, NS

Particle size for both the nearfield and farfield locations range between very fine gravel to medium sand with the far-field location showing slightly higher percentages (Figure 4.30).

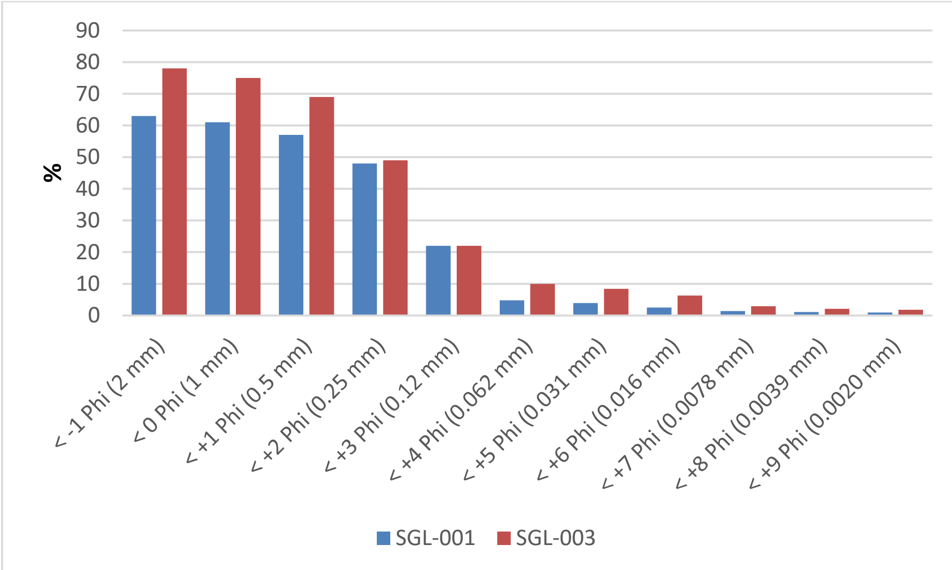


Figure 4.30 Particle Size Range in Sediment Samples October 2017, Scraggy Lake, NS

5.0 SUMMARY

A baseline aquatic monitoring study was implemented in 2017 for Atlantic Gold’s Touquoy Gold Mine to document existing conditions in the receiving environment in Scraggy Lake prior to discharge of mine effluent, anticipated to begin in 2018. The baseline study was designed to mirror the requirements of future EEM program requirements under MMER and thereby support interpretation of future results. The baseline program will also inform the design of the future EEM program.

A reconnaissance survey in August 2017 provided information to support design of the baseline survey, which was conducted in early October 2017. The program included an adult fish survey, a benthic invertebrate community survey, and supporting environmental variables. Although not a requirement under MMER, fish tissue analyses for metals was conducted to establish existing conditions for comparison with future studies, if and as required.

The results of the baseline study establish the existing conditions in Scraggy Lake prior to effluent discharge from the Mine for the fish community, benthic invertebrate community, water and sediment quality, and metals and mercury in fish tissues. These results will be used to inform EEM design and to provide context for interpretation of results from the future EEM program. Recommendations for next steps for baseline data collection and for the EEM program under MMER are provided under separate cover.

The following summary points are provided to document the main findings of the baseline survey:

- Sampling locations were confirmed in Scraggy Lake:
  - nearfield (close to the future effluent final discharge point)
  - farfield (near the outlet of Scraggy Lake to Fish River)
  - baseline sampling was completed for fish, benthic invertebrates, and supporting environmental variables (water, sediment), and fish tissues (metals, mercury)
- Two potential reference lakes were identified:
  - Long Lake to the northwest of Scraggy Lake appears to be suitable as a reference lake for EEM based on:
    - similar fish habitat in the littoral zone
    - same watershed and surrounding land use
    - similar water quality (based on reconnaissance survey sampling)
  - Long Lake – potential limitations as a reference include lack of confirmation of presence of white sucker and yellow perch (although habitat seems to be suitable), and lack of information on sediment quality
  - Alma Lake to the east of Scraggy Lake – similar habitat and size to Scraggy Lake based on desktop analysis; no reconnaissance of baseline sampling has been conducted to confirm its suitability as a reference
- Adult fish survey was conducted in Scraggy Lake to establish baseline conditions:
  - white sucker and yellow perch were targeted for EEM endpoints
    - sufficient numbers of male and females were obtained for each species; baseline data were collected
    - these fish species are broadly used for EEM purposes across Canada and are suitable for this purpose
    - provides information for power analysis for the Cycle 1 EEM study design to detect a difference between sites for the key EEM endpoints
  - fish tissue analysis was conducted, and baseline data were collected for metals and mercury
    - there was an increasing concentration of total mercury with fish length in white sucker and yellow perch, which is a typical pattern for bioaccumulation with increasing age, based on length of fish
- Benthic invertebrate community survey was conducted in Scraggy Lake to establish baseline conditions:
  - sampling of littoral zones for benthic invertebrates is challenging due to substrate with boulders and limited amounts of fine sediment, hence a kick-net sampling approach was used to qualitatively sample the environment, which does not allow for standard EEM endpoints to be calculated (e.g., density) although qualitative information provides value for future reference.
  - a quantitative sampling method is recommended for the future EEM program; consider sampling in deeper areas where finer-grained sediment may be present and sampled using a grab sampler like a petit ponar, which samples a fixed area. Prior to sampling confirm with water quality predictions that effluent plume is mixed from surface to bottom within the nearfield area. Alternately consider a kick net and quadrat with a defined area, however uneven large substrates may make this method difficult
    - confirm that there are similar depths available for sampling in the reference lake(s)
    - avoid sampling the deepest basin areas in Scraggy Lake where there is flocculent material and water quality is poor
- Supporting environmental variables (water and sediment quality) were collected to establish baseline conditions in Long Lake and Scraggy Lake
  - Waters were soft, contain low concentrations of dissolved minerals (i.e., hardness) and had low pH
  - Water was generally clear and with low nutrient levels.

- Trace metal concentrations of key parameters and general chemistry was similar, with the exception of iron and aluminum which showed increased concentrations in some samples.
- A thermocline was not apparent in depths less than 4 m for Scraggy Lake or in Long Lake
- Increased aluminum and iron concentrations in sediment from Scraggy Lake were noted
- Long Lake is a suitable reference lake for Scraggy Lake

6.0 CLOSURE STATEMENT

7.0 REFERENCES

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APPENDIX A

Fish Habitat Photos

Photo 1 **Scraggy Lake – SGL-001 (Nearfield)**

Photo 2 **Scraggy Lake – SGL-001 (Nearfield)**

Photo 3 **Scraggy Lake – SGL-002**

Photo 4 **Scraggy Lake – SGL-002**

Photo 5 **Scraggy Lake – SGL-003 (Farfield)**

Photo 6 **Scraggy Lake – SGL-003 (Farfield)**

Photo 7 Scraggy Lake – SGL-004

Photo 8 Scraggy Lake – SGL-004

Photo 9 Scraggy Lake – SGL-005

Photo 10 Scraggy Lake – SGL-005

Photo 11 Scraggy Lake – SGL-007

Photo 12 Scraggy Lake – SGL-007

Photo 13 **Scraggy Lake – Fish River**

Photo 14 **Scraggy Lake – Fish River**

Photo 15 **Long Lake**

Photo 16 **Long Lake**

APPENDIX B

Fish Survey Raw Data

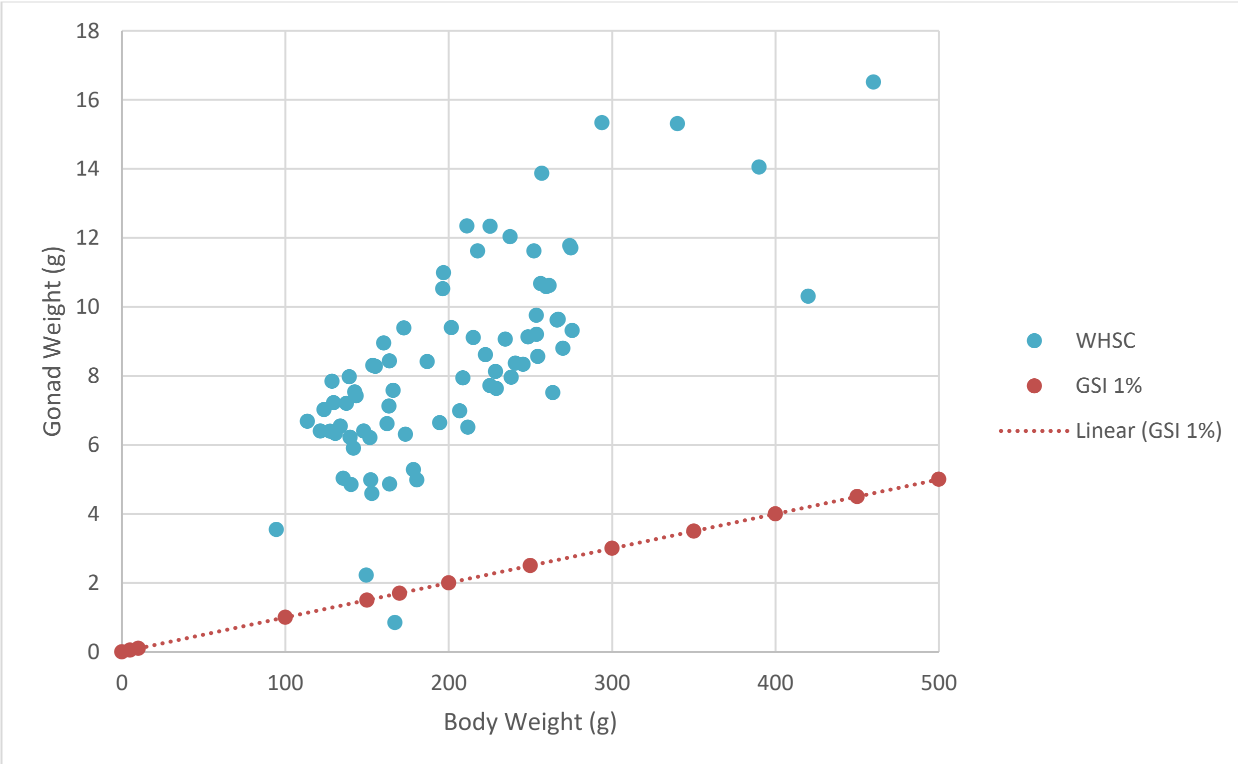

Figure B.1 Scatterplot of Body Weight (g) versus Gonad Weight (g) to Identify Immature White Sucker with Gonadosomatic Index less than 1%

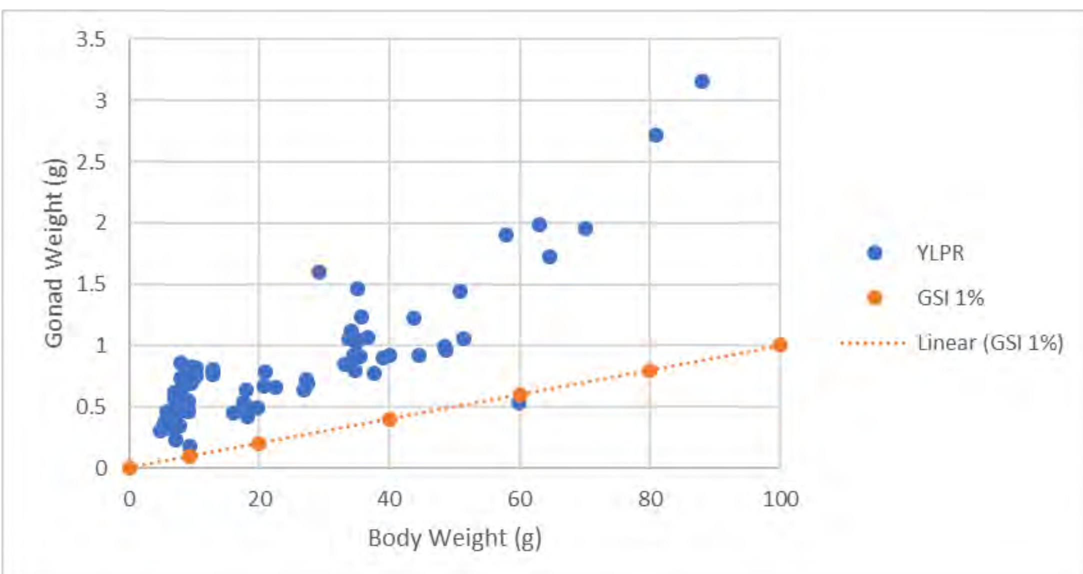

Figure B.2 Scatterplot of Body Weight (g) versus Gonad Weight (g) to Identify Immature Yellow Perch with Gonadosomatic Index less than 1%

APPENDIX C

Fish Tissue Data

Table C.1 Trace Metal Concentrations in Whole Body White Sucker (*Catostomus commersonii*) and Yellow Perch (*Perca flavescens*) in the Nearfield (SGL-001) and Farfield (SGL-003) Locations of Scraggy Lake, NS for EEM Fish Survey

			Yellow Perch										White Sucker								
			Nearfield					Farfield					Nearfield				Farfield				
Parameter	**UNITS**	**RDL**	**SGL-001-YLPR-41**	**SGL-001-YLPR-42**	**SGL-001-YLPR-43**	**SGL-001-YLPR-44**	**SGL-001-YLPR-45**	**SGL-003-YLPR-50**	**SGL-003-YLPR-51**	**SGL-003-YLPR-52**	**SGL-003-YLPR-72**	**SGL-003-YLPR-73**	**SGL-001-WHSC-38**	**SGL-001-WHSC-39**	**SGL-001-WHSC-41**	**SGL-001-WHSC-42**	**SGL-003-WHSC-76**	**SGL-003-WHSC-77**	**SGL-003-WHSC-78**	**SGL-003-WHSC-79**	**SGL-003-WHSC-91**
Aluminum (Al)	mg/kg	2.5	ND	5.8	ND	ND	7.9	5.4	ND	ND	8	6.1	18	13	9	4.4	6.6	13	4.8	5.6	10
Antimony (Sb)	mg/kg	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic (As)	mg/kg	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Barium (Ba)	mg/kg	1.5	ND	ND	ND	ND	ND	1.7	ND	ND	ND	1.8	1.9	2.1	2.8	3.1	2.1	2.7	2.8	2.7	3.5
Beryllium (Be)	mg/kg	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Boron (B)	mg/kg	1.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium (Cd)	mg/kg	0.05	ND	ND	ND	ND	0.15	ND	ND	ND	ND	ND	0.065	ND	0.056	ND	ND	ND	ND	ND	0.07
Chromium (Cr)	mg/kg	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt (Co)	mg/kg	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper (Cu)	mg/kg	0.5	ND	ND	ND	ND	ND	ND	0.5	ND	ND	0.81	0.86	0.81	0.59	0.6	0.54	ND	0.5	0.56	0.58
Iron (Fe)	mg/kg	15	ND	15	18	ND	23	25	ND	ND	42	22	69	52	40	23	25	39	19	19	42
Lead (Pb)	mg/kg	0.18	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.24	0.34	ND	0.22	ND	0.24	ND	ND	0.33
Lithium (Li)	mg/kg	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese (Mn)	mg/kg	0.5	12	35	11	7.3	37	57	25	13	14	23	29	30	38	39	26	50	29	42	36
Molybdenum (Mo)	mg/kg	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel (Ni)	mg/kg	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium (Se)	mg/kg	0.5	ND	ND	ND	ND	0.61	0.75	ND	ND	0.86	0.57	0.69	0.54	0.65	ND	0.76	0.69	0.63	1	0.66
Silver (Ag)	mg/kg	0.12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Strontium (Sr)	mg/kg	1.5	30	36	24	20	20	35	27	29	29	34	11	16	16	21	15	21	20	26	25
Thallium (Tl)	mg/kg	0.02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tin (Sn)	mg/kg	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Uranium (U)	mg/kg	0.02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium (V)	mg/kg	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc (Zn)	mg/kg	1.5	18	23	25	16	20	26	19	18	27	29	17	18	18	23	17	18	21	17	30
Mercury (Hg)	mg/kg	0.01	***0.42***	***0.38***	0.24	***0.59***	0.18	***0.28***	0.16	0.21	0.12	0.18	0.2	0.17	0.15	0.19	0.076	0.12	0.061	0.069	0.2

Note: ND= non-detect; bold-italics indicates exceedance of MOE (2013) partial restriction guideline for human consumption.

APPENDIX D

Benthic Invertebrate Community

BENTHIC INVERTEBRATE SPECIES COMPOSITION IN FRESHWATER KICK NET SAMPLES— SCRAGGY LAKE, NOVA SCOTIA (STANTEC #121619250)

Report to:

Stantec,
Fredericton, New Brunswick

March 2018

By

Envirosphere Consultants Limited
Windsor, Nova Scotia

Lab Number: 2018-5

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BENTHIC INVERTEBRATE SPECIES COMPOSITION IN FRESHWATER KICK NET SAMPLES —SCRAGGY LAKE, NOVA SCOTIA— (STANTEC #121619250)

for

Stantec
Fredericton, New Brunswick

March 2018

INTRODUCTION

Stantec personnel collected ten kick net samples from aquatic environments on October 5, 2017 in Scraggy Lake, Nova Scotia, Stantec Project # 121619250. Samples were taken using a kick net at ten locations (3 reps per station); preserved in 95% ethyl alcohol; and subsequently shipped to Envirosphere Consultants Limited, Windsor, Nova Scotia, for biological analysis (sorting, identification and assessment for biological species composition and abundance). Samples were received on January 23, 2018. The results of the analysis are presented in this report.

METHODS

SIEVING OF WHOLE SEDIMENTS

The sediment samples were provided preserved (95% ethyl alcohol) in plastic 1L jars. Prior to sorting, samples were rinsed on an 0.5 mm sieve to remove preservative.

SORTING AND IDENTIFICATION

Samples were examined at 6 - 6.4x magnification on a stereomicroscope, with a final brief check at 16x and all organisms were removed. Removal efficiency for lab personnel is checked periodically by resorting 10% of samples and is typically 90 % or better (see Attachment 1). Organisms were subsequently stored in labeled vials in 70% ethyl alcohol. Wet weight biomass (grams per sample) was estimated by weighing animals to the nearest milligram at the time of sorting, after blotting to remove surface water.

Organisms were identified to an appropriate taxonomic level, typically to genus, using conventional literature for the groups involved (see Attachment 2). Organisms were identified by Heather Levy (B.Sc. Hons.) and verified by Valerie Kendall (M.Sc.) of Envirosphere Consultants. Abundance of each species, number of species, and wet weight biomass were estimated from the data.

A reference collection containing voucher specimens of the taxa identified was prepared; animals are stored in 20 mL vials in 70% ethyl alcohol.

SUB-SAMPLING

Some samples have been sub-sampled to ensure consistent processing times and adequate numbers of organisms for analysis. Depending on the sample volume and the expected number of organisms present, samples designated for sub-sampling are manually divided to give portions, which are specific fractions of the original sample (e.g. 1/2 or 1/4). All fractions produced during sub-sampling are weighed and verified to be equivalent (i.e. within 0.5 to 1.0 g). Final counts and biomass for the sub-samples are extrapolated to 100%, based on the sub-sample percentage. Sub-sampling can affect measures of animal abundance and biomass by increasing variability, and may lead to slightly reduced estimates of taxon richness compared to whole samples.

RESULTS AND DISCUSSION

Sample descriptions for samples as received are presented in Table 1. Species identifications, abundance, taxon richness, diversity, evenness, and biomass measures are presented in Table 2. Abundance, taxon richness and biomass are expressed on a per sample basis.

Samples contained freshwater animals with most major organism groups represented, although diptera (particularly midge larvae, Chironomidae), ephemeroptera (mayfly), trichoptera (caddisfly), and the amphipod *Hyalella azteca* were most numerous and most commonly occurring. Minor numbers of other groups such as aquatic oligochaetes (worms), coleoptera (beetle) larvae, lepidotpera (butterfly and moths), odonata (dragonfly and damselfly), mollusca (bivalves and gastropods), Hydrachnidia (water mites), Hirudinea (leeches) and plecoptera (stonefly) nymphs also occurred. Communities had a moderate diversity of organisms (taxon richness of 11 – 22 taxa per sample); low to moderate abundances (97 – 654 individuals per sample); and low biomasses (0.05 to 0.90 g per sample (Table 2).

LIMITING CONDITIONS

The quality of the results presented in this report are dependent both on our analysis, and on the quality of samples as provided to Envirosphere Consultants Limited by the client. The analyses are based on practices normally accepted in the analysis of marine and freshwater benthic invertebrate samples, and with suitable controls for quality assurance. No other warranty is made.

Table 1. Characteristics of samples, Stantec Project #121619250, Scraggy Lake, Nova Scotia, October 5, 2017.	
Sample	Sediment Description
SGL-001-B1	Plant and woody debris with sand/gravel with some fines.
SGL-001-B2	Gravel, coarse to fine sand with fines (silt) and organic debris (woody and plant material) present. Animal casings were also present in the sample.
SGL-001-B3	Organic debris (leaf & woody matter) as well as gravel to fine sand and animal casings present in the sample.
SGL-001-B4	Gravel, sand, as well as organics (leafy, plant & woody debris) were present in sample.
SGL-001-B5	Sand, gravel with organic matter (plant & woody debris). Animal casings were also present in the sample.
SGL-003-B1	Organic matter (woody and plant debris) as well as gravel to silt and occasional cobble.
SGL-003-B2	Fines (silt) to gravel with organics (woody and plant debris). Animal casings were also present in sample.
SGL-003-B3	Sand to gravel, as well as silt, and organic debris (aquatic plants & woody material).
SGL-003-B4	Sand with gravel as well as organic debris (plant and woody material).
SGL-003-B5	Fines, medium to fine sand and organic matter (plant debris) noted.
Grain size classes: cobble = 6.4 cm and larger; pebble/ gravel = 4 mm to 6.4 cm; sand = 0.063 mm to 2 mm; silt = 0.004 mm to 0.063 mm; clay = <0.004 mm.	

Table 2. Abundance of benthic organisms in sediments from Stantec Project #121619250, Scraggy Lake, Nova Scotia, October 5, 2017.										
Location	SGL									
	001-B1	001-B2	001-B3	001-B4	001-B5	003-B1	003-B2	003-B3	003-B4	003-B5
Subsample Factor	25%	50%	25%	100%	25%	25%	50%	50%	50%	100%
Abundance	# per sample									
INSECTA										
DIPTERA										
Chironomidae larvae	360	510	268	184	236	68	104	58	28	31
Chrironomidae pupae	0	0	0	0	0	0	0	0	0	3
Ceratopogonidae, *Probezzia/Bezzia* sp	0	2	12	3	0	28	4	4	2	0
Empididae, *Hemerodromia* sp	0	0	4	0	0	0	0	0	2	0
Tabanidae, *Chrysops* sp	4	0	0	0	0	0	0	0	0	0
Tipulidae larvae	0	0	0	0	0	4	0	0	0	0
EPHEMEROPTERA										
Caenidae, *Caenis* sp	0	0	76	2	20	4	0	0	0	1
Ephemerellidae, *Eurylophella* sp	0	0	0	1	0	8	0	0	14	3
Heptageniidae, *Stenacron* sp	0	0	0	0	0	0	0	0	0	10
Ephemeroptera unidentified (no gills)	0	8	24	7	4	0	4	8	26	0
PLECOPTERA										
Perlidae, *Acroneuria* sp	0	0	0	0	0	0	0	0	2	0
Perlidae, *Perlinella?* sp	0	0	0	0	0	0	0	0	0	1
Plecoptera, young nymph	0	0	0	0	0	0	0	0	2	0
TRICHOPTERA										
Hydroptilidae, *Hydroptila* sp	4	2	0	0	4	0	2	0	2	0
Hydroptilidae, *Oxyethira* sp	0	8	8	0	4	0	0	2	0	0
Leptoceridae, *Oecetis* sp	4	20	12	0	8	4	6	6	2	1
Leptoceridae, *Mystacides?* sp	4	2	8	2	0	0	0	2	0	0
Leptoceridae, *Triaenodes?* sp	0	0	0	3	4	0	0	0	0	0
Limnephildae unidentified	0	0	0	0	0	12	2	0	2	0
Phryganeidae, *Ptilostomis?* sp	0	0	0	0	0	0	0	4	0	0
Phryganeidae? unidentified	4	0	0	0	0	8	0	0	2	0
Polycentropodidae, *Nyctiophylax* sp	0	0	0	0	0	0	0	0	0	1
Polycentropodidae, *Phylocentropus* sp	4	0	0	0	0	0	0	0	0	0
Polycentropodidae, *Polycentropus* sp	0	0	0	0	0	0	0	0	2	0
Polycentropodidae unidentified (damaged)	0	0	0	0	0	0	0	0	0	1
COLEOPTERA										
Dytiscidae larvae, *Hydroporus?* sp	0	0	0	0	0	4	0	0	0	0

Table 2. Abundance of benthic organisms in sediments from Stantec Project #121619250, Scraggy Lake, Nova Scotia, October 5, 2017.										
Location	SGL									
	001-B1	001-B2	001-B3	001-B4	001-B5	003-B1	003-B2	003-B3	003-B4	003-B5
Subsample Factor	25%	50%	25%	100%	25%	25%	50%	50%	50%	100%
Abundance	# per sample									
Elmidae larvae, *Dubiraphia* sp	36	0	44	0	0	16	0	0	0	0
Elmidae larvae, *Stenelmis* sp	0	0	4	0	0	8	0	2	6	3
Elmidae adult	0	0	8	0	0	0	0	0	0	0
Hydrophilidae larvae	0	0	0	0	0	0	0	0	2	0
LEPIDOPTERA										
Aquatic Lepidoptera sp A	0	2	0	0	0	0	2	0	0	0
Aquatic Lepidoptera sp B	0	0	0	0	0	0	0	0	2	0
NEUROPTERA										
Neuroptera?	0	2	0	0	0	0	0	0	0	0
ODONATA										
Coenagrionidae, *Enallagma* sp	0	0	0	1	0	0	0	0	0	0
Odonata unidentified (damaged)	0	0	0	0	0	4	2	0	0	0
CRUSTACEA										
Amphipoda - *Hyalella azteca*	40	56	112	40	28	80	82	56	36	18
Cladocera	0	26	28	4	4	24	24	16	26	16
MOLLUSCA										
Bivalves										
Sphaeriidae juvenile	0	2	12	2	0	0	2	0	2	2
Gastropods										
Ancylidae, *Ferrissia?* sp	0	2	0	1	0	0	0	0	0	0
Gastropod sp A	0	2	0	0	0	0	0	0	0	0
ANNELIDS										
Oligochaeta (Worms)										
Oligochaetes	8	10	12	2	20	0	12	6	14	6
PLATYHELMINTHES										
Flatworm	0	0	0	1	0	0	0	0	0	0
Hirudinea (Leeches)										
Glossiphoniidae, *Helobdella stagnalis*	4	0	0	0	0	0	0	10	4	0
Hirudinea sp A	0	0	0	0	0	0	0	0	2	0
HYDRACHNIDIA										
Hydrachnidia sp A	0	0	4	0	0	0	2	2	0	0
Hydrachnidia sp B	0	0	0	0	4	0	0	2	0	0

Table 2. Abundance of benthic organisms in sediments from Stantec Project #121619250, Scraggy Lake, Nova Scotia, October 5, 2017.										
Location	SGL									
	001-B1	001-B2	001-B3	001-B4	001-B5	003-B1	003-B2	003-B3	003-B4	003-B5
Subsample Factor	25%	50%	25%	100%	25%	25%	50%	50%	50%	100%
Abundance	# per sample									
Hydrachnidia sp C	0	0	0	1	0	0	0	2	0	0
Hydrachnidia sp D	0	0	4	0	0	0	0	0	2	0
Hydrachnidia sp E	0	0	0	1	0	0	0	0	0	0
SUMMARY										
Abundance (#/sample)	472	654	640	255	336	272	248	180	182	97
Biomass – Wet Weight (grams/sample)	11	15	17	16	11	14	13	15	22	14
Taxon Richness (#/sample)	0.90	0.17	0.41	0.31	0.16	0.15	0.10	0.09	0.36	0.05

ATTACHMENT 1 – SORTING EFFICIENCY

Envirosphere CONSULTANTS LIMITED

Sorting Efficiency Report

Client Name/Address: STANTEC - 845 PROSPECT St. FREDERICTON, NB E3B 2T7

Sample Information: ATLANTIC GOLD EEM BASELINE #121619250

Sorted by: Joy Baker

Date: March 2018

Checked by: Heather Levy

Date Checked: March 14, 2018

Approved by: Heather Levy

Date: March 14, 2018

SAMPLE NUMBER	STATED NUMBER OF ORGANISMS (A)	NUMBER OF ADDITIONAL ORGANISMS FOUND (B)	SORTING EFFICIENCY (%) (A/(A+B)) X 100	SORTED BY (Initials)
1. B4 (S62-003) 50%	91	2	97.8%	JB
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

Comments:

M:\myfiles\ENVIROSPHERE Benthic Lab\QA_QC forms\Sorting Efficiency Report Form\Sorting Efficiency Report Form.docx

ATTACHMENT 2 – TAXONOMIC LITERATURE

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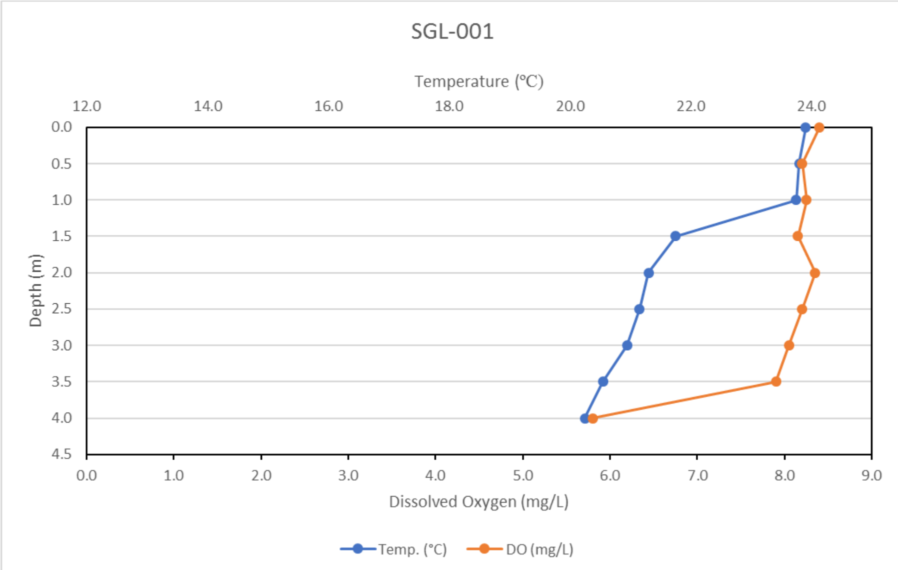
APPENDIX E

Water and Sediment Quality Data



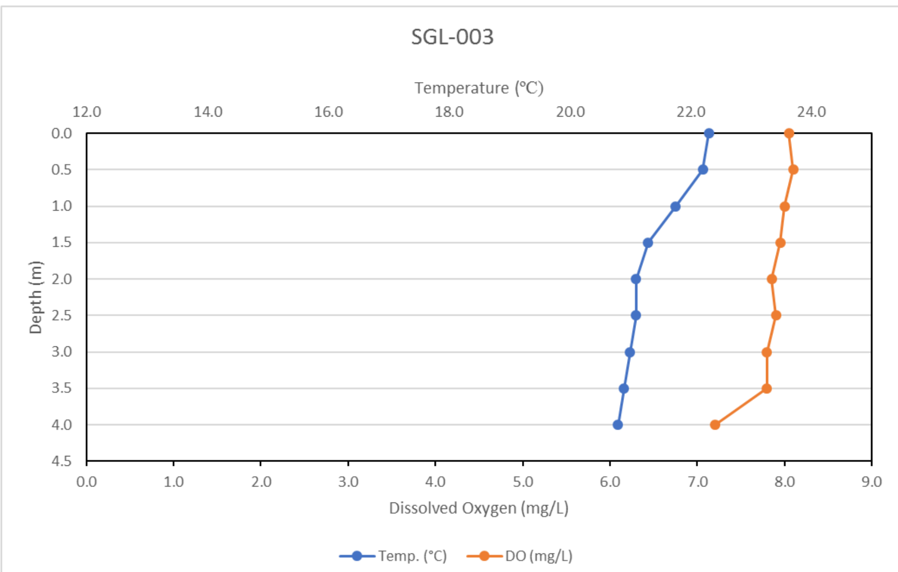
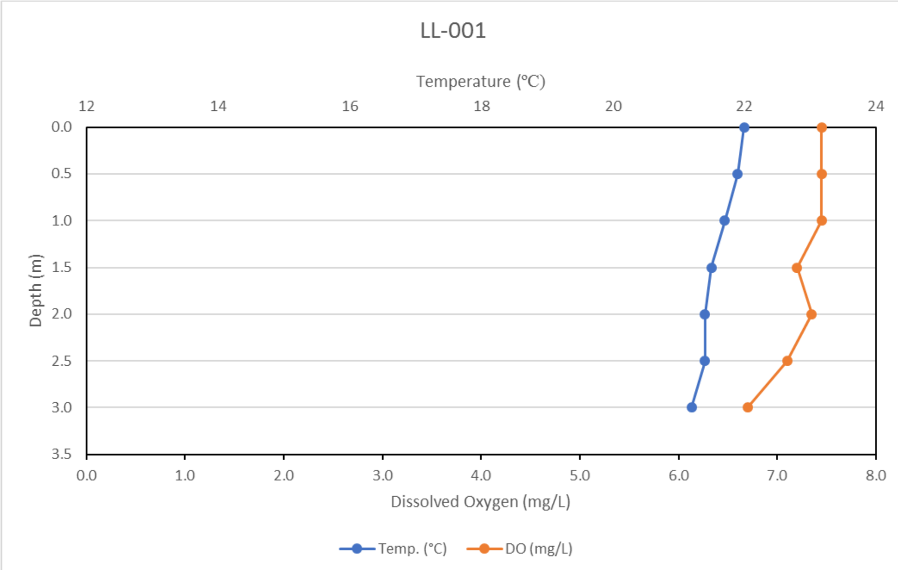


Figure E.1 Dissolved Oxygen and Temperature Profiles for SGL-001 and SGL-003, August 2017



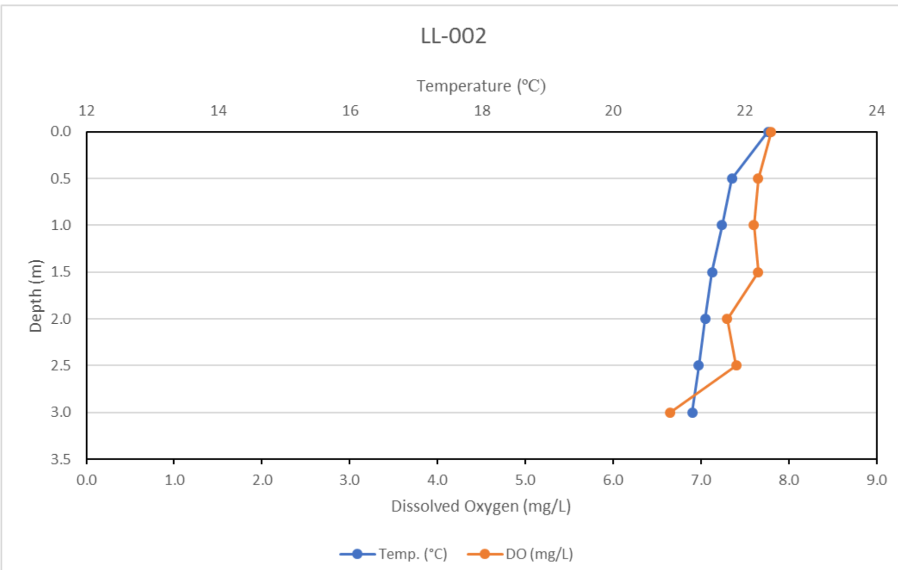


Figure E.2 Dissolved Oxygen and Temperature Profiles for LL-001 and LL-002, August 2017

Table E.1 In-Situ Water Quality Profile Raw Data for Scraggy Lake (August 2017)

Depth (m)	DO (mg/L)	DO (%)	SpCond. (µs/cm)	Temp. (°C)	pH	Turbidity (NTU)	Secchi (m)
SGL-001 (22-Aug-2017)							
0.0	8.4	99.0	24.7	23.9	6.20	1.09	2.41
0.5	8.2	96.5	24.5	23.8			
1.0	8.3	98.0	24.1	23.8			
1.5	8.2	93.5	24.1	21.8			
2.0	8.4	94.5	23.6	21.3			
2.5	8.2	93.0	24.6	21.2			
3.0	8.1	89.5	25.0	21.0			
3.5	7.9	87.0	24.9	20.6		3.72	
4.0	5.8	66.0	25.3	20.3			
4.5	Bottom						
SGL-002 (24-Aug-2017)							
0.0	7.9	93.5	24.7	23.3	6.50	1.06	2.46
0.5	8.0	92.5	24.8	23.1			
1.0	7.7	89.0	24.6	22.4			
1.5	7.9	88.5	24.4	21.4			
2.0	7.6	85.0	24.3	21.2			
2.5	7.5	85.0	24.6	21.1			
3.0	7.7	85.5	24.5	21.0			
3.5	7.6	84.0	24.8	21.0			
4.0	7.4	82.0	24.7	20.9			
4.5	7.5	84.0	25.1	20.8			
5.0	7.6	84.5	25.0	20.8			
5.5	7.5	82.5	24.9	20.8			
6.0	7.4	81.5	24.8	20.8			
6.5	7.3	81.5	24.8	20.7			
7.0	7.3	81.0	25.1	20.7			
7.5	7.3	81.5	24.9	20.7			
8.0	6.7	73.5	24.6	20.4			
8.5	4.9	53.5	25.2	19.7			
9.0	1.4	14.5	25.6	18.2			
9.5	0.1	1.0	26.0	17.8			
10.0	0.1	1.0	26.0	17.8			
10.5						6.11	
11.0					6.50		
10.5							
11.2	Bottom						

Table E.1 In-Situ Water Quality Profile Raw Data for Scraggy Lake (August 2017)

Depth (m)	DO (mg/L)	DO (%)	SpCond. (µs/cm)	Temp. (°C)	pH	Turbidity (NTU)	Secchi (m)
SGL-003 (24-Aug-2017)							
0.0	8.1	92.5	19.8	22.3	6.45	1.41	2.50
0.5	8.1	93.0	20.1	22.2			
1.0	8.0	90.5	20.1	21.8			
1.5	8.0	89.5	20.1	21.3			
2.0	7.9	88.0	19.9	21.1			
2.5	7.9	88.5	20.0	21.1			
3.0	7.8	88.0	20.2	21.0			
3.5	7.8	86.0	20.1	20.9			
4.0	7.2	79.5	20.4	20.8			
4.5	Bottom						
SGL-004 (24-Aug-2017)							
0.0	8.0	89.5	20.9	21.8	7.10	0.74	3.50
0.5	7.8	88.0	20.1	21.5			
1.0	7.7	85.0	19.9	21.3			
1.5	7.6	86.0	20.1	21.3			
2.0	7.5	84.0	107.2	21.2			
2.5	7.6	84.0	20.1	21.2			
3.0	7.6	86.0	20.2	21.2			
3.5	7.2	80.5	20.0	21.2			
4.0	7.6	84.0	20.4	21.1			
4.5	7.4	83.0	20.1	21.1			
5.0	7.3	81.5	20.5	21.4			
5.5	5.9	65.0	20.5	20.2			
6.0	3.1	33.0	21.4	18.4			
6.5	2.6	26.0	21.8	15.9			
7.0	2.2	21.5	21.8	14.4			
7.5	1.8	17.5	21.8	13.9			
8.0	1.5	14.0	21.7	13.5			
8.5	1.3	12.0	21.7	13.2			
9.0	1.2	11.0	22.0	13.0			
9.5	1.1	10.5	22.0	12.8			
10.0	0.8	7.0	22.1	12.7			
10.5	0.8	7.0	22.2	12.7		3.15	
11.0	0.7	6.5	22.2	12.6			
11.5	0.6	5.5	22.4	12.6			
12.0	0.5	4.5	22.3	12.5			
12.5	0.3	3.0	22.4	12.5			
13.0	0.1	1.0	22.4	12.4			
13.5	0.1	1.0	22.3	12.4			

Table E.1 In-Situ Water Quality Profile Raw Data for Scraggy Lake (August 2017)

Depth (m)	DO (mg/L)	DO (%)	SpCond. (µs/cm)	Temp. (°C)	pH	Turbidity (NTU)	Secchi (m)
14.0	Organic Layer						
20.0	Bottom						
SGL-005 (23-Aug-2017)							
0.0	8.5	96.0	20.3	21.50	5.85	1.35	

Table E.2 In-Situ Water Quality Profile Data for Scraggy Lake (October 2017)

SGL-001 (2-Oct-2017)							
Depth (m)	**DO (mg/L)**	**DO (%)**	**SpCond. (µs/cm)**	**Temp. (°C)**	**pH**	**Turbidity (NTU)**	**Secchi (m)**
0.0	8.7	89.0	25.1	16.4	4.90	1.39	2.65
0.5	8.6	87.5	25.1	16.4			
1.0	8.6	87.0	24.9	16.4			
1.5	8.5	86.5	25.0	16.4			
2.0	8.5	86.5	24.9	16.4			
2.5	8.5	87.0	24.9	16.4			
3.0	8.5	86.0	25.0	16.4			
3.5	8.5	86.5	24.9	16.4	4.90	1.78	
4.0	8.4	86.0	24.9	16.4			
4.4	Bottom						
SGL-003 (3-Oct-2017)							
0.0	9.7	96.0	20.3	15.4	6.60	1.35	2.40
0.5	9.7	96.0	20.2	15.4			
1.0	9.6	95.0	20.2	15.4			
1.5	9.6	94.0	20.1	15.3			
2.0	9.6	94.0	20.1	15.3			
2.5	9.7	94.5	20.0	15.3	6.60	1.35	
3.0	9.6	94.0	20.1	15.3			
3.5	Bottom						
SGL-007 (4-Oct-2017)							
0.0	9.8	89	23.3	14.6	5.10	1.50	

Table E.3 In-Situ Water Quality Profile Data for Long Lake (August 2017)

Depth (m)	DO (mg/L)	DO (%)	SpCond. (µs/cm)	Temp. (°C)	pH	Turbidity (NTU)	Secchi (m)
LL-001 (25-Aug-2017)							
0.0	7.5	85.5	29.8	22.0	6.75	2.10	2.48
0.5	7.5	84.5	29.8	21.9			
1.0	7.5	85.0	29.8	21.7			
1.5	7.2	82.0	29.8	21.5			
2.0	7.4	83.5	29.7	21.4			
2.5	7.1	80.0	29.7	21.4		2.76	
3.0	6.7	76.0	29.8	21.2			
3.1	Bottom						
LL-002 (25-Aug-2017)							
0.0	7.8	89.0	29.9	22.4	6.47	2.42	2.28
0.5	7.7	87.0	29.6	21.8			
1.0	7.6	86.5	29.5	21.7			
1.5	7.7	87.0	29.3	21.5			
2.0	7.3	81.5	29.5	21.4			
2.5	7.4	83.5	29.6	21.3			
3.0	6.7	74.5	29.7	21.2		2.52	
3.5	Bottom						

Table E.4 General Chemistry and Trace Metal Concentrations of Surface Water for Scraggy Lake in August and October 2017

Metals	UNITS	RDL	MMER‡	CCME-FAL	SGL-001-0M	SGL-001-3.5M	SGL-002-0M	SGL-002-10.5M	SGL-003-0M	SGL-003-3M	SGL-004-0M	SGL-004-10.5M	SGL-005	SGL-006 (Dupl. for SGL-005)	SGL-001-0M	SGL-001-3.5M	SGL-003-0M	SGL-003-2.5M	SGL-007-0M	SGL-008-0M (Dupl. for SGL-007-0M)	Descriptive Statistics					
Sampling Date					2017/08/22 14:00	2017/08/22 14:44	2017/08/24 15:00	2017/08/24 15:15	2017/08/24 13:40	2017/08/24 13:50	2017/08/24 11:35	2017/08/24 11:50	2017/08/23 14:05	2017/08/23 13:44	2017/10/02 14:10	2017/10/02 14:33	2017/10/03 13:20	2017/10/03 13:35	2017/10/04 10:20	2017/10/04 10:30	Min	Max	Mean	Std Dev	Std Err	CCME FAL Exceedances
Dissolved Aluminum (Al)	ug/L	5			110	110	100	250	71	74	72	110	72	70	100	100	77	77	100	100	70	250	99.6	43.1	10.8	NA
Total Aluminum (Al)	ug/L	5		5-100[a]	***130***	***170***	***130***	***320***	98	***110***	***130***	***190***	***97***	***100***	***130***	***130***	***110***	***110***	***120***	***110***	97	320	136.6	55.0	13.7	9
Dissolved Antimony (Sb)	ug/L	1			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0	0.0	NA
Total Antimony (Sb)	ug/L	1			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0	0.0	NA
Dissolved Arsenic (As)	ug/L	1			1.2	1.2	1.1	11	0.5	0.5	0.5	0.5	0.5	0.5	1	1.1	0.5	0.5	0.5	0.5	0.5	11	1.4	2.6	0.6	NA
Total Arsenic (As)	ug/L	1	500	5	1.3	1.6	1.3	***13***	0.5	0.5	0.5	0.5	0.5	0.5	1.2	1.3	0.5	0.5	1.1	1	0.5	13	1.6	3.1	0.8	1
Dissolved Barium (Ba)	ug/L	1			2.8	2.7	2.5	3.1	2.1	2.2	2.1	3.1	2.2	2.2	2.5	2.5	2.1	2.1	2.2	2.3	2.1	3.1	2.4	0.3	0.1	NA
Total Barium (Ba)	ug/L	1			2.5	2.8	2.7	5.4	2.4	2.2	2.4	3.3	2	2	2.6	2.5	2	2	2.3	2.3	2	5.4	2.6	0.8	0.2	NA
Dissolved Beryllium (Be)	ug/L	1			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0	0.0	NA
Total Beryllium (Be)	ug/L	1			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0	0.0	NA
Dissolved Bismuth (Bi)	ug/L	2			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.0	0.0	0.0	NA
Total Bismuth (Bi)	ug/L	2			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.0	0.0	0.0	NA
Dissolved Boron (B)	ug/L	50			25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25.0	0.0	0.0	NA
Total Boron (B)	ug/L	50		1500	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25.0	0.0	0.0	0
Dissolved Cadmium (Cd)	ug/L	0.01			0.005	0.005	0.005	0.013	0.011	0.005	0.005	0.012	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.013	0.0	0.0	0.0	NA
Total Cadmium (Cd)	ug/L	0.01		0.09	0.005	0.005	0.005	0.014	0.005	0.005	0.005	0.013	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.014	0.0	0.0	0.0	0
Dissolved Calcium (Ca)	ug/L	100			980	1100	930	1100	620	600	600	670	630	630	1000	1100	640	630	910	920	600	1100	816.3	203.8	51.0	NA
Total Calcium (Ca)	ug/L	100			1000	1000	940	1100	640	640	660	680	590	600	1100	1100	680	690	970	940	590	1100	833.1	199.4	49.8	NA
Dissolved Chromium (Cr)	ug/L	1			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0	0.0	NA
Total Chromium (Cr)	ug/L	1			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0	0.0	NA
Dissolved Cobalt (Co)	ug/L	0.4			0.2	0.2	0.2	1.6	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1.6	0.3	0.4	0.1	NA
Total Cobalt (Co)	ug/L	0.4			0.2	0.2	0.2	1.5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1.5	0.3	0.3	0.1	NA
Dissolved Copper (Cu)	ug/L	2			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.0	0.0	0.0	NA
Total Copper (Cu)	ug/L	2	300	2[b]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.0	0.0	0.0	0
Dissolved Iron (Fe)	ug/L	50			180	200	180	5700	77	95	66	380	82	76	190	190	96	92	160	160	66	5700	495.3	1390.1	347.5	NA
Total Iron (Fe)	ug/L	50		300	280	***350***	260	***6000***	160	180	120	***1300***	180	180	***340***	***330***	240	240	***310***	***320***	120	6000	674.4	1445.9	361.5	7
Dissolved Lead (Pb)	ug/L	0.5			0.25	0.25	0.25	1.2	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	1.2	0.3	0.2	0.1	NA
Total Lead (Pb)	ug/L	0.5	200	1[b]	0.25	0.25	0.25	***1.6***	0.25	0.25	0.25	0.92	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	1.6	0.4	0.4	0.1	1
Dissolved Magnesium (Mg)	ug/L	100			410	410	400	410	310	310	330	340	310	310	450	450	350	350	420	420	310	450	373.8	52.3	13.1	NA
Total Magnesium (Mg)	ug/L	100			400	420	390	400	320	330	320	340	320	320	480	480	380	370	430	420	320	480	382.5	54.8	13.7	NA
Dissolved Manganese (Mn)	ug/L	2			52	54	48	420	28	29	35	140	27	27	36	35	32	32	29	29	27	420	65.8	98.4	24.6	NA
Total Manganese (Mn)	ug/L	2			53	57	48	410	32	33	39	140	30	30	40	39	37	36	32	32	30	410	68.0	95.0	23.7	NA
Dissolved Mercury (Hg)	ug/L	0.013			0.0065	0.0065	0.0065	0.013	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.013	0.0	0.0	0.0	NA
Total Mercury (Hg)	ug/L	0.013		0.026	0.0065	0.0065	0.0065	0.017	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.017	0.0	0.0	0.0	0
Dissolved Molybdenum (Mo)	ug/L	2			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.0	0.0	0.0	NA
Total Molybdenum (Mo)	ug/L	2		73	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.0	0.0	0.0	0
Dissolved Nickel (Ni)	ug/L	2			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.0	0.0	0.0	NA
Total Nickel (Ni)	ug/L	2	500	25[b]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.0	0.0	0.0	0
Dissolved Phosphorus (P)	ug/L	100			50	50	50	50	50	50	50	50	50	50	320	290	200	190	280	310	50	320	130.6	112.3	28.1	NA
Total Phosphorus (P)	ug/L	100			50	50	50	50	50	50	50	50	50	50	350	330	220	220	290	330	50	350	140.0	124.5	31.1	NA
Dissolved Potassium (K)	ug/L	100			300	290	310	310	240	230	200	210	170	170	50	50	50	50	50	50	50	310	170.6	105.8	26.4	NA
Total Potassium (K)	ug/L	100			360	360	260	270	160	160	150	170	220	250	50	50	50	50	50	50	50	360	166.3	111.3	27.8	NA
Dissolved Selenium (Se)	ug/L	1			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0	0.0	NA
Total Selenium (Se)	ug/L	1		1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0	0.0	0
Dissolved Silver (Ag)	ug/L	0.1			0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.0	0.0	NA
Total Silver (Ag)	ug/L	0.1		0.25	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.0	0.0	0
Dissolved Sodium (Na)	ug/L	100			2300	2300	2300	2200	1900	1900	2000	2000	1900	1900	2500	2500	2100	2100	2400	2400	1900	2500	2168.8	221.3	55.3	NA
Total Sodium (Na)	ug/L	100			2400	2500	2200	2100	1900	2000	2000	1900	2100	2200	2600	2600	2300	2200	2400	2400	1900	2600	2237.5	230.6	57.6	NA
Dissolved Strontium (Sr)	ug/L	2			5.1	5.2	4.6	6.2	3.9	4.2	4.5	4.5	4	4.2	5.5	5.2	3.9	3.8	5.1	5.1	3.8	6.2	4.7	0.7	0.2	NA
Total Strontium (Sr)	ug/L	2			5.4	5.4	4.8	6.6	4.2	4.2	4.1	5.1	3.8	4.1	5.3	5.6	4.3	4.2	4.8	4.5	3.8	6.6	4.8	0.7	0.2	NA
Dissolved Thallium (Tl)	ug/L	0.1			0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.0	0.0	NA
Total Thallium (Tl)	ug/L	0.1		0.8	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.0	0.0	0
Dissolved Tin (Sn)	ug/L	2			1	2.4	1	1	1	2.4	1	1	1	1	1	6.2	1	1	1	1	1	6.2	1.5	1.3	0.3	NA
Total Tin (Sn)	ug/L	2			1	2.4	1	1	1	2.6	1	2.7	1	1	***1***	***5.6***	***1***	***3***	***1***	***1***	1	5.6	1.7	1.3	0.3	NA
Dissolved Titanium (Ti)	ug/L	2			1	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	5	1.3	1.0	0.3	NA
Total Titanium (Ti)	ug/L	2			1	3.5	2.1	6.5	1	1	1	2.3	1	1	2.1	2.3	2.1	1	2.4	2.1	1	6.5	2.0	1.4	0.4	NA
Dissolved Uranium (U)	ug/L	0.1			0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.0	0.0	NA
Total Uranium (U)	ug/L	0.1		15	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.0	0.0	0
Dissolved Vanadium (V)	ug/L	2			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.0	0.0	0.0	NA
Total Vanadium (V)	ug/L	2			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.0	0.0	0.0	NA
Dissolved Zinc (Zn)	ug/L	5			6.9	5.1	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	6.9	2.9	1.2	0.3	NA
Total Zinc (Zn)	ug/L	5	500	30	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0.0	0.0	0
Hardess	mg/L	1			4.2	4.4	4	4.5	2.8	2.8	2.8	3.1	2.9	2.9	4.4	4.5	3	3	4	4	2.8	4.5	3.6	0.7	0.2	NA
Chlorophyll a (Acidification Technique)	ug/L	NA			2.47	2.06	2.66	0.46	2.84	1.28	1.56	0.56	-	-	-	-	-	-	-	-	0.46	2.84	1.7	0.9	0.3	NA
Chlorophyll a (Welschmeyer Technique)	ug/L	NA			2.52	2.25	2.77	1.19	2.84	1.43	1.67	0.81	-	-	-	-	-	-	-	-	0.81	2.84	1.9	0.8	0.3	NA
Anion Sum	me/L	N/A			0.11	0.11	0.11	0.11	0.1	0.08	0.09	0.1	0.09	0.09	0.16	0.16	0.09	0.09	0.11	0.11	0.08	0.16	0.1	0.0	0.0	NA
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	1			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0	0.0	NA
Calculated TDS	mg/L	1			9	9	9	17	7	6	6	9	7	7	12	11	7	7	9	9	6	17	8.8	2.8	0.7	NA
Carb. Alkalinity (calc. as CaCO3)	mg/L	1			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0	0.0	NA
Cation Sum	me/L	N/A			0.2	0.2	0.19	0.42	0.15	0.15	0.15	0.17	0.15	0.15	0.21	0.21	0.16	0.16	0.2	0.2	0.15	0.42	0.2	0.1	0.0	NA
Hardness (CaCO3)	mg/L	1			4.2	4.4	4	4.5	2.8	2.8	2.8	3.1	2.9	2.9	4.4	4.5	3	3	4	4	2.8	4.5	3.6	0.7	0.2	NA
Ion Balance (% Difference)	%	N/A			29	29	26.7	58.5	20	30.4	25	25.9	25	25	13.5	13.5	28	28	29	29	13.5	58.5	27.2	9.8	2.5	NA
Langelier Index (@ 20C)	N/A				NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NA
Langelier Index (@ 4C)	N/A				NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NA
Nitrate (N)	mg/L	0.05		2.9	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.16	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.16	0.0	0.0	0.0	0
Saturation pH (@ 20C)	N/A				NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NA
Saturation pH (@ 4C)	N/A				NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NA
Inorganics					0	0	0	0	0	0	0	0	0	0												NA
Total Alkalinity (Total as CaCO3)	mg/L	5			2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0.0	0.0	NA
Total Chemical Oxygen Demand	mg/L	20			22	24	17	36	15	22	22	18	12	13	20	23	13	23	23	20	12	36	20.2	5.8	1.5	NA
Dissolved Chloride (Cl)	mg/L	1		120	3.8	3.8	3.9	4	3.4	2.8	3.2	3.4	2.9	3.3	4.2	4	3.2	3.3	3.8	3.8	2.8	4.2	3.6	0.4	0.1	0
Colour	TCU	5			44	45	42	110 (1)	25	24	25	43	24	24	42	42	27	25	41	41	24	45	34.3	9.2	2.4	NA
Strong Acid Dissoc. Cyanide (CN)	mg/L	0.001			0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0011	0.0005	0.0005	0.0005	0.0005	0.0005	0.0011	0.0	0.0	0.0	NA
Dissolved Fluoride (F-)	mg/L	0.1		0.12	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.0	0.0	0
Nitrate + Nitrite (N)	mg/L	0.05			0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.16	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.16	0.0	0.0	0.0	NA
Nitrite (N)	mg/L	0.01		0.06	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.0	0.0	0.0	0
Nitrogen (Ammonia Nitrogen)	mg/L	0.05		4[c]	0.025	0.025	0.025	0.34	0.025	0.025	0.025	0.082	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.34	0.0	0.1	0.0	0
Total Organic Carbon (C)	mg/L	0.5			6	6.2	5.6	11 (1)	4.6	5.9 (1)	4.4	6.3 (1)	4.9	4.6	5.4	5.7	4.6	4.6	5.5	6	4.4	6.2	5.2	0.6	0.2	NA
Orthophosphate (P)	mg/L	0.01			0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.0	0.0	0.0	NA
pH	pH	N/A	6.0-9.5	6.5-9.0	6.24	6.42	6.68	6.15	6.5	6.21	5.94	6.08	6.46	6.16	5.88	5.84	6.46	5.97	5.87	6.31	5.84	6.68	6.2	0.3	0.1	14
Salinity	N/A	2			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.0	0.0	0.0	NA
Reactive Silica (SiO2)	mg/L	0.5			0.57	0.66	0.55	2.9	0.25	0.25	0.25	1.9	0.25	0.84	0.78	0.79	0.57	0.57	0.7	0.71	0.25	2.9	0.8	0.7	0.2	NA
Total Suspended Solids	mg/L	1	15.0		8	0.5	2.2	20	2	1.8	1.2	6.4	0.5	2.1	1.6	1.8	1.8	2.4	1.6	2	0.5	20	3.5	4.8	1.2	NA
Dissolved Sulphate (SO4)	mg/L	2			1	1	1	1	1	1	1	1	1	1	2.1	2	1	1	1	1	1	2.1	1.1	0.4	0.1	NA
Turbidity	NTU	0.1			0.92	2	0.98	14	0.88	1.3	0.69	2.7	1	1.1	1.2	1.2	1.5	1.4	1.4	1.4	0.69	14	2.1	3.2	0.8	NA
Conductivity	uS/cm	1			23	24	23	26	19	18	18	20	19	18	23	23	19	18	22	23	18	26	21.0	2.6	0.7	NA

Note: a CCME FAL varies with pH; b CCME FAL varies with hardness, value which were below the detection limit are presented as half of the detection limit and used in calculations

Table E.5 General Chemistry and Trace Metal Concentrations for Long Lake in August 2017

Metals	UNITS	RDL	MMER‡	CCME-FAL	LL-001-0M	LL-001-2.5M	LL-002-0M	LL-002-3.0M	Descriptive Statistics					
Sampling Date					2017/08/25 10:00	2017/08/25 10:10	2017/08/25 11:15	2017/08/25 11:40	Min	Max	Mean	Std Dev	Std Err	CCME FAL Exceedances
Dissolved Aluminum (Al)	ug/L	5			95	95	92	87	87	95	92.3	3.77	1.89	NA
Total Aluminum (Al)	ug/L	5		5-100[a]	***130***	***150***	***130***	***140***	130	150	137.5	9.57	4.79	4
Dissolved Antimony (Sb)	ug/L	1			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.00	0.00	NA
Total Antimony (Sb)	ug/L	1			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.00	0.00	NA
Dissolved Arsenic (As)	ug/L	1			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.00	0.00	NA
Total Arsenic (As)	ug/L	1	500	5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.00	0.00	0
Dissolved Barium (Ba)	ug/L	1			3.5	3.5	3.8	3.7	3.5	3.8	3.6	0.15	0.08	NA
Total Barium (Ba)	ug/L	1			4	4.2	4.3	3.7	3.7	4.3	4.1	0.26	0.13	NA
Dissolved Beryllium (Be)	ug/L	1			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.00	0.00	NA
Total Beryllium (Be)	ug/L	1			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.00	0.00	NA
Dissolved Bismuth (Bi)	ug/L	2			1	1	1	1	1	1	1.0	0.00	0.00	NA
Total Bismuth (Bi)	ug/L	2			1	1	1	1	1	1	1.0	0.00	0.00	NA
Dissolved Boron (B)	ug/L	50			25	25	25	25	25	25	25.0	0.00	0.00	NA
Total Boron (B)	ug/L	50		1500	25	25	25	25	25	25	25.0	0.00	0.00	0
Dissolved Cadmium (Cd)	ug/L	0.01			0.005	0.005	0.005	0.005	0.005	0.005	0.0	0.00	0.00	NA
Total Cadmium (Cd)	ug/L	0.01		0.09	0.005	0.005	0.005	0.005	0.005	0.005	0.0	0.00	0.00	0
Dissolved Calcium (Ca)	ug/L	100			1100	1100	1100	1000	1000	1100	1075.0	50.00	25.00	NA
Total Calcium (Ca)	ug/L	100			1000	1000	1000	960	960	1000	990.0	20.00	10.00	NA
Dissolved Chromium (Cr)	ug/L	1			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.00	0.00	NA
Total Chromium (Cr)	ug/L	1			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.00	0.00	NA
Dissolved Cobalt (Co)	ug/L	0.4			0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.00	0.00	NA
Total Cobalt (Co)	ug/L	0.4			0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.00	0.00	NA
Dissolved Copper (Cu)	ug/L	2			1	1	1	1	1	1	1.0	0.00	0.00	NA
Total Copper (Cu)	ug/L	2	300	2[b]	1	1	1	1	1	1	1.0	0.00	0.00	0
Dissolved Iron (Fe)	ug/L	50			300	300	280	280	280	300	290.0	11.55	5.77	NA
Total Iron (Fe)	ug/L	50		300	***470***	***470***	***440***	***470***	440	470	462.5	15.00	7.50	4
Dissolved Lead (Pb)	ug/L	0.5			0.25	0.25	0.25	0.25	0.25	0.25	0.3	0.00	0.00	NA
Total Lead (Pb)	ug/L	0.5	200	1[b]	0.25	0.25	0.25	0.25	0.25	0.25	0.3	0.00	0.00	0
Dissolved Magnesium (Mg)	ug/L	100			410	410	410	420	410	420	412.5	5.00	2.50	NA
Total Magnesium (Mg)	ug/L	100			430	400	410	410	400	430	412.5	12.58	6.29	NA
Dissolved Manganese (Mn)	ug/L	2			24	26	34	34	24	34	29.5	5.26	2.63	NA
Total Manganese (Mn)	ug/L	2			44	48	53	58	44	58	50.8	6.08	3.04	NA
Dissolved Mercury (Hg)	ug/L	0.013			0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0	0.00	0.00	NA
Total Mercury (Hg)	ug/L	0.013		0.026	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0	0.00	0.00	0
Dissolved Molybdenum (Mo)	ug/L	2			1	1	1	1	1	1	1.0	0.00	0.00	NA
Total Molybdenum (Mo)	ug/L	2		73	1	1	1	1	1	1	1.0	0.00	0.00	0
Dissolved Nickel (Ni)	ug/L	2			1	1	1	1	1	1	1.0	0.00	0.00	NA
Total Nickel (Ni)	ug/L	2	500	25[b]	1	1	1	1	1	1	1.0	0.00	0.00	0
Dissolved Phosphorus (P)	ug/L	100			50	50	50	50	50	50	50.0	0.00	0.00	NA
Total Phosphorus (P)	ug/L	100			50	50	50	50	50	50	50.0	0.00	0.00	NA
Dissolved Potassium (K)	ug/L	100			220	220	220	210	210	220	217.5	5.00	2.50	NA
Total Potassium (K)	ug/L	100			160	140	130	140	130	160	142.5	12.58	6.29	NA
Dissolved Selenium (Se)	ug/L	1			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.00	0.00	NA
Total Selenium (Se)	ug/L	1		1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.00	0.00	0
Dissolved Silver (Ag)	ug/L	0.1			0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.00	0.00	NA
Total Silver (Ag)	ug/L	0.1		0.25	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.00	0.00	0
Dissolved Sodium (Na)	ug/L	100			3300	3300	3200	3200	3200	3300	3250.0	57.74	28.87	NA
Total Sodium (Na)	ug/L	100			3300	3300	3300	3200	3200	3300	3275.0	50.00	25.00	NA
Dissolved Strontium (Sr)	ug/L	2			4.3	4.7	4.3	4.2	4.2	4.7	4.4	0.22	0.11	NA
Total Strontium (Sr)	ug/L	2			4.7	4.7	4.7	4.8	4.7	4.8	4.7	0.05	0.02	NA
Dissolved Thallium (Tl)	ug/L	0.1			0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.00	0.00	NA
Total Thallium (Tl)	ug/L	0.1		0.8	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.00	0.00	0
Dissolved Tin (Sn)	ug/L	2			1	2.1	1	1	1	2.1	1.3	0.55	0.28	NA
Total Tin (Sn)	ug/L	2			1	2.2	1	1	1	2.2	1.3	0.60	0.30	NA
Dissolved Titanium (Ti)	ug/L	2			1	1	1	1	1	1	1.0	0.00	0.00	NA
Total Titanium (Ti)	ug/L	2			2.3	2.3	2.4	2.5	2.3	2.5	2.4	0.10	0.05	NA
Dissolved Uranium (U)	ug/L	0.1			0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.00	0.00	NA
Total Uranium (U)	ug/L	0.1		15	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.00	0.00	0
Dissolved Vanadium (V)	ug/L	2			1	1	1	1	1	1	1.0	0.00	0.00	NA
Total Vanadium (V)	ug/L	2			1	1	1	1	1	1	1.0	0.00	0.00	NA
Dissolved Zinc (Zn)	ug/L	5			2.5	2.5	2.5	2.5	2.5	2.5	2.5	0.00	0.00	NA
Total Zinc (Zn)	ug/L	5	500	30	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0.00	0.00	0
Hardess					4.4	4.4	4.5	4.3	4.3	4.5	4.4	0.08	0.04	NA
Chlorophyll a (Acidification Technique)	ug/L	NA			1.46	2.22	1.3	2.15	1.3	2.22	1.8	0.47	0.24	NA
Chlorophyll a (Welschmeyer Technique)	ug/L	NA			1.63	2.23	1.43	2.27	1.43	2.27	1.9	0.42	0.21	NA
Anion Sum	me/L	N/A			0.15	0.15	0.15	0.15	0.15	0.15	0.2	0.00	0.00	NA
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	1			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.00	0.00	NA
Calculated TDS	mg/L	1			11	11	11	11	11	11	11.0	0.00	0.00	NA
Carb. Alkalinity (calc. as CaCO3)	mg/L	1			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.00	0.00	NA
Cation Sum	me/L	N/A			0.25	0.25	0.25	0.24	0.24	0.25	0.2	0.01	0.00	NA
Hardness (CaCO3)	mg/L	1			4.4	4.4	4.5	4.3	4.3	4.5	4.4	0.08	0.04	NA
Ion Balance (% Difference)	%	N/A			25	25	25	23.1	23.1	25	24.5	0.95	0.48	NA
Langelier Index (@ 20C)	N/A				NC	NC	NC	NC	0	0	-	-	-	NA
Langelier Index (@ 4C)	N/A				NC	NC	NC	NC	0	0	-	-	-	NA
Nitrate (N)	mg/L	0.05		2.9	0.025	0.025	0.025	0.025	0.025	0.025	0.0	0.00	0.00	0
Saturation pH (@ 20C)	N/A				NC	NC	NC	NC	0	0	-	-	-	NA
Saturation pH (@ 4C)	N/A				NC	NC	NC	NC	0	0	-	-	-	NA
Inorganics					0	0	0	0	0	0	0.0	0.00	0.00	NA
Total Alkalinity (Total as CaCO3)	mg/L	5			2.5	2.5	2.5	2.5	2.5	2.5	2.5	0.00	0.00	NA
Total Chemical Oxygen Demand	mg/L	20			24	22	22	24	22	24	23.0	1.15	0.58	NA
Dissolved Chloride (Cl)	mg/L	1		120	5.3	5.4	5.4	5.4	5.3	5.4	5.4	0.05	0.03	0
Colour	TCU	5			35	36	35	36	35	36	35.5	0.58	0.29	NA
Strong Acid Dissoc. Cyanide (CN)	mg/L	0.001			0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0	0.00	0.00	NA
Dissolved Fluoride (F-)	mg/L	0.1		120	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.00	0.00	0
Nitrate + Nitrite (N)	mg/L	0.05			0.025	0.025	0.025	0.025	0.025	0.025	0.0	0.00	0.00	NA
Nitrite (N)	mg/L	0.01		0.06	0.005	0.005	0.005	0.005	0.005	0.005	0.0	0.00	0.00	0
Nitrogen (Ammonia Nitrogen)	mg/L	0.05		8[c]	0.025	0.025	0.064	0.025	0.025	0.064	0.0	0.02	0.01	0
Total Organic Carbon (C)	mg/L	0.5			5.9	6.9 (1)	5.9	6	5.9	6	5.9	0.06	0.03	NA
Orthophosphate (P)	mg/L	0.01			0.005	0.005	0.005	0.005	0.005	0.005	0.0	0.00	0.00	NA
pH	pH	N/A	6.0-9.5	6.5-9.0	6.67	6.27	6.79	6.24	6.24	6.79	6.5	0.28	0.14	2
Salinity	N/A	2			1	1	1	1	1	1	1.0	0.00	0.00	NA
Reactive Silica (SiO2)	mg/L	0.5			0.25	0.25	0.25	0.25	0.25	0.25	0.3	0.00	0.00	NA
Total Suspended Solids	mg/L	1	15.0		2.2	3	2.6	2.6	2.2	3	2.6	0.33	0.16	NA
Dissolved Sulphate (SO4)	mg/L	2			1	1	1	1	1	1	1.0	0.00	0.00	NA
Turbidity	NTU	0.1			1.6	2.1	1.6	1.6	1.6	2.1	1.7	0.25	0.13	NA
Conductivity	uS/cm	1			28	27	28	27	27	28	27.5	0.58	0.29	NA

Note: a CCME FAL varies with pH; b CCME FAL varies with hardness, value which were below the detection limit are presented as half of the detection limit and used in calculations

Table E.6 Relative Percent Difference of Parent and Field Duplicate Surface Water Samples Taken for Quality Assurance and Quality Control

Parameter	UNITS	RDL	SGL-005	SGL-006 (Dupl. for SGL-005)	Relative Percent Difference (%)	SGL-007-0M	SGL-008-0M (Dupl. for SGL-007-0M)	Relative Percent Difference (%)
Dissolved Aluminum (Al)	ug/L	5	72	70	3%	100	100	0%
Total Aluminum (Al)	ug/L	5	**97**	**100**	3%	**120**	**110**	9%
Dissolved Antimony (Sb)	ug/L	1	ND	ND	NA	ND	ND	NA
Total Antimony (Sb)	ug/L	1	ND	ND	NA	ND	ND	NA
Dissolved Arsenic (As)	ug/L	1	ND	ND	NA	ND	ND	NA
Total Arsenic (As)	ug/L	1	ND	ND	NA	1.1	1	10%
Dissolved Barium (Ba)	ug/L	1	2.2	2.2	0%	2.2	2.3	4%
Total Barium (Ba)	ug/L	1	2	2	0%	2.3	2.3	0%
Dissolved Beryllium (Be)	ug/L	1	ND	ND	NA	ND	ND	NA
Total Beryllium (Be)	ug/L	1	ND	ND	NA	ND	ND	NA
Dissolved Bismuth (Bi)	ug/L	2	ND	ND	NA	ND	ND	NA
Total Bismuth (Bi)	ug/L	2	ND	ND	NA	ND	ND	NA
Dissolved Boron (B)	ug/L	50	ND	ND	NA	ND	ND	NA
Total Boron (B)	ug/L	50	ND	ND	NA	ND	ND	NA
Dissolved Cadmium (Cd)	ug/L	0.01	ND	ND	NA	ND	ND	NA
Total Cadmium (Cd)	ug/L	0.01	ND	ND	NA	ND	ND	NA
Dissolved Calcium (Ca)	ug/L	100	630	630	0%	910	920	1%
Total Calcium (Ca)	ug/L	100	590	600	2%	970	940	3%
Dissolved Chromium (Cr)	ug/L	1	ND	ND	NA	ND	ND	NA
Total Chromium (Cr)	ug/L	1	ND	ND	NA	ND	ND	NA
Dissolved Cobalt (Co)	ug/L	0.4	ND	ND	NA	ND	ND	NA
Total Cobalt (Co)	ug/L	0.4	ND	ND	NA	ND	ND	NA
Dissolved Copper (Cu)	ug/L	2	ND	ND	NA	ND	ND	NA
Total Copper (Cu)	ug/L	2	ND	ND	NA	ND	ND	NA
Dissolved Iron (Fe)	ug/L	50	82	76	8%	160	160	0%
Total Iron (Fe)	ug/L	50	180	180	0%	**310**	**320**	3%
Dissolved Lead (Pb)	ug/L	0.5	ND	ND	NA	ND	ND	NA
Total Lead (Pb)	ug/L	0.5	ND	ND	NA	ND	ND	NA
Dissolved Magnesium (Mg)	ug/L	100	310	310	0%	420	420	0%
Total Magnesium (Mg)	ug/L	100	320	320	0%	430	420	2%
Dissolved Manganese (Mn)	ug/L	2	27	27	0%	29	29	0%
Total Manganese (Mn)	ug/L	2	30	30	0%	32	32	0%
Dissolved Mercury (Hg)	ug/L	0.013	ND	ND	NA	ND	ND	NA
Total Mercury (Hg)	ug/L	0.013	ND	ND	NA	ND	ND	NA
Dissolved Molybdenum (Mo)	ug/L	2	ND	ND	NA	ND	ND	NA
Total Molybdenum (Mo)	ug/L	2	ND	ND	NA	ND	ND	NA
Dissolved Nickel (Ni)	ug/L	2	ND	ND	NA	ND	ND	NA
Total Nickel (Ni)	ug/L	2	ND	ND	NA	ND	ND	NA
Dissolved Phosphorus (P)	ug/L	100	ND	ND	NA	ND	ND	NA
Total Phosphorus (P)	ug/L	100	ND	ND	NA	ND	ND	NA
Dissolved Potassium (K)	ug/L	100	170	170	0%	280	310	10%
Total Potassium (K)	ug/L	100	220	250	13%	290	330	13%
Dissolved Selenium (Se)	ug/L	1	ND	ND	NA	ND	ND	NA
Total Selenium (Se)	ug/L	1	ND	ND	NA	ND	ND	NA
Dissolved Silver (Ag)	ug/L	0.1	ND	ND	NA	ND	ND	NA
Total Silver (Ag)	ug/L	0.1	ND	ND	NA	ND	ND	NA
Dissolved Sodium (Na)	ug/L	100	1900	1900	0%	2400	2400	0%
Total Sodium (Na)	ug/L	100	2100	2200	5%	2400	2400	0%
Dissolved Strontium (Sr)	ug/L	2	4	4.2	5%	5.1	5.1	0%
Total Strontium (Sr)	ug/L	2	3.8	4.1	8%	4.8	4.5	6%
Dissolved Thallium (Tl)	ug/L	0.1	ND	ND	NA	ND	ND	NA
Total Thallium (Tl)	ug/L	0.1	ND	ND	NA	ND	ND	NA
Dissolved Tin (Sn)	ug/L	2	ND	ND	NA	ND	ND	NA
Total Tin (Sn)	ug/L	2	ND	ND	NA	ND	ND	NA
Dissolved Titanium (Ti)	ug/L	2	ND	ND	NA	ND	ND	NA
Total Titanium (Ti)	ug/L	2	ND	ND	NA	2.4	2.1	13%
Dissolved Uranium (U)	ug/L	0.1	ND	ND	NA	ND	ND	NA
Total Uranium (U)	ug/L	0.1	ND	ND	NA	ND	ND	NA
Dissolved Vanadium (V)	ug/L	2	ND	ND	NA	ND	ND	NA
Total Vanadium (V)	ug/L	2	ND	ND	NA	ND	ND	NA
Dissolved Zinc (Zn)	ug/L	5	ND	ND	NA	ND	ND	NA
Total Zinc (Zn)	ug/L	5	ND	ND	NA	ND	ND	NA
Chlorophyll a (Acidification Technique)	ug/L	NA	-	-	NA	-	-	NA
Chlorophyll a (Welschmeyer Technique)	ug/L	NA	-	-	NA	-	-	NA
Anion Sum	me/L	N/A	0.09	0.09	0%	0.11	0.11	0%
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	1	ND	ND	NA	ND	ND	NA
Calculated TDS	mg/L	1	7	7	0%	9	9	0%
Carb. Alkalinity (calc. as CaCO3)	mg/L	1	ND	ND	NA	ND	ND	NA
Cation Sum	me/L	N/A	0.15	0.15	0%	0.2	0.2	0%
Hardness (CaCO3)	mg/L	1	2.9	2.9	0%	4	4	0%
Ion Balance (% Difference)	%	N/A	25	25	0%	29	29	0%
Langelier Index (@ 20C)	N/A		NC	NC	NA	NC	NC	NA
Langelier Index (@ 4C)	N/A		NC	NC	NA	NC	NC	NA
Nitrate (N)	mg/L	0.05	0.16	ND	NA	ND	ND	NA
Saturation pH (@ 20C)	N/A		NC	NC	NA	NC	NC	NA
Saturation pH (@ 4C)	N/A		NC	NC	NA	NC	NC	NA
Total Alkalinity (Total as CaCO3)	mg/L	5	ND	ND	NA	ND	ND	NA
Total Chemical Oxygen Demand	mg/L	20	12	13	8%	23	20	14%
Dissolved Chloride (Cl)	mg/L	1	2.9	3.3	13%	3.8	3.8	0%
Colour	TCU	5	24	24	0%	41	41	0%
Strong Acid Dissoc. Cyanide (CN)	mg/L	0.001	ND	ND	NA	ND	ND	NA
Dissolved Fluoride (F-)	mg/L	0.1	ND	ND	NA	ND	ND	NA
Nitrate + Nitrite (N)	mg/L	0.05	0.16	0.05	NA	ND	ND	NA
Nitrite (N)	mg/L	0.01	ND	ND	NA	ND	ND	NA
Nitrogen (Ammonia Nitrogen)	mg/L	0.05	ND	ND	NA	ND	ND	NA
Total Organic Carbon (C)	mg/L	0.5	4.9	4.6	6%	5.5	6	9%
Orthophosphate (P)	mg/L	0.01	ND	ND	NA	ND	ND	NA
pH	pH	N/A	6.46	6.16	5%	5.87	6.31	7%
Salinity	N/A	2	ND	ND	NA	ND	ND	NA
Reactive Silica (SiO2)	mg/L	0.5	ND	0.84	NA	0.7	0.71	1%
Total Suspended Solids	mg/L	1	ND	2.1	NA	1.6	2	22%
Dissolved Sulphate (SO4)	mg/L	2	ND	ND	NA	ND	ND	NA
Turbidity	NTU	0.1	1	1.1	10%	1.4	1.4	0%
Conductivity	uS/cm	1	19	18	5%	22	23	4%

Table E.7 Trace Metal Concentrations of Sediment for Scraggy Lake October 2017

Parameter	Units	RDL	CCME-PEL	Nearfield (SGL-001)	Farfield (SGL-003)
Acid Extractable Aluminum (Al)	mg/kg	10		4100	2300
Acid Extractable Antimony (Sb)	mg/kg	2		ND	ND
Acid Extractable Arsenic (As)	mg/kg	2	17	3.7	ND
Acid Extractable Barium (Ba)	mg/kg	5		11	8.3
Acid Extractable Beryllium (Be)	mg/kg	2		ND	ND
Acid Extractable Bismuth (Bi)	mg/kg	2		ND	ND
Acid Extractable Boron (B)	mg/kg	50		ND	ND
Acid Extractable Cadmium (Cd)	mg/kg	0.3	3.5	ND	ND
Acid Extractable Chromium (Cr)	mg/kg	2	90	6.7	3.1
Acid Extractable Cobalt (Co)	mg/kg	1		2.4	1.3
Acid Extractable Copper (Cu)	mg/kg	2	197	3.2	ND
Acid Extractable Iron (Fe)	mg/kg	50		8400	3000
Acid Extractable Lead (Pb)	mg/kg	0.5	91.3	13	5.5
Acid Extractable Lithium (Li)	mg/kg	2		7.9	3.2
Acid Extractable Manganese (Mn)	mg/kg	2		180	77
Acid Extractable Mercury (Hg)	mg/kg	0.1	0.486	ND	ND
Acid Extractable Molybdenum (Mo)	mg/kg	2		ND	ND
Acid Extractable Nickel (Ni)	mg/kg	2		6.3	3.3
Acid Extractable Rubidium (Rb)	mg/kg	2		ND	ND
Acid Extractable Selenium (Se)	mg/kg	1		ND	ND
Acid Extractable Silver (Ag)	mg/kg	0.5		ND	ND
Acid Extractable Strontium (Sr)	mg/kg	5		ND	ND
Acid Extractable Thallium (Tl)	mg/kg	0.1		ND	ND
Acid Extractable Tin (Sn)	mg/kg	2		ND	ND
Acid Extractable Uranium (U)	mg/kg	0.1		0.24	0.12
Acid Extractable Vanadium (V)	mg/kg	2		6.3	2.7
Acid Extractable Zinc (Zn)	mg/kg	5	315	21	9.5

Note: RDL = Reportable Detection Limit, ND = Not Detected

Table E.8 Particle Size Distributions of Sediment for Scraggy Lake, October 2017

	UNITS	RDL	Nearfield (SGL-001)	Farfield (SGL-003)
Total Organic Carbon	mg/kg	500	1600	13000
< -1 Phi (2 mm)	%	0.1	63	78
< 0 Phi (1 mm)	%	0.1	61	75
< +1 Phi (0.5 mm)	%	0.1	57	69
< +2 Phi (0.25 mm)	%	0.1	48	49
< +3 Phi (0.12 mm)	%	0.1	22	22
< +4 Phi (0.062 mm)	%	0.1	4.8	10
< +5 Phi (0.031 mm)	%	0.1	3.9	8.4
< +6 Phi (0.016 mm)	%	0.1	2.5	6.3
< +7 Phi (0.0078 mm)	%	0.1	1.4	2.9
< +8 Phi (0.0039 mm)	%	0.1	1.1	2.1
< +9 Phi (0.0020 mm)	%	0.1	0.92	1.8
Gravel	%	0.1	37	22
Sand	%	0.1	58	68
Silt	%	0.1	3.8	8.1
Clay	%	0.1	1.1	2.1

Note: RDL = Reportable Detection Limit