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Study Design for the Phase 1 Environmental Effects Monitoring Program

Atlantic Gold
A St Barbara Ltd Company

Study Design for the Phase 1 Environmental Effects Monitoring Program for the Touquoy Mine, Nova Scotia

July 18, 2019

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1.0 INTRODUCTION

Atlantic Mining NS Corporation (AMNS) operates the Touquoy Gold Mine (Touquoy Mine; the mine), an open pit mine located in an area called Moose River Gold Mines, approximately 110 km northeast of Halifax, NS (Figure 1.1). The mine includes an open pit to extract ore and processing for gold on site. Treated effluent from the Mine site is discharged into Scraggy Lake, which then flows into Fish River, which in turns flows into Lake Charlotte and discharges into Ship Harbour on the eastern shore of NS.

In accordance with the federal *Fisheries Act*, mines in Canada regulated under the Metal and Diamond Mining Effluent Regulations (MDMER) are required to conduct periodic Environmental Effects Monitoring (EEM) studies as part of their authority to deposit effluent. The Touquoy Gold Mine became subject to MDMER on July 20, 2018 when it began discharging treated effluent to Scraggy Lake.

This document provides the study design for the first (Phase 1) EEM program, which is due to be submitted to the federal regulator, Environment and Climate Change Canada (ECCC), within 12 months of the mine becoming subject to MDMER, therefore by July 20, 2019. This document was prepared by Stantec Consulting Ltd. (Stantec) for AMNS.

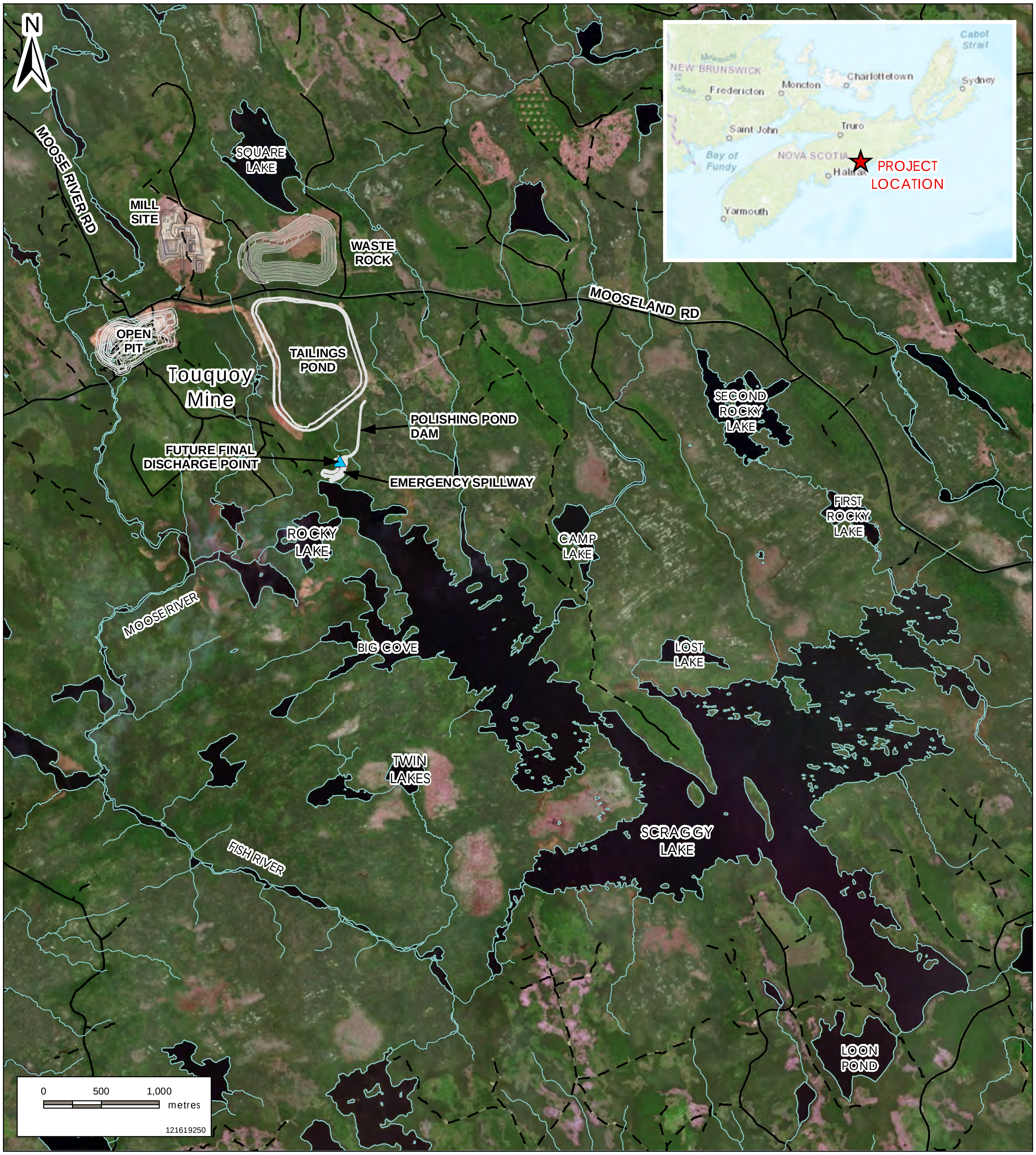
1.1 OVERVIEW OF EEM PROGRAM

The objective of EEM under MDMER is to evaluate the effects of metal and diamond mining effluents on fish, fish habitat, and the use of fisheries resources, and to function as a performance tool to inform ECCC on the adequacy of the regulations.

EEM programs consists of two general components, namely biological monitoring studies (fish population study, fish tissue study, and benthic invertebrate community survey) and effluent and water quality monitoring studies (effluent characterization, water quality monitoring, and sublethal toxicity testing). Schedules for each component are set out in the MDMER.

For the purposes of the EEM program, an effect is defined as follows:

- an effect on the fish population means a statistical difference between fish population measurements taken in an exposure and a reference area;
- an effect on fish tissue (if this component is required) means measurements of concentrations of total mercury that exceed 0.5 µg/g wet weight in fish tissue taken in an exposure area and that are statistically different from and higher than the concentrations of total mercury in fish tissue taken in a reference area; and
- an effect on the benthic invertebrate community means a statistical difference between prescribed benthic invertebrate community measurements taken in an exposure area and a reference area (e.g., control/impact design) or a statistical difference between measurements taken at sampling areas in the exposure area that indicate gradually decreasing effluent concentrations (e.g., a gradient design).



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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

The guiding principles of the EEM program are that the program be scientifically defensible, cost effective, and provide flexibility for site-specific requirements, without subjecting field crews to unsafe sampling conditions.

1.2 STUDY DESIGN COMPONENTS

The required study design components under MDMER are provided in the following chapters.

- **Chapter 2.0** describes the general mine area characteristics including the climate and topography, regional geology, land use practices in the area, general vegetative cover, hydrology, and anthropogenic, natural or other factors not related to the treated effluent that may contribute to any observed effect.
- **Chapter 3.0** provides mine site characterization information including; a description of the production process, the manner in which the effluent mixes within the exposure area; and environmental protection practices in place at the mine.
- **Chapter 4.0** provides a summary of federal and provincial laws and regulations pertaining to the aquatic receiving environment.
- **Chapter 5.0** provides a summary of previous aquatic monitoring study results.
- **Chapter 6.0** presents the proposed study design for the Phase 1 EEM program including a description of effluent and water quality monitoring, plume delineation study, biological studies for fish population, fish tissue (if applicable), benthic invertebrate community, supporting environmental variables, and quality assurance and quality control measures that will be implemented to ensure data validity.
- **Chapter 7.0** contains a list of literature resources used in preparation of this report.

A guide on where to find the information required for the study design under MDMER in the present document is provided in Table 1.1.

Table 1.1 First Study Design Requirements from MDMER, Schedule 5

Section 10 Requirement		Location of the Information in the Present Document
(a) a site characterization that includes:		
	(i) a description of the manner in which the effluent mixes within each exposure area, during a period in which there are deposits, including an estimate of the concentration of effluent in the exposure area at 100 m and 250 m from every point at which the effluent enters the area from a final discharge point and — in respect of each calendar year — any supporting data, including raw data, for the estimate	See Section 3.7.1 and 6.2.1
	(ii) a description of the exposure and reference areas where the biological monitoring studies would be conducted — whether or not they are required — that includes information on the geological, hydrological, limnological, chemical and biological features of those areas	See Chapter 2.0 and 6.2.2
	(iii) the type of production process used by the mine and the environmental protection practices in place at the mine	See Chapter 3.0
	(iv) a description of any anthropogenic, natural or other factors that are not related to the effluent but that may reasonably be expected to	See Chapter 2.0

Table 1.1 First Study Design Requirements from MDMER, Schedule 5

Section 10 Requirement	Location of the Information in the Present Document
affect the results of any biological monitoring study, whether or not it is required	
(v) any additional information that would enable a determination as to whether studies would be conducted in accordance with generally accepted standards of good scientific practice	See Section 6.2.7
(b) a description of how any required study respecting fish population, fish tissue mercury and fish tissue selenium will be conducted that includes a description of and the scientific rationale for:	
(i)(A) the fish species selected, taking into account the abundance of the species most exposed to effluent	See Section 6.2.3
(i)(B) the sampling areas selected within the exposure area and the reference area	See Section 6.2.2
(i)(C) the sampling period selected	See Section 6.2.2
(i)(D) the sample size selected	See Section 6.2.2 and 6.2.3
(i)(E) the field and laboratory methodologies selected	See Section 6.2.2 and 6.2.3
(ii) an explanation as to how, in the case of the study respecting fish population or fish tissue mercury, the study will provide the information necessary to determine if the effluent has an effect on fish population or on fish tissue from mercury	See Section 6.2.4
(c) a description of how any required study respecting the benthic invertebrate community will be conducted that includes a description of and the scientific rationale for:	
(i)(A) the sampling areas selected, taking into account the benthic invertebrate diversity and the area most exposed to effluent	See Section 6.2.2
(i)(B) the sampling period selected	Section 6.2.5
(i)(C) the sample size selected	Section 6.2.5
(i)(D) the field and laboratory methodologies selected	Section 6.2.5
(ii) an explanation as to how the study will provide the information necessary to determine if the effluent has an effect on the benthic invertebrate community;	Section 6.2.5
(d) the month in which the samples will be collected for each required biological monitoring study	Section 6.2
(e) a description of the quality assurance and quality control measures that will be implemented for each required biological monitoring study to ensure the validity of the data that is collected	Section 6.2.2, 6.2.3, 6.2.5 and 6.2.7
(f) a summary of the results of any studies to determine whether the effluent was causing an effect on the fish population, fish tissue from mercury or the benthic invertebrate community and of any studies in the exposure and reference areas respecting fish tissue selenium completed before the mine becomes subject to section 7 of these Regulations and any scientific data to support the results.	Chapter 5

2.0 SITE CHARACTERIZATION

2.1 CLIMATE AND TOPOGRAPHY

The mine is located within the Eastern Drumlins ecodistrict, a further subdivision of the Eastern eco-region. The ecodistrict is characterized by drumlin fields with generally north-south oriented drumlins. The area has relatively low relief with frequent drumlins and numerous lakes, ponds, streams, and wetlands. The drumlins consist of clayey material. The mine catchment area is drained by the Moose River and its tributaries.

The site is located inland, sheltered from the immediate effects of the Atlantic Ocean, such that climate conditions are characterized by warmer summers and cooler winters. The coldest temperature recorded was -41.1°C on January 31, 1920, at Upper Stewiacke (Environment Canada 2019). Precipitation is well distributed throughout the year. July and August are the driest months on average.

The Environment Canada climate station at Middle Musquodoboit (Station ID 8203535, in operation between 1961-2011), located approximately 20 km northwest of the mine site, was used to characterize the climatic conditions at the mine site. As presented in Table 2.1, the climate normal precipitation is approximately 1358 mm and the average snowfall is 172 cm, based on a period of record from 1981 to 2010 (climate normal, Environment Canada, 2019). The extreme one-day precipitation of 173 mm for the period of record of the selected climate station occurred in 1961. Temperatures typically drop below 0°C between the months of December through March each year.

Average annual evaporation for the mine site area is 515 mm based on average lake evaporation at the Environment Canada climate station in Truro (Environment Canada 2019) and corresponding monthly evaporation rates are presented in Table 2.1.

Table 2.1 Representative Climate Information for the Mine Site

Climate Normal at Middle Musquodoboit Climate Station for the 30-year period (1981-2010)													
Parameter	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Temperature (°C)	-6.2	-5.2	-1.3	4.4	9.9	14.8	18.5	18.4	14.2	8.5	3.5	-2.4	6.4
Rainfall (mm)	80.4	62.1	92.8	99.5	104.9	99.8	103.8	91.9	110.7	116.7	128.6	97.2	1188.3
Snowfall (cm)	49.4	41.3	31.4	9.5	0.5	0.0	0.0	0.0	0.0	0.0	8.2	31.9	172.2
Precipitation (mm)	129.8	100.5	124.2	109.0	105.4	99.8	103.8	91.9	110.7	116.7	136.8	129.1	1357.7
Snow Depth (cm)	40	67	64	22	6	1	0	0	0	0	25	28	21.1
Monthly Lake Evaporation at Truro Climate Station for 30-year period (1981-2010)													
Parameter	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Lake Evaporation (mm/day)	0	0	0	0	89.9	102	117.8	96.1	69	40.3	0	0	515.1

2.2 REGIONAL 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 of the gold occurs within the 25-180 m thick Touquoy Argillite, which is part of the lowermost unit of the Goldenville Formation, in the Moose River Member. Gold is mostly disseminated within the Touquoy Argillite close to, and on both limbs of, the Moose River-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 had 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.

Trace metals are found in soils and sediments of various forms and are released into the water by weathering processes. The interactions between rainwater and geological materials in the form of weathering results in the dissolution of minerals and introduction of dissolved and suspended materials into groundwater and surface water runoff. Weathering, which results in increased concentrations of major ions (e.g., calcium, magnesium, sodium, potassium, bicarbonate, chloride) in the water, also results in higher concentrations of trace metals (including aluminum, iron, and other metals). Concentrations of major ions and trace metals in surface water at the Touquoy Mine site have been found to be reflective of the local geology (Stantec 2018a).

2.3 FORESTRY AND VEGETATION

Prior to current mine development, much of the vegetation covering the Touquoy mine site had been historically disturbed through forestry, mining, road building, housing activities, recreation, and fire. As a result, there is a mixed forest with mostly coniferous trees, dominated by spruce and balsam fir with maple, birch, and aspen present in well-drained areas.

Coniferous trees found within the Touquoy mine site consist mainly of red spruce (*Picea rubens*) and balsam fir (*Abies balsamea*). Other areas are characterized by second-growth white spruce (*Picea glauca*) in upland areas and black spruce (*Picea mariana*) in wetter areas. The understory/ground cover vegetation varies from open and moss-dominated to typical groundcover species such as bunchberry (*Cornus candadensis*) and goldthread (*Coptis trifolia*).

There are small pockets of mixed wood forest to the south and deciduous forest to the north of the mine site area. Forest cover for the mixed forest includes red spruce and balsam fir with red maple (*Acer rubrum*) and white birch (*Betula papyrifera*). Forest cover for the deciduous forest includes large-tooth aspen (*Populus grandidentata*), white birch, yellow birch (*Betula alleghaniensis*), American beech (*Fagus grandifolia*), and red maple (CRA 2007).

2.4 HYDROLOGY

The outlet of Scraggy Lake drains an area of 4360.1 ha. Scraggy Lake is located within the Moose River watershed, which is 41 km^2 and is a sub-watershed of the Fish River-Charlotte Lake Watershed (Figure 2.1). The mine discharges treated effluent into Scraggy Lake, which flows into Fish River, which in turns flows into Lake Charlotte, which drains into Ship Harbour where it enters the Atlantic Ocean along the eastern shore of NS.

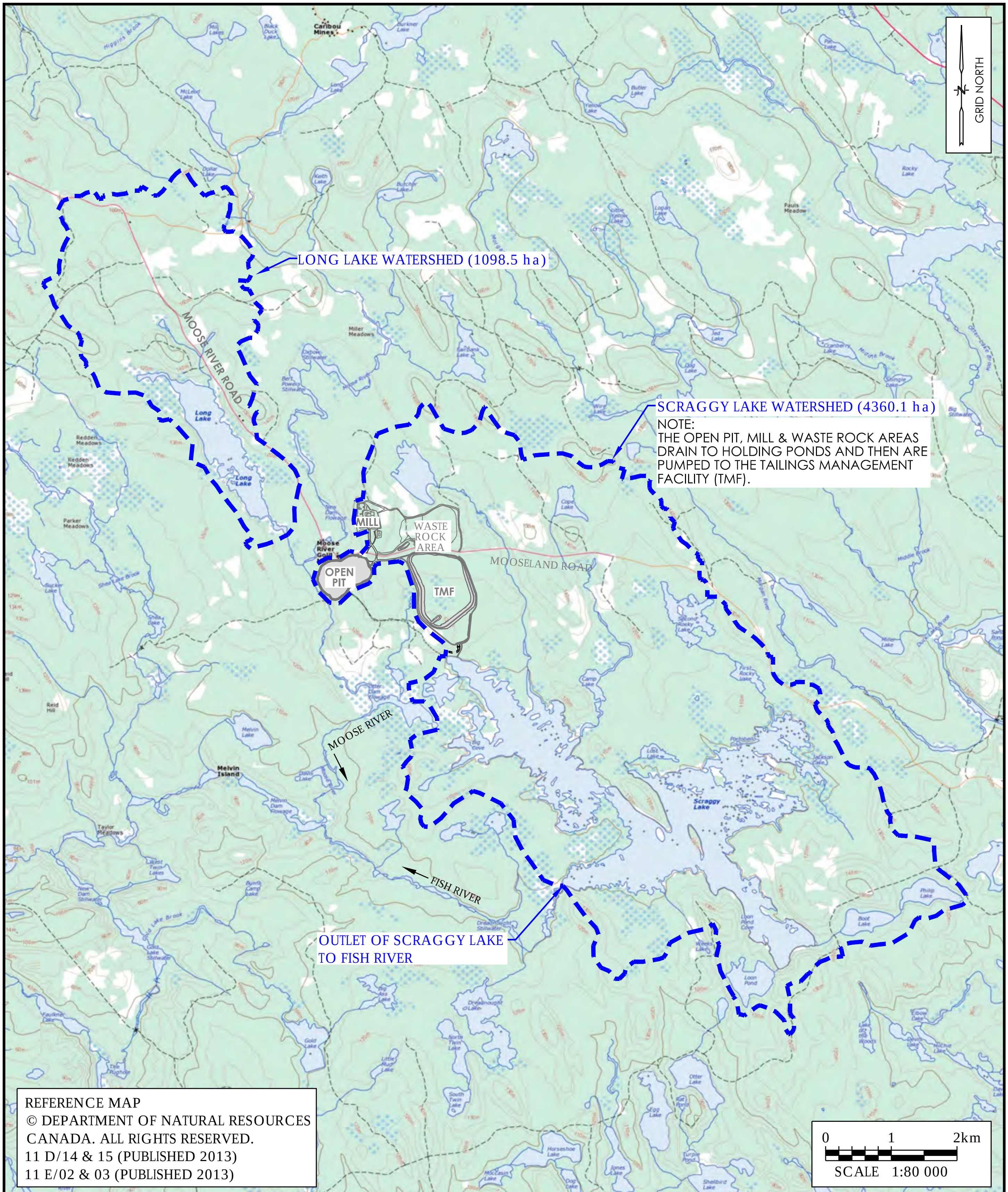
More specifically, site drainage from the waste rock stockpiles, areas surrounding the milling complex, and the open pit are directed towards the tailings management facility (TMF) for storage and subsequent treatment. More details on site drainage are provided in Chapter 3.

2.5 AQUATIC ENVIRONMENT

Aquatic baseline studies on Scraggy Lake and in Fish River were undertaken in 2017 and in 2018 prior to mine effluent discharge. Water quality, benthic invertebrates, fish, fish tissue, sediment, and aquatic habitat characteristics were surveyed, and detailed internal reports were prepared for AMNS; relevant results are summarized herein.

Scraggy Lake is characterized by two large basins. The basin closest to the final discharge point (FDP) for mine effluent is approximately 3 km in length and 1 km in width. Water depths are generally shallow (<6 m) and a deeper area (6-11 m) runs approximately 75% of the length of the basin. Maximum depth in this basin is 11 m. The second basin is approximately 4 km in length and a maximum of 4 km in width with generally shallow water depth (<6 m) and a deeper area (>12 m) located near the south end of the basin. Maximum depth of the basin is 14 m.

Fish habitat in Scraggy Lake is 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 is a mix of cobble, rock, and some sand in littoral areas. Rock outcrops and large boulders are prevalent in Scraggy Lake. The profundal zone of the lake is characterized by rich organic flocculent/mucky substrate. The fish habitat in Scraggy Lake is suitable for species that prefer shallow (<3 m) rocky substrate and structure.



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STUDY DESIGN PHASE I EEM

Project No.
121619250

Title
WATERSHED AREAS

Revision	Date
0	2019.06.27
Reference Sheet	**Figure No.**
-	2.1

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Fish populations are present downstream of the FDP indicating the water quality and habitat within Scraggy Lake and Fish River is suitable for supporting fish. Baseline studies revealed that the following fish species are present within Scraggy Lake: alewife (*Alosa pseudoharengus*), American eel (*Anguilla rostrate*), Atlantic salmon (*Salmo salar*), banded killifish (*Fundulus diaphanus*), brown bullhead (*Ameiurus nebulosus*), brook trout (*Salvelinus fontinalis*), golden shiner (*Notemigonus crysoleucas*), lake chub (*Couesius plumbeus*), white perch (*Morone americana*), ninespine stickleback (*Pungitius pungitius*), white sucker (*Catostomus commersonii*), and yellow perch (*Perca flavescens*).

The benthic invertebrate community was also sampled in Scraggy Lake. Over 40 species consisting of 31 families were identified during baseline sampling in 2017 and 2018. The predominant benthic invertebrate families were Diptera, Crustacea, Ephemeroptera, Tricoptera, and Coleptera.

Water quality in Scraggy Lake is characterized as being generally clear, soft water with low concentrations of dissolved minerals (i.e., low hardness) with low pH (5.8-6.8) and low nutrient levels. Concentrations of key trace metals were similarly low, with the exception of iron and aluminum, which naturally exceeded the Canadian Water Quality Guideline for Protection of Freshwater Aquatic Life (Freshwater) (CWQG PAL). Sediment samples collected in Scraggy Lake mirrored the water quality results, with naturally elevated concentrations of aluminum and iron.

2.6 ANTHROPROGENIC, NATURAL, OR OTHER FACTORS

Other than the current mining activities on the mine site, the natural environment in the area has been affected by past and on-going human activities, such as forestry, mineral exploration, mining, and recreational activities such as recreational fishing.

The mine site encompasses most of the previous Moose River Gold Mines, a former gold mining community with a population in the thousands during its most productive period in the late 1800s. By the 2000s, the population was less than 30 and the area is noted to have numerous vacant dwellings. By October 2006, the permanent population of Moose River Gold Mine was eight and since the development of the new open pit in 2017, no permanent residents remain in the immediate vicinity of the mine site (CRA, 2007, Stantec 2017).

A small museum remains near the main entry point to the mine site off of Moose River Road. This museum is the former schoolhouse and today operates in the summer months under the auspices of the Musquodoboit Valley Tourism Association.

Moose River Road is a provincially designated road that divides the mine site area in two and travels from east to west. Most of the mine site is surrounded by wooded areas, cut blocks, and natural features such as lakes and watercourses.

3.0 MINE OPERATIONS

3.1 HISTORY OF THE MINE SITE

Gold production from Moose River Gold Mines 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.

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

Modern exploration commenced in 1983 by Seabright Explorations Inc. (Seabright); Seabright staked the property and conducted 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 northwestern end of the deposit and processed by flotation at the Gays River Mill, 40 km from Moose River Gold Mines (Stantec 2018b). Over the next two decades there were multiple changes in ownership, the mine is now operated by AMNS.

In 2014, AMNS (formerly DDV Gold) received its first approval to initiate site development activities. In 2016, the detailed design of the tailings management facility (TMF) was completed and submitted to Nova Scotia Environment (NSE) for Industrial Approval, which was issued in 2017.

Subsequent to receiving the Industrial Approval, commissioning work on the open pit and the milling complex was initiated in the latter part of 2017, with the mine achieving its first gold pour in October of the same year. The mine achieved commercial production in March of 2018 and has been consistently producing since that time. The layout of the mine site is illustrated in Photo 1.

Photo 1 Touquoy Gold Mine in Moose River Gold Mines, NS. View is looking to the north-northwest.

3.2 OPEN PIT MINING AND MILLING METHODS

Based on the shallow depth, broad ore zones with irregular boundaries in places, and requirement for selective mining, an opencut or open pit mining method is used to extract ore at the mine site. Open pit mining is conducted using conventional hydraulic excavator / truck fleet with drill and blast. This method provides the lowest risk for the scale of mining, expected ground conditions, and orebody geometry at the mine (Merit Engineers 2010).

Blasting operations occur at 5 m bench interval. Run of Mine (ROM) is loaded onto rigid body off-highway rock trucks via a hydraulic excavator. ROM is then trucked from the open pit to the ROM stockpile located north of the milling complex, where it is crushed and run through the mill at an average rate of 6,000 tonnes per day. Based on the current resource estimate and milling rate, the remaining life of mine (LoM) is expected to be approximately five years.

Waste rock from the open pit operation is trucked to the waste rock storage area located near the milling complex. Ore is extracted from an open pit operation using conventional drill/blast, truck/shovel methods. Gold extraction employs gravity concentration to remove the coarse gold followed by Carbon-in-Leach (CIL) recovery. The mill provides cyanide destruction through its circuit using the INCO/Air SO_2 Process followed by arsenic reduction by means of the introduction of ferric sulphate prior to discharge to the TMF. Further details on waste rock storage are provided in Section 3.4.

3.3 MINE WATER REQUIREMENTS

The major project components of the TMF water management plan are the mill, tailings pond, water treatment plant, and the polishing pond. As required under the Industrial Approval, all wastewater and surface runoff associated with the mine site is directed to the TMF. An overview of key features of the TMF water management plan is described below and shown in Figure 3.1 and the mine water process flow is shown in Figure 3.2.

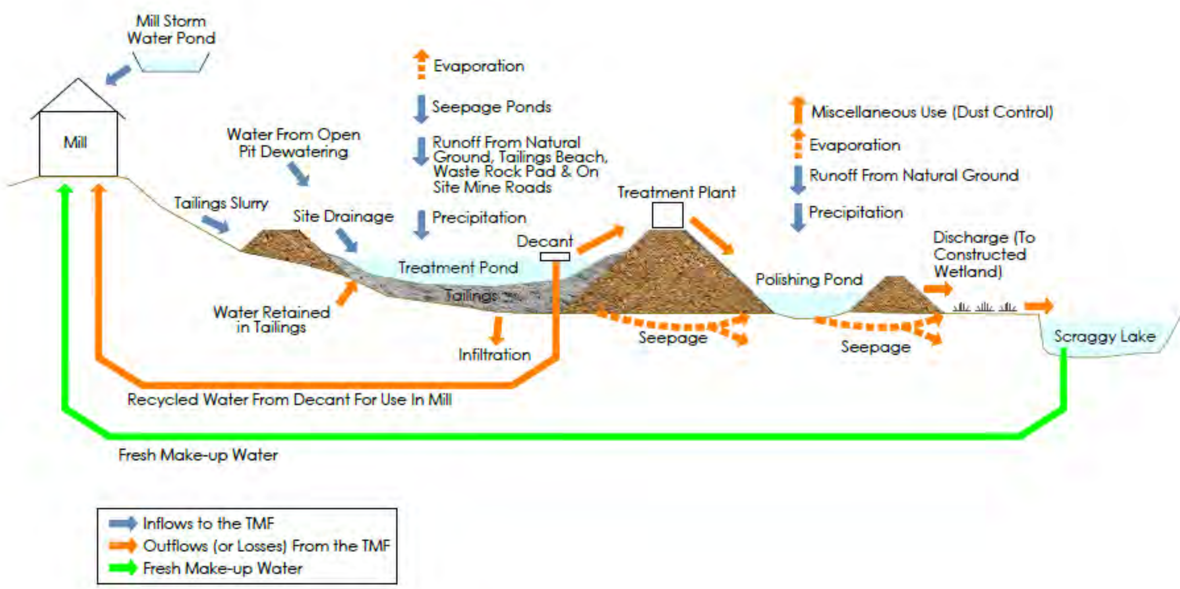
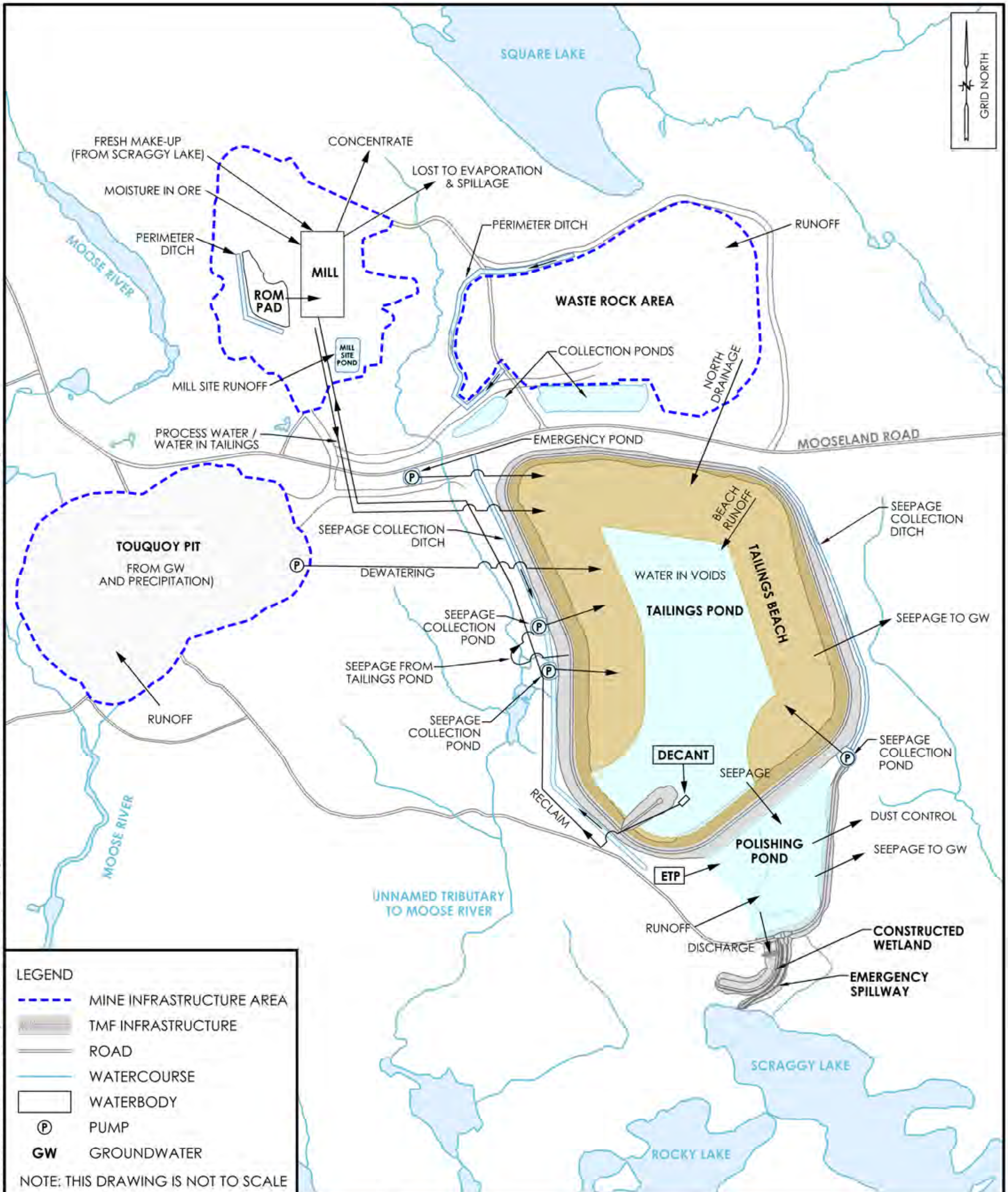


Figure 3.1 Water Management Plan for the Tailings Management Facility



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Client/Project
ATLANTIC GOLD CORPORATION
PHASE 1 ENVIRONMENTAL EFFECTS MONITORING PROGRAM

Project No.
121619250

Title
MINE PROCESS FLOW DIAGRAM

Revision	Date
REV-0	2019.07.12
Reference Sheet	Figure No.
-	3-2

The tailings pond receives water from the mill via slurry, the seepage collection pond discharge (which captures runoff from the mill site and the waste rock storage facility), dewatering of the open pit, runoff from tailings pond un-diverted upstream catchment areas, waste rock piles, on-site mine roads, and direct precipitation. Losses in the TMF include decant water, discharges to the polishing pond, water retained in the tailings matrix, seepage, and evaporation.

Seepage collection ditches are installed around the toe of the TMF to collect shallow seepage from the tailings pond. Ditches flow into seepage collection ponds where water is pumped and returned to the tailings pond. The mill site storm water retention pond and ROM stockpile run-off is directed to the TMF or reused in the mill process. Mine water from dewatering the open pit is collected in sumps and pumped to the TMF.

Water in the tailings pond pools in the southern area of the tailings pond. Water is collected in this area through strategic tailings deposition. Water collected in the south end of the pond is reclaimed through the decant barge for treatment and/or mill reclaim.

Water is stored in the tailings pond and undergoes natural degradation of cyanide (CN) as water is exposed to sunlight. Surplus water in the tailings pond is discharged through the water treatment plant to the polishing pond. The TMF effluent discharge period is dependent on ice cover, stream flows, and climatic conditions. Water discharged from the tailings pond is treated in the water treatment plant to provide metals removal, solids removal, and pH control to meet MDMER discharge limits.

The polishing pond water is released to a constructed wetland that drains into an unnamed tributary to Scraggy Lake. The polishing pond provides additional passive treatment. Outflow from the pond generally matches the inflow due to limited capacity in the pond. Extreme events exceeding the Inflow Design Flood (IDF) in the polishing pond will bypass the constructed wetland and flow via an emergency spillway directly to Scraggy Lake.

Water withdrawal from Scraggy Lake is used for potable water and freshwater make-up for the mill.

Other water uses for the site besides process water are fire suppression and dust suppression.

Water on site is not used for drinking or eating. Potable water used at the mill for eye wash stations, safety showers, and in the control room is treated water from Scraggy Lake. Bottled water is supplied to the site offices, gate house, and assay lab for drinking.

Fire suppression water is supplied from Scraggy Lake to a water/fire water storage tank located adjacent to the mill. Any additional water required is withdrawn from the stormwater retention pond.

Water from the polishing pond is used for all dust suppression activities on site.

3.4 RUN OF MINE AND WASTE ROCK STOCKPILES

Based on acid-based accounting (ABA) results, waste rock and marginal ore units from the open pit operation are considered to be non-acid generating (Merit Engineers 2010). The waste rock storage facility (WRSF) is located north of the TMF on the opposite side of Mooseland Road. The associated water management facilities for the WRSF include ditches and collection ponds, which are directed to the TMF for subsequent treatment (see Section 3.5 for further information on water treatment process). The WRSF was located based on the least potential to affect existing natural watercourses. The WRSF is sized to accommodate the current LoM waste rock storage requirements of approximately 20 million tonnes.

The ROM storage area is located north of the milling complex. This area has a maximum storage capacity of approximately 300,000 tonnes. Water in the ROM storage area is directed to collection ditches that run into the milling complex stormwater pond and is used for process water. Process water is directed into the TMF, where it is treated prior to discharge to the receiving environment.

3.5 WATER TREATMENT PLANT

The effluent quality treatment chain involves the tailings pond, water treatment facility, and the polishing pond, which is designed to provide a final effluent that meets the MDMER effluent water quality criteria.

Water quality treatment involves the following:

- mill whole tailings cyanide destruction at the mill using the SO_2/Air process;
- sedimentation of mill tailings suspended solids, and supplemental natural CN degradation of mill tailings solution in the TMF, with seasonal discharge to the effluent treatment facility;
- arsenic removal, solids filtration, and pH adjustment in the effluent treatment facility;
- metals and solids removal in the sludge containment cells (i.e., geobags); and
- effluent equalization and sedimentation in the polishing pond.

Effluent treatment involves passive and active treatment processes. The tailings pond is designed to facilitate the sedimentation processes, precipitation of dissolved and suspended arsenic solids, and co-precipitation of cyanide-metal complexes. Water is stored in the TMF during open water conditions to promote natural degradation of residual CN, when possible. The CN degradation process in the tailings pond is primarily comprised of natural acidification, volatilization, and UV light degradation.

The treatment plant is located between the tailings dam and the polishing pond. The treatment process involves the addition of ferric sulphate to the effluent to precipitate arsenic, hydrated lime to adjust pH, hydrogen peroxide to promote oxidation, and coagulant polymer to facilitate the removal of colloidal-sized suspended matter. The plant has a maximum design capacity of 450 m^3/hr, operating at an average rate of 350 m^3/hr (CRA 2012). Currently, the treatment plant is in operation year round.

Treated effluent is discharged through the geobags, which use chemical polymers and flocculants for further settlement and removal of sediments. Treated effluent is stored in the polishing pond, where it is subsequently released to the environment via a controlled discharge structure. Outflow from the polishing pond flows through a constructed wetland where flow is dispersed and seeps through the embankment and into Scraggy Lake. The final discharge point from the polishing pond is controlled by a valve (Stantec 2018b).

3.6 EFFLUENT CHARACTERIZATION

Effluent monitoring includes chemical analysis of mine effluent, generally on a weekly basis (when there is discharge), to measure parameters listed as deleterious substances in Schedule 4 of MDMER. Monthly acute lethality testing involving rainbow trout and *Daphnia magna,* and quarterly reporting of these results is conducted, as is effluent volume, flow rate, and loadings of deleterious substances listed in MDMER Schedule 4 when effluent is being discharged from the site. Effluent characterization during the Phase 1 period (2018-2020) will be presented in the Interpretive Report.

3.6.1 Effluent Mixing

The FDP is located at the outlet of the polishing pond. Effluent flows through a constructed wetland prior to entering Scraggy Lake. Scraggy Lake, which is located south of the mine site. Treated effluent has been discharged since July 2018 with flow rate based on TMF water level requirements.

A preliminary plume delineation investigation using conductivity was conducted in June 2019 to confirm effluent mixing conditions and extent of the plume in the nearfield area of the receiving environment in Scraggy Lake. Given the large volume of Scraggy Lake, the average effluent concentration was estimated to be approximately 5% at both 100 m and 250 m from where effluent enters the lake. It appears that effluent is thoroughly mixed horizontally and vertically within the nearfield area. Based on this preliminary work, effluent likely mixes relatively quickly as it flows through the two distinct basins of Scraggy Lake before discharging into Fish River. More information on plume delineation is provided in Section 6.2.1.

3.7 ENVIRONMENTAL PROTECTION SYSTEMS

Environmental protection measures are defined and organized in several plans, including environmental protection plans, emergency response plans, and contingency plans.

3.7.1 Emergency Response Plan

The Touquoy Mine is subject to provincial and federal guidelines and regulations. As such, environmental management systems have been implemented to adequately mitigate environmental liabilities that might arise from mining and milling operations. Water and toxicity testing are conducted on a weekly and monthly basis, respectively, at the FDP and at other locations in and around the mine site. As described in Sections 3.4 and 3.5, mine waste is managed in accordance with permit requirements and associated waters are treated as required.

AMNS has an Emergency Response Plan (ERP) in place for the mine. This plan is prepared and implemented in part to mitigate potential environmental effects of accidents and malfunctions. An ERP does not prevent accidents, but rather mitigates the potential magnitude of accidents and malfunctions. The ERP contains procedures for these events when they occur. ERP's have been developed and are updated as needed for the following procedures/guides:

- Tailings Management Facility Emergency Preparedness and Response Plan
- Tailings Management Facility Operations, Management, and Surveillance Manual
- Evacuation
- Surface Mine Rescue
- Medical Emergency
- Emergency Transport
- Fire Fighting
- Vehicle Incident (on site)
- Cyanide Exposure
- Explosion
- Pit Wall/Ramp Failure
- Spill Contingency Plan
- Hazardous Chemical Exposure
- Entrapment/Confined Space Rescue
- Radiation Exposure
- Ground Collapse
- TMF Failure
- Sever Electrical Storm
- Forest Fire
- Natural Event
- Flooding
- Tire Fire
- Hazardous Substance Release
- LPG Release
- Operational Preparedness and Response Plan for Upset Water Levels in the Tailings Pond
- External Emergency
- Bomb Threat
- Security Breach Power Failure

4.0 REGULATORY CONTEXT

The federal MDMER and the Nova Scotia *Environment Act* are the two main pieces of legislation that pertain to the receiving environment for the Touquoy Mine and are discussed in more detail below. Other legislation applies to the Touquoy Mine but, for the purpose of this report, only related acts and regulations specifically dealing with the direct operational environmental requirements and the aquatic receiving environments are discussed.

4.1 FEDERAL CONTEXT

4.1.1 Fisheries Act

Under Section 36 of the *Fisheries Act*, the MDMER, which came into effect on June 1, 2018 applies in respect of diamond and metal mines that, at any time:

(i.) *exceed an effluent flow rate of 50 m³ per day, based on the effluent deposited from all the final discharge points of the mine, and*

(ii.) *deposit a deleterious substance in any water or place referred to in subsection 36(3) of the Act.*

The Touquoy Mine became subject to the MDMER on July 20, 2018 when effluent was discharged from the TMF to Scraggy Lake.

The MDMER sets authorized limits for the discharge of deleterious substances. The limits shown in Table 4.1 are in place until May 31, 2021, after which new limits will be in place, some of which are lower than the current limits.

Table 4.1 MDMER Schedule 4 – Federally Authorized Limits

Parameter	Maximum Monthly Mean Concentration	Maximum Concentration in a Composite Sample	Maximum Concentration in a Grab Sample
Arsenic (As)	0.50 mg/L	0.75 mg/L	1.00 mg/L
Copper (Cu)	0.30 mg/L	0.45 mg/L	0.60 mg/L
Cyanide (CN^-)	1.00 mg/L	1.50 mg/L	2.00 mg/L
Lead (Pb)	0.20 mg/L	0.30 mg/L	0.40 mg/L
Nickel (Ni)	0.50 mg/L	0.75 mg/L	1.00 mg/L
Zinc (Zn)	0.50 mg/L	0.75 mg/L	1.00 mg/L
Total Suspended Solids (TSS)	15.00 mg/L	22.50 mg/L	30.00 mg/L

Table 4.1 MDMER Schedule 4 – Federally Authorized Limits

Parameter	Maximum Monthly Mean Concentration	Maximum Concentration in a Composite Sample	Maximum Concentration in a Grab Sample
Radium 226 (Ra-226)	0.37 Bq/L	0.74 Bq/L	1.11 Bq/L
pH	≥6.0 - ≤9.5 units		
Acute Lethality	Non-acutely lethal at all times		

The MDMER also sets out requirements for EEM in Schedule 5, including water and effluent quality and also biological studies. EEM studies are required to be conducted in phases with one phase every three years. Phases can extend to six years if there are no effects detected in biological endpoints in the previous two phases.

4.2 PROVINCIAL CONTEXT

4.2.1 Provincial Environmental Assessment

The Touquoy Mine underwent a Class I Environmental Assessment under the Nova Scotia *Environment Act* and Environmental Assessment Regulations in 2007. On February 1, 2008, the Touquoy Gold Project received approval pursuant to Section 18(a) of the Environmental Assessment Regulations.

4.2.2 Nova Scotia Environment Act

Pursuant to Part V of the *Nova Scotia Environment Act*, S.N.S. 1994-95, c.1 s.1, an approval to operate (2012-084244-03) was granted to Atlantic Mining NS Corp. on July 13, 2017 which allows for the construction and operation of the open pit, processing plant, tailings management facility and waste rock storage area. The most recent revision to this approval was issued on July 19, 2018 (2012-084244-05).

Table 4.2 outlines authorized effluent discharge limits as specified in Condition 15 of the provincial approval to operate the Touquoy Gold Mine.

Table 4.2 Approval to Operate Condition 15 – Provincially Authorized Discharge Limits

Industrial Approval 2012-084244-05, Section 15 Liquid Effluent (NSE 2018)		
Parameter	**TSS - Normal Background Conditions**	**TSS - Spring Freshets and Storm Events**
Total Suspended Solids (mg/L)	Max increase of 25 mg/L from background, short term (<24 hrs) Max average increase of 5 mg/L from background, long term (24 hrs – 30 days)	Max increase of 25 mg/L from background at any time when background is >25 mg/L and <250 mg/L Shall not increase more than 10% when background is >250 mg/L
General Chemistry & Trace Metals	To Comply with MDMER Effluent Discharge Limits (see Table 4.1)	
pH - Grab sample	≥5.0 and ≤9.0	
pH - Arithmetic mean	≥6.0 and ≤9.5	
Cyanide (WAD)	Weekly average = ≤1 mg/L	
Petroleum Hydrocarbons	Nova Scotia Tier 1 Environment Quality Standards for Surface Water - Petroleum Hydrocarbons (PHC) Parameters	
NOTE: WAD = Weak Acid Dissociable		

5.0 SUMMARY OF PREVIOUS AQUATIC MONITORING STUDIES

Aquatic monitoring studies were conducted in Scraggy Lake (exposure, Photo 2) and Long Lake (reference, Photo 3) in 2017 and 2018 and in Alma Lake (potential reference) in 2018. As yellow perch were not found to be present within Alma Lake it was not considered a suitable reference lake and therefore this location is not discussed further.

Photo 2 Scraggy Lake, 2017 Baseline Aquatic Monitoring

Photo 3 Long Lake, 2017 Baseline Aquatic Monitoring

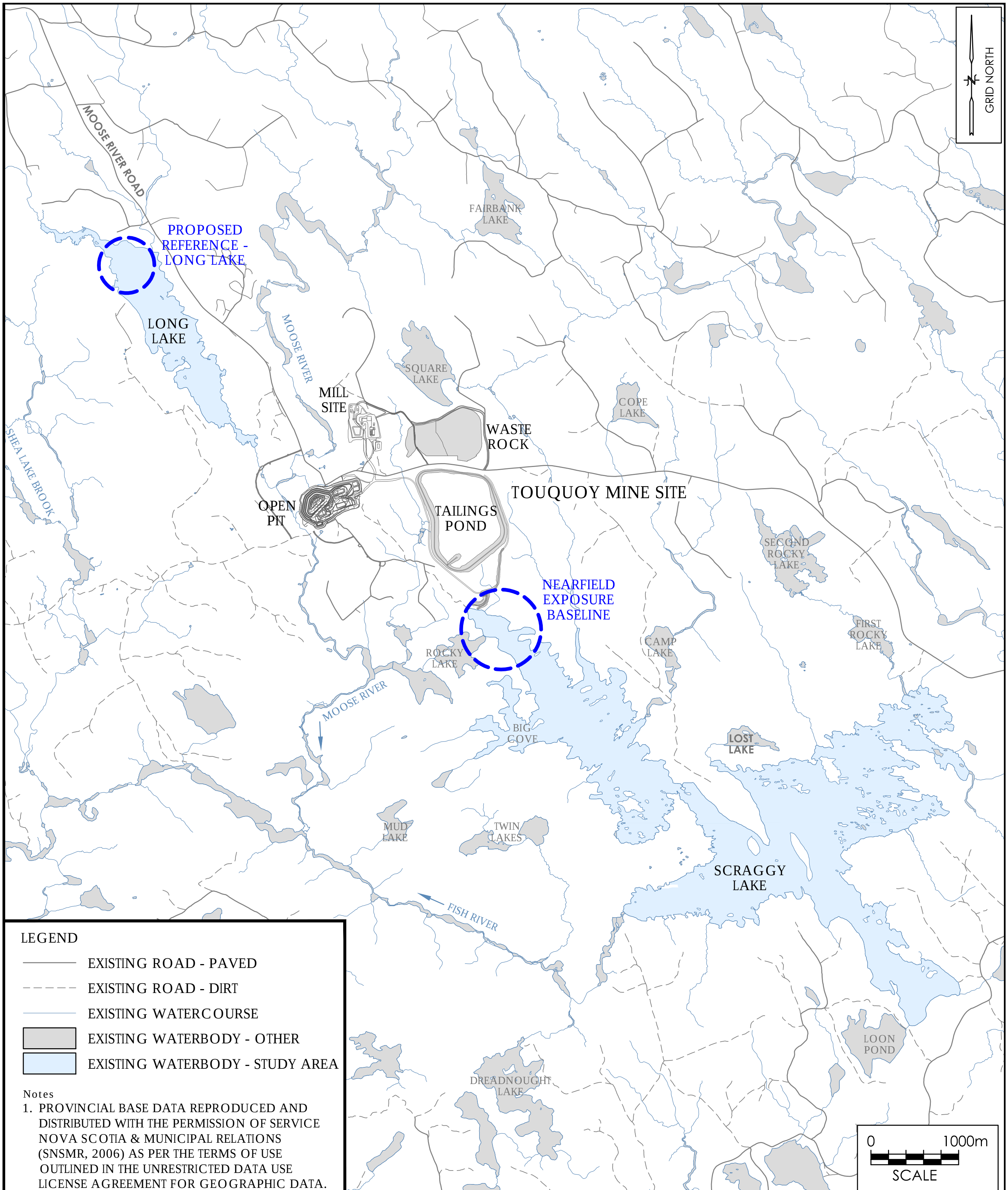
5.1 BIOLOGICAL MONITORING STUDIES

In 2017 and 2018, baseline aquatic monitoring was conducted to establish existing conditions in Scraggy Lake prior to effluent discharge and to support the design of the Phase 1 EEM study. The baseline aquatic monitoring also sought to identify potential reference lakes for EEM.

The baseline aquatic monitoring program included the following components:

- fish habitat surveys;
- fish community studies;
- fish tissue studies;
- benthic invertebrate community (BIC) surveys;
- supporting environmental variables (water and sediment quality); and
- anthropogenic, natural, or other factors that could influence EEM study design.

A high-level summary of the baseline aquatic monitoring conducted in 2017 and 2018 and how it contributed to the Phase 1 study design is provided in more detail below. Figures 5.1 to 5.3 show locations for baseline aquatic sampling conducted in in 2017 and 2018.



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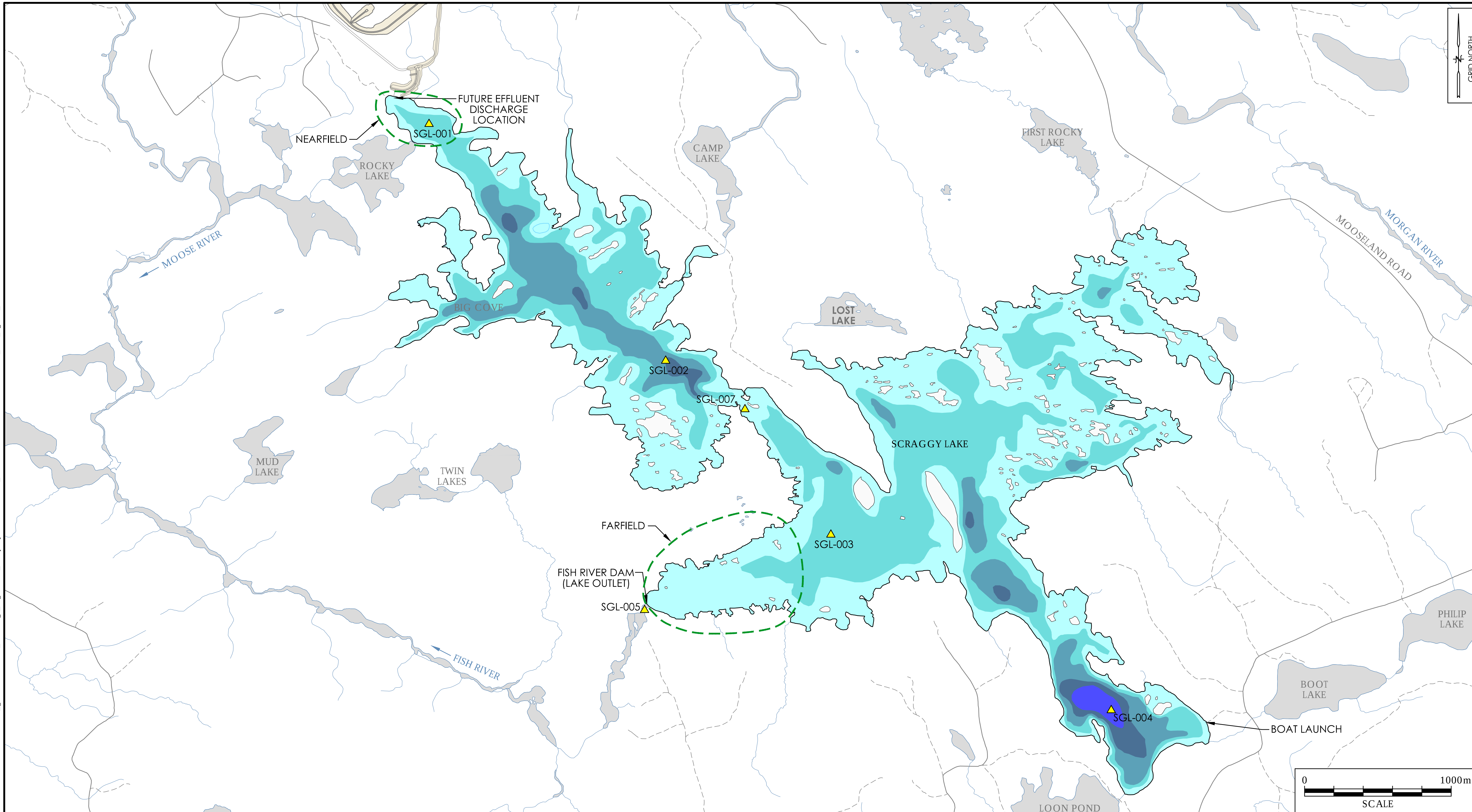
Client/Project
ATLANTIC GOLD CORPORATION
PHASE 1 ENVIRONMENTAL EFFECTS MONITORING PROGRAM

Project No.
121619250

Title
BASELINE AQUATIC SAMPLING AREAS FOR TOUQUOY MINE

Revision	Date
REV-0	2019.05.14
Reference Sheet	Figure No.
-	5-1



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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

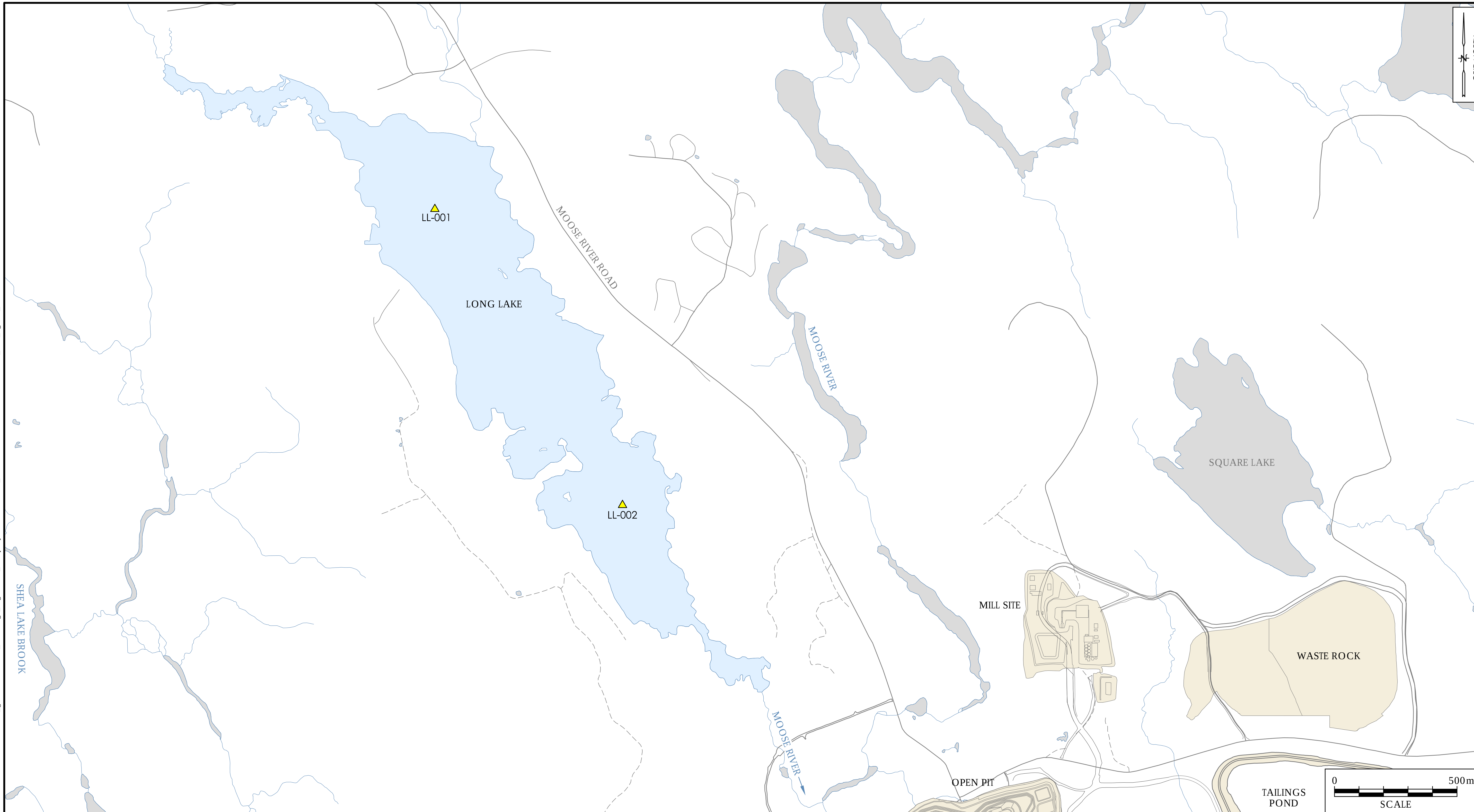
BATHYMETRY
- 0 - 3 m DEPTH
- 3 - 6 m DEPTH
- 6 - 9 m DEPTH
- 9 - 12 m DEPTH
- > 12 m DEPTH

Client/Project
ATLANTIC GOLD CORPORATION
PHASE 1 ENVIRONMENTAL EFFECTS MONITORING PROGRAM

Project No.
121619250

Title
BASELINE AQUATIC SAMPLING AREAS IN SCRAGGY LAKE FOR TOUQUOY MINE

Revision	Date
REV-1	2019.07.12
Reference Sheet	**Figure No.**
-	5-2



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LEGEND

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

Client/Project

ATLANTIC GOLD CORPORATION
PHASE 1 ENVIRONMENTAL EFFECTS MONITORING PROGRAM

Project No.
121619250

Title

BASELINE AQUATIC SAMPLING AREAS IN LONG LAKE FOR TOUQUOY MINE

Revision	Date
REV-1	2019.07.12
Reference Sheet	**Figure No.**
-	5-3

5.1.1 Fish Surveys

Baseline fish community surveys of Scraggy Lake were conducted over four days in October 2017 and supplemented with data from the fish tissue survey in July 2018. Fish community surveys within Long Lake were conducted over two days in July 2018 to confirm presence and abundance of suitable sentinel species (i.e., white sucker and yellow perch) for future EEM for comparison with Scraggy Lake as the exposure site. The fish sampling was conducted under Scientific Fish Collection Licences issued to Stantec by Fisheries and Oceans Canada.

In both 2017 and 2018, overnight sets of gill nets were the primary method used to sample fish. 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 sample the fish community and target male yellow perch.

In Scraggy Lake the fish community was made up of twelve species from nine families (Table 5.1). Catch on Long Lake resulted in ten species from nine families (Table 5.1). Catch per unit effort for yellow perch and white sucker was higher in Scraggy Lake than Long Lake. (Table 5.1) More effort was placed to gather fish in Scraggy Lake than in Long Lake so that a robust baseline data set for target species would be gathered as baseline for Scraggy Lake.

Table 5.1 Total Number of Fish Captured from Scraggy Lake and Long Lake, NS for EEM Fish Survey in 2017 and 2018.

Species	Scraggy Lake		Long Lake
	2017	2018	2018
Alewife (*Alosa pseudoharengus*)	146	20	0
American eel (*Anguilla rostrata*)	8	1	1
Atlantic salmon (*Salmo salar*)	2	0	0
Banded Killifish (*Fundulus diaphanus*)	37	0	30
Brown Bullhead (*Ameiurus nebulosus*)	88	16	32
Brook Trout (*Salvelinus fontinalis*)	10	3	1
Golden Shiner (*Notemigonus crysoleucas*)	8	6	12
Lake Chub (*Couesius plumbeus*)	19	0	1
Ninespine stickleback (*Pungitius pungitius*)	0	0	1
White Perch (*Morone americana*)	8	0	33
White Sucker (*Catostomus commersonii*)	155	66	8
Yellow Perch (*Perca flavescens*)	611	31	7
Grand Total	**1091**	**143**	**126**

Table 5.2 Summary of Catch Per Unit Effort (CPUE) by Fishing Method in Scraggy Lake and Long Lake, NS

Species	Waterbody Name	Year	Gill Nets			Minnow Traps			Fyke Nets		
			Total Effort (neta hours)	Total Catch	CPUE (fish / neta / day)	Total Effort (trap hours)	Total Catch	CPUE (fish / trap / day)	Total Effort (trap hours)	Total Catch	CPUE (fish / trap / day)
Yellow Perch	Scraggy Lake	2017	244	126	12.4	1196	364	7.3	108	125	27.8
		2018	120	31	6.2	-	-	-	-	-	-
	Long Lake	2018	48	0	0	215	7	0.8	-	-	-
White Sucker	Scraggy Lake	2017	244	155	15.2	1004	0	0	108	0	0
		2018	120	66	13.2	-	-	-	-	-	-
	Long Lake	2018	48	8	4	215	0	0	-	-	-

NOTE: [a] One net is equivalent to a 30.5 m (100 ft) gill net

Based on the abundance and size of white sucker and yellow perch in Scraggy Lake, these two species were targeted as the sentinel species for the lethal baseline program summarized below. Both species are routinely used in EEM programs in Canada (EC 2012). A high-level summary of the internal baseline reports is provided below. Note that the focus was on gathering baseline data for the two target species in Scraggy Lake prior to effluent discharge. Although these same species were caught in Long Lake to confirm availability, no analysis was conducted on the fish that were caught.

Following the Technical Guidance Document (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 5 fish of varying sizes retained for fish tissue analysis (Section 5.1.2). 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 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. Fish were measured to the nearest millimetre. Body weights 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 by Northshore Environmental.

A summary of the descriptive statistics from white sucker (Table 5.3) and yellow perch (Table 5.4) for Scraggy Lake is based on the Technical Guidance Document (EC 2012) and includes weight, length, condition, gonad somatic index (GSI), liver somatic index (LSI), and age. Male yellow perch were noticeably smaller than female yellow perch.

Table 5.3 Descriptive Statistics for White Sucker Captured in October 2017 for Touquoy Mine

Statistic	Length (cm)	Weight (g)	Condition1	GSI2	LSI3	Age4
Male White Sucker – Nearfield Scraggy Lake (n = 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
Female White Sucker – Nearfield Scraggy Lake (n = 18 for length, weight, condition; n = 17 for GSI, LSI, Age)						
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

NOTES:
1 Condition: body weight relative to length.
2 GSI: gonad somatic index; relative gonad size (gonad weight versus body weight).
3 LSI: liver somatic index; relative liver size (liver weight versus body weight).
4 Age unit is years.

Table 5.4 Descriptive Statistics for Weight, Length, Condition, GSI, LSI and Age for Yellow Perch Captured in October 2017, AMNS, Touquoy Mine

Statistic	Length (cm)	Weight (g)	Condition[1]	GSI[2]	LSI[3]	Age[4]
Male Yellow Perch – Nearfield (n = 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

Table 5.4 Descriptive Statistics for Weight, Length, Condition, GSI, LSI and Age for Yellow Perch Captured in October 2017, AMNS, Touquoy Mine

Statistic	Length (cm)	Weight (g)	Condition[1]	GSI[2]	LSI[3]	Age[4]
Female Yellow Perch – Nearfield (n = 21)						
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

NOTES:
1 Condition: body weight relative to length.
2 GSI: gonad somatic index; relative gonad size (gonad weight versus body weight).
3 LSI: liver somatic index; relative liver size (liver weight versus body weight).
4 Age unit is years.

5.1.2 Fish Tissue

Fish tissue analysis for metals was conducted on specimens collected from Scraggy Lake in 2017 and 2018. Reported concentrations of mercury and selenium have been extracted for each species (yellow perch and white sucker) within the nearfield and farfield sample locations and are summarized in Table 5.5.

Fish were measured to the nearest 1 mm and weighed using A&D® balance (EJ-300) accurate to 0.01 g. Each fish was transferred to a large Ziploc® bag for whole-body analysis. The skinless, boneless muscle fillet of yellow perch was removed using a scalpel, tweezers, and a fillet knife, then weighed and placed in a Whirl-Pak® bag for analysis. The remaining carcass was put in a separate Whirl-Pak® bag for analysis. Samples were labelled with a unique sample number and placed immediately into a freezer for storage prior to being submitted in a cooler on ice for trace metals analysis to Maxxam Analytics in Bedford, NS. Fish tissue samples were analyzed for several parameters, including a complete scan for metals, using Inductively Coupled Plasma Mass Spectrometry (ICP-MS), lipids (i.e., crude fat) and moisture.

The skinless, boneless fillets samples from yellow perch were not analyzed for moisture because there was insufficient tissue weight for analysis. The total wet weight body metal concentration for yellow perch was calculated by adding the metal concentration in the skinless, boneless fillet and carcass.

Table 5.5 Tissue Analysis – Summary of Mercury and Selenium Concentrations from Fish Caught in Scraggy Lake in 2017 and 2018

Year	Concentration (mg/kg wet weight)		
	2017	2018	
Analysis	Whole-Body	Whole-Body	Muscle Tissue
Yellow Perch			
n=	5	4	4
Mercury (mg/kg)	0.18 - 0.59	0.34 - 0.58	0.661 - 0.815
Selenium (mg/kg)	0.61	0.56 - 1.20	0.569 - 1.19
White Sucker[1]			
n=	4	5	-
Mercury (mg/kg)	0.15 - 0.20	0.182 - 0.348	-
Selenium (mg/kg)	0.54 - 0.69	0.603 - 0.959	-

NOTES:
[1] – Insufficient weight was retained to conduct muscle tissue analysis for metals therefore whole-body analysis was conducted.

For mercury concentration in yellow perch, all four muscle tissue samples in 2018, one of four whole-body samples in 2017, and one of five whole body samples in 2018 exceeded the Health Canada fish consumption guideline for human consumption (0.5 mg/kg fresh weight) at the nearfield sites in Scraggy Lake.

For white sucker, none of the whole-body samples exceeded the Health Canada fish consumption guideline for human consumption for mercury in 2017 or 2018 in Scraggy Lake.

An increasing trend in mercury concentration with fish length was determined for whole-body and muscle tissue samples from yellow perch and whole-body white sucker from Scraggy Lake in 2017 and 2018.

5.1.3 Benthic Invertebrate Community Survey

In 2017 and 2018, five samples from each of the nearfield and farfield locations were collected in Scraggy Lake. Baseline benthic invertebrate sampling has not been conducted in Long Lake.

In 2017, 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 invertebrate 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 1 m 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 Document (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 prior to being preserved.

In 2018, BIC samples were collected in deeper areas of the nearfield and farfield locations using a petit ponar grab. As in 2017, attempts were made to sample within the littoral zone (~ 1 m water depth). Following extensive testing at various depths (1-4 m) within the nearfield and farfield basins it was determined that appropriate substrate was available only at depths greater than 3 m. Based on the bathymetry and substrate testing it appeared that hard rocky substrates with little depositional substrates existed around the perimeter of the lake in the nearfield and farfield locations at depths less than the 3 m bathymetric contour. It is speculated that these hard substrates may be related to shorelines that were submerged as a result of the past construction of a water control structure at the outlet of Scraggy Lake, prior to acquisition of the property by AMNS.

The BIC samples were collected in deposition areas at ~3.5 m water depth at each of the nearfield and farfield stations using a petit ponar grab. The petit ponar had a surface area of 0.0255 m^2. Depth of sample locations was verified using a digital depth sounder (HawkEye H22PX Handheld Sonar System). Each sample consisted of a composite of three subsamples. Subsamples were collected at least 5 m apart. Samples were sieved through a 500 μm bucket sieve prior to preservation, in accordance with the Technical Guidance Document (EC 2012).

Total benthic invertebrate density, taxa richness, Simpson’s Evenness Index, and Bray-Curtis Dissimilarity Index are required EEM endpoints in the Technical Guidance Document (EC 2012); however, the Bray-Curtis Dissimilarity Index was not calculated for baseline because this would require a reference location for comparison, which was not sampled.

Results from 2017 and 2018 baseline sampling events are summarized in Figure 5.4. The 2018 summary statistics for the effect endpoints required by the Technical Guidance Document (EC 2012) are shown in Table 5.6 and include density (i.e., abundance), taxa richness (at family level), and Simpson’s Evenness Index, as well as Simpson’s Diversity Index and biomass (wet weight) per sample.

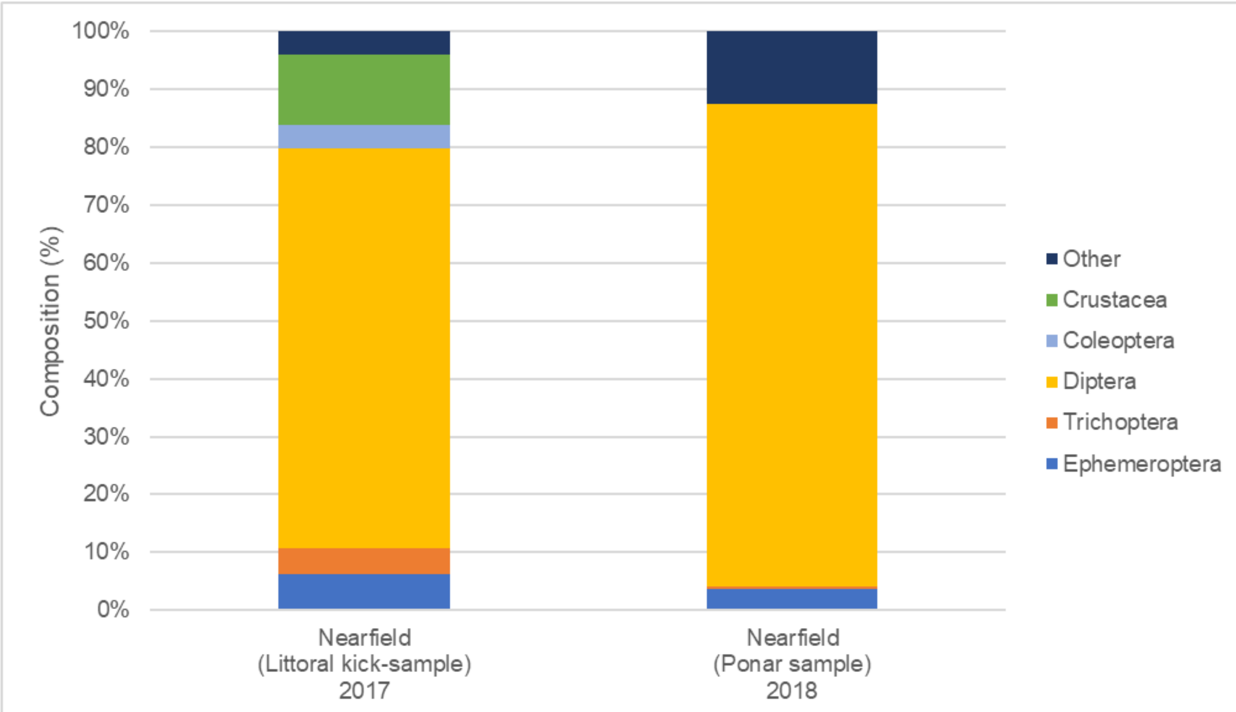


Figure 5.4 Summary of Baseline Benthic Invertebrate Community Composition for Surveys Conducted in Scraggy Lake in 2017 and 2018

Table 5.6 Benthic Invertebrate Community Summary Statistics for the 2018 Survey Conducted in Scraggy Lake

Parameter	Nearfield (SGL-001)	Parameter	Nearfield (SGL-001)
N of Samples	5	N of Samples	5
Density (# individuals per m^2)		**Simpson's Evenness Index**	
Minimum	863	Minimum	0.31
Maximum	1,582	Maximum	0.45
Median	1,176	Median	0.34
Arithmetic Mean	1,239	Arithmetic Mean	0.36
Standard Error of Arithmetic Mean	127	Standard Error of Arithmetic Mean	0.02
Standard Deviation	283	Standard Deviation	0.05
Taxa Richness (number of taxa - families)		**Simpson's Diversity Index**	
Minimum	6	Minimum	0.51
Maximum	8	Maximum	0.63
Median	7	Median	0.61
Arithmetic Mean	6.8	Arithmetic Mean	0.58
Standard Error of Arithmetic Mean	0.4	Standard Error of Arithmetic Mean	0.03
Standard Deviation	0.8	Standard Deviation	0.06

Table 5.6 Benthic Invertebrate Community Summary Statistics for the 2018 Survey Conducted in Scraggy Lake

Parameter	Nearfield (SGL-001)	Parameter	Nearfield (SGL-001)
Biomass (wet weight in grams)			
Minimum	0.11		
Maximum	0.17		
Median	0.14		
Arithmetic Mean	0.14		
Standard Error of Arithmetic Mean	0.01		
Standard Deviation	0.03		

5.1.4 Supporting Environmental Variables

Supporting environmental variables (water and sediment quality) were collected to establish baseline conditions in Long Lake and Scraggy Lake.

Surface water samples were collected to provide baseline conditions in Scraggy Lake prior to effluent discharge and determine similarities or differences to reference lakes. In both Scraggy Lake and Long Lake, surface water was “soft” meaning they contained low concentrations of dissolved minerals (i.e., hardness), had low pH, and was nutrient poor. Total aluminum concentrations were elevated in both Long Lake and Scraggy Lake relative to the Canadian Water Quality Guideline for Protection of Freshwater Aquatic Life (Freshwater) (CWQG PAL), inferring that water quality is influenced by the regional geology.

Sediment samples were collected to provide additional baseline data for Scraggy Lake and Long Lake. There were no exceedances of the Canadian Sediment Quality Guideline Probable Effects Levels (CSQG PEL) for cadmium, chromium, copper, lead, mercury, and zinc in any of the lakes sampled. Arsenic levels were above the CSQG PEL at one nearfield station (SGL-001; 18 mg/kg versus guideline of 17 mg/kg) in Scraggy Lake and at one reference station in Long Lake (LL-002; 21 mg/kg versus guideline of 17 mg/kg) in 2018.

6.0 PROPOSED STUDY DESIGN FOR THE PHASE 1 ENVIRONMENTAL EFFECTS MONITORING PROGRAM

Environmental Effects Monitoring consists of effluent and water quality monitoring studies (Schedule 5, Part 1) and biological monitoring studies (Schedule 5, Part 2), as described in detail below.

6.1 Effluent and water quality monitoring studies

Under MDMER Part 1, effluent and water quality monitoring studies include effluent characterization, sublethal toxicity testing, and water quality monitoring.

AMNS followed the effluent monitoring requirements and conducted effluent characterization, sublethal toxicity testing, and water quality monitoring since becoming subject to MDMER in July 2018. Results of effluent and water testing have been entered into ECCC's on-line database.

6.1.1 Effluent Characterization

Effluent characterization is to be conducted for a sample of treated effluent from the FDP quarterly for the following laboratory and field parameters:

- Laboratory parameters (Schedule 5) – Total Al, Cd, Fe, Hg, Mo, Se, NO_3^-, Cl, Cr, Co, SO_4^-, Tl, U, P, Mn, NH_3, alkalinity and hardness;
- Laboratory parameters (Schedule 4) – Total As, Cu, CN, Pb, Ni, Zn, TSS, Ra226;
- Field Measurements – electrical conductivity, water temperature, pH and dissolved oxygen

Effluent characterization will be conducted by AMNS for three of the four quarterly events and by Stantec as part of the biological monitoring for the quarterly event that coincides with biological study sampling.

6.1.2 Sublethal Toxicity Testing

Under MDMER, sublethal toxicity testing is to be conducted twice a year. Effluent samples for sublethal toxicity testing have been collected for sublethal testing since the mine became subject to MDMER in July 2018.

The objective of sublethal toxicity tests is to verify if mine effluent has the potential to affect the biological components in the exposure area. Four organisms are exposed to varying concentrations of effluent as described in Schedule 5 Section 5(1) of the MDMER using the following tests:

- Fathead Minnow (*Pimephales promelas*) 7-Day Survival and Growth Test (Reference Method EPS 1/RM/22, 2nd ed. (Environment Canada 2011)
- *Ceriodaphnia dubia* Survival and Reproduction Test (Reference Method EPS 1/RM/21), 2nd ed. (Environment Canada 2007a)
- *Raphidocelis subcapitata* 72-hour Growth Inhibition Test (Reference Method EPS 1/RM/25), 2nd ed. (Environment Canada 2007b)

- *Lemna minor* 7-Day Plant Growth Inhibition Test (Reference Method EPS 1/RM/37), 2nd ed. (Environment Canada 2007c).

Effluent samples are submitted to Aquatox, a qualified toxicity testing laboratory based in Guelph, ON, within the holding time for testing. Results of these tests (i.e., LC50, IC25, EC25 where applicable, 95% confidence limits) are submitted online and will be summarized in the Interpretive Report and discussed in relation to the potential zone of effect, per the Technical Guidance Document (EC 2012). In this method the potential zone of effect is estimated by dividing the length (in m) of the 1% plume by the geometric mean of the LC50 or IC25 (in % effluent) for each bioassay test.

6.1.3 Water Quality Monitoring

In accordance with MDMER, water quality monitoring is conducted four times per year at least one month apart for water samples collected from exposure and reference areas selected in the biological monitoring studies (Section 6.2.2). The exposure area is in the nearfield area of Scraggy Lake at Station SGL-001 (44.970413°N, 62.917723°W), approximately 100 m from the shoreline. The reference area is at the north end of Long Lake at Station LL-001 (45.00648°N, 062.96925°W).

Samples are analyzed for the following laboratory and field parameters:

- Laboratory parameters (Schedule 5) – Al, Cd, Fe, Hg, Mo, Se, NO_3^-, Cl, Cr, Co, SO_4^-, Ti, U, P, Mn, NH_3, alkalinity and hardness;
- Laboratory parameters (Schedule 4) - As, Cu, CN, Pb, Ni, Zn, TSS, Ra226;
- Field Measurements – electrical conductivity, water temperature, pH, and dissolved oxygen

Water quality monitoring is conducted by AMNS for all of the required sampling events at the exposure and reference stations registered under Part 1 of Schedule 5 of MDMER with the exception of one of the sampling events that coincides with biological monitoring, which will be collected by Stantec.

6.2 Study design overview for biological monitoring

The objective of the Touquoy Mine Phase 1 EEM biological monitoring is to evaluate the effects of mine effluent discharged from the Touquoy Mine FDP on the fish and benthic invertebrate populations present in the downstream receiving environment.

The main components of the biological monitoring under MDMER Part 2 of Schedule 5 are:

- a study respecting the fish population;
- a study respecting the BIC;
- a study respecting mercury in fish tissue; and
- a study respecting selenium in fish tissue.

A fish population study is required if, during a period in which there is effluent deposited, the highest concentration of effluent in the exposure area (i.e., receiving environment) is greater than 1% at any location that is 250 m downstream from a final discharge point.

A BIC study is required if, during a period in which there is effluent deposited, the highest concentration of effluent in the exposure area, is greater than 1% at any location that is 100 m downstream from a final discharge point.

A fish tissue mercury study is required if effluent characterization reveals an annual mean concentration of total mercury in the effluent that is equal to or greater than 0.10 µg/L, based on a calendar year or at least two of four effluent samples in a calendar year is equal to or greater than 0.10 µg/L. In accordance with the MDMER, for the first biological monitoring studies, effluent mercury concentration is determined for the timeframe beginning on the day on which the mine became subject to section 7 of the MDMER and ending on the day before the day on which the first study design is required to be submitted, therefore the timeframe of July 20, 2018 to July 19, 2019.

A fish tissue selenium study is required if effluent characterization reveals an annual mean concentration of total selenium in the effluent that is equal to or greater than 10 µg/L, based on a calendar year or at least two of four effluent samples in a calendar year is equal to or greater than 5 µg/L. For the first biological monitoring studies, effluent selenium concentration is determined for the same timeframe as used for mercury, above, between July 20, 2018 and July 19, 2019.

Each main component of the biological monitoring is discussed further in the sections below. Results for the biological components will be entered into ECCC's EEM database and presented in the Interpretive Report.

6.2.1 Plume Delineation

The plume delineation study provides information on how the mine effluent behaves within the receiving environment and identifies the boundaries of the effluent plume so that exposure areas can be accurately established. The plume delineation study also provides an indication of the concentration of effluent in the receiving environment to which organisms may be exposed.

To support the Phase 1 study design, conductivity was used to delineate the effluent plume in the nearfield of where effluent enters the receiving environment in Scraggy Lake. As described previously, the FDP is located downstream of the polishing pond. Effluent is discharged from the FDP and flows through a constructed wetland prior to entering Scraggy Lake.

The plume delineation was conducted on June 7, 2019 by AMNS using a YSI 556MPS (Ohio, USA). Conductivity of the effluent at the FDP and at the outflow of the artificial wetland was measured between April 16 and June 18, 2019 to provide context for effluent treatment through the constructed wetland because the FDP is not discharging directly into Scraggy Lake. Resulting data for the plume delineation are provided in Appendix A and summarized herein.

To calculate effluent concentration entering Scraggy Lake, the effluent conductivity in the constructed wetland was divided by the effluent conductivity at the FDP on that particular day. Generally, the effluent conductivity at the downstream extent of the constructed wetland (prior to entry into Scraggy Lake) was more than 90% of the conductivity of effluent at the FDP (a reduction in conductivity of less than 10%), inferring that the constructed wetland may reduce the concentration of some parameters in the effluent, prior to the effluent entering Scraggy Lake.

At the time of the survey on June 7, 2019, effluent had been continuously discharged into Scraggy Lake since July 2018. The average effluent flow rate since January 2019 is 348 m^3/h, and was 483 m^3/h on the day of the survey. The conductivity of the effluent at the FDP on June 7, 2019 was 2,396 µS/cm.

Plume delineation in the nearfield was conducted at two transects placed at 100 and 250 m from the location where the effluent enters Scraggy Lake. The first and last sampling locations in the transect were located nearest to shore (~10 m), with the other sampling locations spaced at 25 m increments along the transects, as shown in Figure 6.1. At each sampling location water temperature and conductivity profiles were collected at 0.5 m increments along a vertical profile, with the deepest sample collected at approximately 0.2 m from the bottom of the lake.

Background conductivity in Scraggy Lake was determined using the laboratory derived conductivity from surface water samples collected monthly at SW-21 between April 2016 and June 2018. Background conductivity prior to mine discharge ranged from 18 to 63 µS/cm, with an average of 33 µS/cm.

To determine effluent concentration in the receiving environment, the average baseline conductivity (33 µS/cm) was subtracted from the conductivity in Scraggy Lake along the transect and divided by the effluent concentration at the FDP (2,396 µS/cm).

The plume delineation using conductivity indicated that at 100 and 250 m from where the mine effluent enters Scraggy Lake the plume is well mixed through the water column at all sampling locations across the transect. At 100 and 250 m the mine effluent has a concentration of approximately 5% (Appendix A). The plume was not delineated to the extent of a 1% effluent plume as the information obtained was sufficient to inform the Phase 1 Study Design. Additional sampling locations along the 50 m transect and in other areas of the lake (e.g., farfield or other potential lake reference basins) may be collected to inform subsequent study designs and will be included in the Phase 1 EEM Interpretive Report.

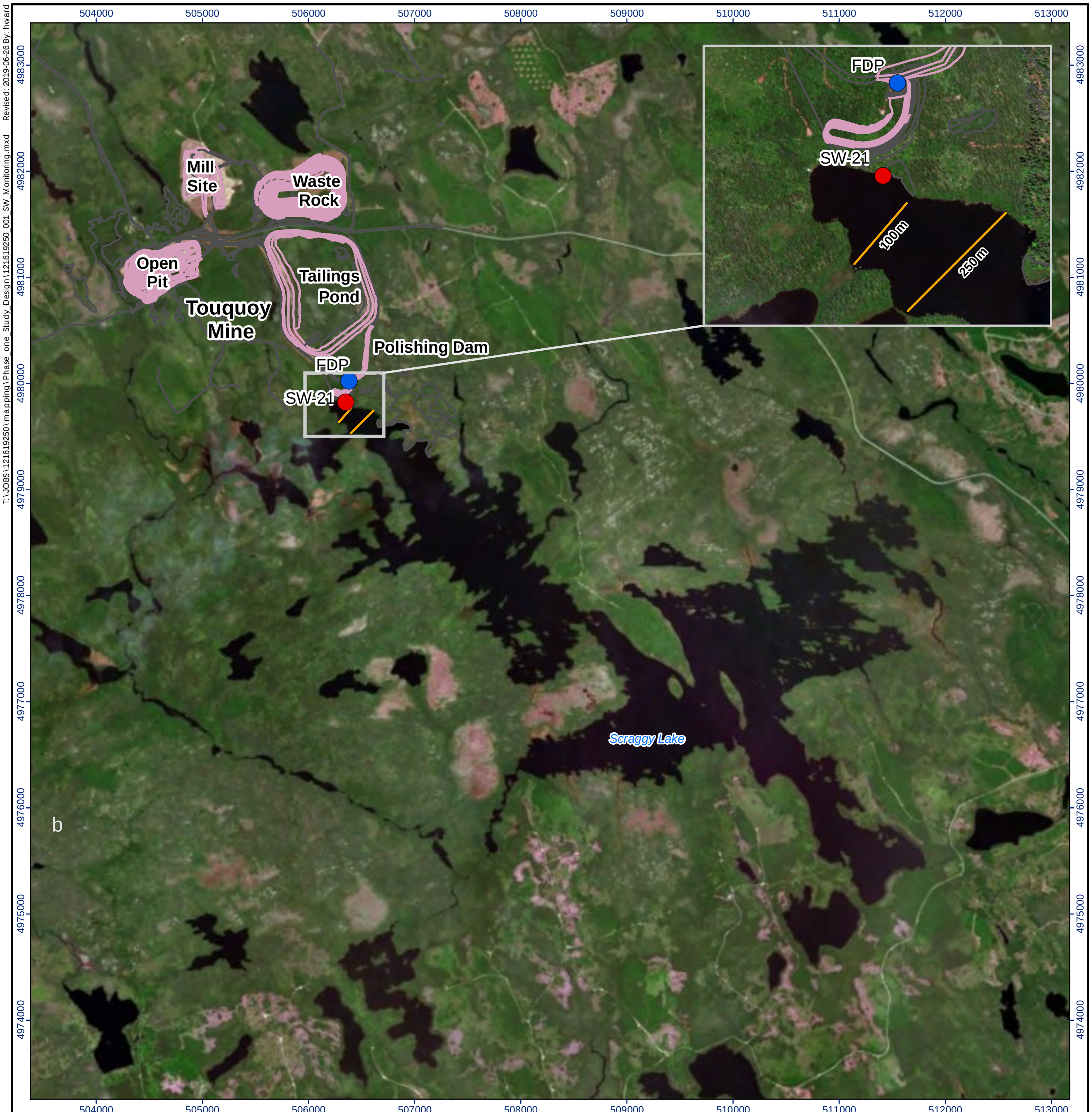
Plume delineation using conductivity is supported by the analysis of surface water quality data using dissolved sulphate as an additional effluent tracer, indicating an effluent concentration of 5 to 9% at a distance of ~15 m of the location where effluent enters Scraggy Lake (water sampling location SW-21). Analysis of surface water quality data using sulphate indicated that the effluent concentration is approximately 1% near the outlet of Scraggy Lake to Fish River.

6.2.2 Biological Monitoring Sampling Locations

Sampling areas are designed to capture potential effects of the mine effluent downstream of the FDP in the exposure area for fish and benthic invertebrate communities as compared to reference areas.

The EEM program for Phase 1 of the Touquoy Mine site is based on the exposure area selected during previous baseline sampling in 2017 and 2018. This consists of a nearfield (SGL-001) sampling area within the receiving environment of Scraggy Lake (Figure 5.2).

The nearfield area (SGL-001) is in the northern bay of Scraggy Lake closest to the effluent discharge location, within the smaller of the two basins. The bay is approximately 330 m wide at its widest point and 500 m in length. Water depths are generally shallow (<6 m). Fish habitat in the nearfield is comprised principally of shallow water rocky habitats (<3 m water depth). Substrate is a mix of cobble, rock, and some sand in sheltered littoral areas. Sparse amounts of patchy aquatic vegetation (e.g., water lilies) are present in the sheltered portions of the bay along the shoreline in areas with fine substrates.



Final Discharge Point
Monitoring Station
Touquoy Mine
Plume Deliniation Transect (Approximate)
Watercourse
Waterbody

0 500 1,000 metres
1:55,072 (at original document size of 8.5x11)

Stantec

Notes
1. Coordinate System: NAD 1983 CSRS UTM Zone 20N
2. Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS,

Figure 6.1 Existing Surface Water Quality Monitoring Stations and Proposed Locations of Plume Delineation Transects in Scraggy Lake, NS.

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Two references areas are proposed for the Phase 1 EEM.

Long Lake, is proposed as one of the reference lakes for the Phase 1 EEM based on the baseline aquatic sampling conducted in 2017 and 2018, for the following reasons:

- Long Lake is in the same watershed as Scraggy Lake (Moose River Watershed).
- Water depths are generally shallow (<3 m) and similar to Scraggy Lake.
- Fish habitat in Long Lake is comprised principally of shallow water rocky habitats (<3 m water depth) with sparse amounts of emergent vegetation near the shoreline, similar to Scraggy Lake.
- The fish community in Long Lake is similar to Scraggy Lake (i.e., freshwater and diadromous species) and includes adult white sucker and yellow perch in sufficient abundance to conduct a lethal EEM survey.
- There are no known historical mining activities on Long Lake.
- The prevailing wind direction is from the south to southwest in the summer and west to northwest in the winter.. Long Lake is not located downwind of the mine, reducing the potential for the deposition mine related dust.
- Long Lake and Scraggy Lake have similar land use patterns (i.e., forested and wetlands, a few cottages/camps).

A second reference lake or area will be selected prior to the Phase 1 EEM based on same or nearby watershed, similar mineralization zone and land use without mining, similar size and habitat type, availability of the two selected sentinel fish species, and ease of access. Nearby Alma Lake was investigated in 2018 as a potential reference lake but was found to only possess one the desired sentinel fish species (white sucker, but not yellow perch) and was therefore not considered a good option and is not discussed further.

Other potential options for a second reference area include:

- Northeastern basin of Scraggy Lake
- Ship Harbour Long Lake
- Tangier Grand Lake

6.2.3 Fish Population Survey

The objective of the fish population survey is to determine whether mine effluent is influencing growth, reproduction (energy use), condition (energy storage), or survival of local resident fish species via a lethal or non-lethal study design. An effect on the fish population is defined as a statistically significant difference in endpoints between fish population measurements taken in exposure and reference areas.

A lethal survey would provide information regarding potential for mine effluent to affect total body weight, gonad weight at total body weight, fecundity, liver weight at total body weight, condition, and age at an exposure area relative to a reference area.

6.2.3.1 Sentinel Species

During baseline sampling in 2017 and 2018, white sucker and yellow perch were determined to be in sufficient abundance in Scraggy Lake and in the reference lake (Long Lake) for use in the Phase 1 EEM.

The ecology of these two species is well understood (Scott and Crossman 1973) and they are broadly used for EEM studies across Canada (EC 2012). Based on their ecology and habitat needs for feeding and spawning, white sucker and yellow perch are likely to remain resident for a substantial portion of their lives in the northern basin of Scraggy Lake to which effluent is discharged, so fish caught in the nearfield have likely been resident in that general area and exposed to effluent. White sucker and yellow perch spawn in spring in shallow waters with suitable habitat, such as is found in the littoral zone of Scraggy Lake and Long Lake.

Adult fish of a reproductive age would be the target for sampling. The study would be conducted in September to early October of 2020, which is a suitable time of year to measure gonad size and developing eggs (size and fecundity) because this is several months after spawning and gonad tissues will be rebuilding.

6.2.3.2 Field Collection

Based on baseline survey experience, overnight sets of gill nets will be the primary method used to catch yellow perch and white sucker. Mesh size will range from 13 mm to 64 mm and nets will be 30.5 m in length and 1.82 m in height. Gill nets will be 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 held within organza bags will also be used to target male yellow perch. Location and effort for all gear types will be recorded. Following the Technical Guidance Document (EC 2012), a minimum of 40 fish of each species will be targeted per location, consisting of a minimum of 20 males and 20 females. Mature white sucker and yellow perch will be euthanized by a blow to the head and stored immediately on ice in labelled bags. Non-target species will be identified, counted and released. Non-target species or immature yellow perch and white sucker will be measured as time permits, taking care to measure the smallest and largest fish to assess the size range of species within the lake. All other species captured will be identified and counted.

Mature males will be those with opaque white gonads and mature females will be those with opaque orange gonads where developing eggs are visible. Mature white sucker and yellow perch will be processed for fork length, total body weight, liver weight, gonad weight, age, and fecundity EEM endpoints.

Fish measurement precision will be in accordance with Technical Guidance Document (EC 2012) as outlined in Table 6.1. Body weight will be 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.

Table 6.1 Fish Measurements and Required Precision

Measurement	Target Precision
Length (fork or total or standard)	+/- 1 mm
Total body weight (fresh)	+/- 1.0%
Age	+/- 1 year (10% to be independently confirmed)
Gonad weight (if fish are sexually mature)	+/- 0.1 g for large-bodied fish species
Fecundity (if fish are sexually mature)	+/- 1.0%
Liver Weight	+/- 0.1 g for large-bodied fish species
Abnormalities (i.e., lesions, tumours, parasites, other)	Not applicable
Sex	Not applicable
Source: Environment Canada (2012)	

Two aging structures per fish will also be retained for determination of age. The first pectoral ray and scales will be retained for white sucker and the third dorsal spine and scales will be retained for yellow perch. The pectoral rays and dorsal spines will be used as the primary aging structure with the scales used as back up if and as needed to verify or confirm fish ages. Age analysis will be conducted by a qualified person (i.e., Bob Irwin in Maynooth, ON or Northshore Environmental). Approximately 10% of the aging structures will be checked against the secondary aging structure for quality assurance and quality control (QA/QC).

Fecundity estimates and the average egg size (i.e., weight) per female will be determined. A subsample consisting of a minimum of 100 eggs will be weighed and counted by Stantec. The average egg weight per female will be determined by dividing the subsample weight by the number of eggs counted in the subsample. The average egg weight per female will then be divided into the total gonad weight to provide an estimate of fecundity.

6.2.3.3 Fish Data Analysis

Prior to analysis, data will be checked for transcription errors. Outliers will be detected using visual screening techniques, such as scatterplots, box and whisker plots or normal probability plots. Immature fish will be screened using the general rule of a GSI less than 1% per the Technical Guidance Document (Environment Canada 2012). Removal of outliers will also consider the raw data, field conditions, and sampling and analysis procedures. Outlier values not attributed to entry errors or technical problems will be identified and their influence on the results will be determined by performing analyses with and without the extreme values.

Summary statistics, including the sample size, mean, median, standard deviation, standard error, and minimum and maximum values, will be calculated by species and sex for each effect endpoint or supporting endpoint for exposure and reference areas (Table 6.1).

Table 6.2 summarizes the effect indicators, effect endpoints and associated supporting endpoints for the lethal fish survey.

Table 6.2 Lethal Fish Survey Effect Indicators

Effect Indicator	Effect Endpoint	Supporting Endpoint
Growth (Energy Use)	• Size-at-age (body weight against age)	• Body Weight • Length • Size-at-age
Reproduction (Energy Use)	• Relative gonad size (GSI)	• Relative gonad size (gonad weight versus body weight) • Relative fecundity (# eggs per female versus body weight) • Relative fecundity (# eggs per female versus length) • Relative fecundity (# eggs per female versus age) • Relative egg size (mean egg weight versus age)
Condition (Energy Storage)	• Body weight relative to length • Relative liver size (LSI)	• Relative liver size (liver weight versus body weight) • Relative egg size (mean eggs weight versus body weight)
Survival	• Age	• Age

Analysis of Variance (ANOVA) will be used to analyze for differences between reference and exposure areas for whole body weight, length, and age of each sentinel species. An analysis of covariance (ANCOVA) will be used to detect difference between reference and exposure areas for all reproduction effect indicators (i.e., relative gonad size, relative fecundity), condition (i.e., body weight relative to length, liver weight against body weight), and size at age (body weight against age) as described in Table 6.2.

6.2.3.4 Effect Determination

An effect is defined as a statistically significant difference in effect indicators measured between an area exposed to effluent and a reference area (Environment Canada 2012).

The effect endpoints for the lethal fish survey are listed below and described in more detail in Table 6.2.

- Growth (size at age).
- Reproduction (relative gonad size and fecundity).
- Condition (body weight relative to length, relative liver weight and egg size).
- Age.

The null hypothesis for the control-impact study proposed is the following: there is no difference in the endpoint for fish populations exposed to effluent, relative to the endpoint of fish populations not exposed to the effluent. To reduce the likelihood of committing either a Type I or Type II error, α and β are each set to 0.10 for statistical and power analysis.

If statistically significant differences are found between exposure and reference areas, the magnitude of the effect will be calculated as described in Schedule 5(12)(2) of the MDMER and compared to the critical effect size for each effect endpoint Schedule 5(2) (Table 6.3).

Table 6.3 Critical Effect Sizes for Fish Populations

Effect Indicator	Critical Effect Size
Total body weight at age	±25%
Gonad weight at total body weight	±25%
Liver weight at total body weight	±25%
Total body weight at length (condition)	±10%
Age	±25%

6.2.4 Fish Tissue Study

A fish tissue study is required if the mean annual effluent concentration of selenium exceeds 5 µg/L or exceeds 10 µg/L in two of four grab samples or if the mean annual effluent concentration of mercury exceeds 0.10 µg/L or exceeds 0.10 µg/L in two of four grabs.

Results in final effluent for mercury and selenium concentrations (grab samples, annual means) for 2018 and 2019 (to date) are provided in Table 6.4. Based on these results, no fish tissue studies for mercury or selenium are required for Phase 1 EEM. If mercury or selenium concentrations in effluent samples collected between June 27 and July 19, 2019 (the day before the First Study Design is required to be submitted) result in a requirement to conduct a fish tissue study, ECCC will be notified.

Table 6.4 Concentrations of Mercury and Selenium in Final Effluent, 2018 and 2019 (to date)

Date	Total Selenium[1] (µg/L)	Total Mercury[2] (µg/L)	Date	Total Selenium[1] (µg/L)	Total Mercury[2] (µg/L)
2018[3]			**2019[4]**		
24-Jul-18	<1.0	-	8-Jan-19	5.2	<0.013
7-Aug-18	<1.0	-	15-Jan-19	5.8	<0.013
14-Aug-18	<1.0	0.015	16-Jan-19	6.3	<0.013
15-Aug-18	<1.0	-	22-Jan-19	5.8	<0.013
21-Aug-18	<1.0	-	29-Jan-19	4.9	<0.013
28-Aug-18	<1.0	<0.013	5-Feb-19	5.5	<0.013
7-Sep-18	<1.0	<0.013	12-Feb-19	6.1	<0.013
11-Sep-18	<1.0	0.013	19-Feb-19	5.7	<0.013
20-Sep-18	<1.0	<0.013	26-Feb-19	5.6	<0.013
25-Sep-18	<1.0	0.015	5-Mar-19	5.3	<0.013
2-Oct-18	<1.0	<0.013	12-Mar-19	4.9	<0.013
9-Oct-18	1.4	<0.013	18-Mar-19	4.4	<0.013
17-Oct-18	1.6	<0.013	26-Mar-19	3.8	<0.013
23-Oct-18	1.7	<0.013	2-Apr-19	3	<0.013
25-Oct-18	1.9	<0.013	9/Apr/19	2.9	<0.013
30-Oct-18	1.7	<0.013	16-Apr-19	2.8	<0.013
8-Nov-18	1.9	<0.013	24-Apr-19	3.2	<0.013
13-Nov-18	2	<0.013	30-Apr-19	2.8	<0.013
20-Nov-18	2.9	<0.013	7-May-19	3	<0.013
26-Nov-18	2.9	<0.013	14-May-19	2.8	<0.013
27-Nov-19	3	<0.013	21-May-19	2.6	<0.013
4-Dec-18	2.2	<0.013	28-May-19	2.5	<0.013
11-Dec-18	2.9	<0.013	4-Jun-19	2.4	<0.013
18-Dec-18	3.5	<0.013	11-Jun-19	2.5	<0.013
24-Dec-18	3.7	<0.013	18-Jun-19	2.6	<0.0020
27-Dec-18	3.7	<0.013	25-Jun-19	2.7	<0.0020
27-Dec-18	3.7	<0.013	26-Jun-19	2.6	<0.0020
31-Dec-18	4.2	<0.013	**Annual Average[5]**	**4.0**	**<0.012**
Annual Average[5]	**1.9**	**0.013**	**Maximum**	**6.3**	**<0.013**
Maximum	**4.2**	**0.015**			

NOTES:
1. Laboratory method detection limit for selenium is 1 µg/L.
2. Laboratory method detection limit for mercury was lowered from 0.013 µg/L to 0.002 µg/L for samples taken after June 11, 2019.
3. Touquoy Mine became subject to MDMER on July 20, 2018.
4. Dates in 2019 include available results prior to Study Design submission on July 20, 2019.
5. For annual average, results that were below the laboratory method detection limit were substituted with the laboratory method detection limit before averaging.

6.2.5 Benthic Invertebrate Community

The objective of this survey is to assess the effects of the mine effluent on the BIC. An effect is defined as a statistically significant difference in required endpoints between the BIC in the exposure area as compared to reference area(s).

6.2.5.1 Field Collection

Five samples will be collected at the nearfield location of Scraggy Lake and two reference lakes (Long Lake and one other lake) in September to early October 2020 for BIC assessment. Sampling in the early fall will provide more mature forms of benthic invertebrates for identification. Based on experience gained in baseline sampling, BIC samples will be collected using a boat and a petit ponar grab. Sampling will target depositional areas at ~3.5 m water depth using a petit ponar grab with a surface area of 0.0255 m^2. Depth of the BIC samples will be verified using a digital depth sounder (HawkEye H22PX Handheld Sonar System). Each sample will consist of a composite of three subsamples taken at least 5 m apart as judged from surface with each replicate sample taken approximately 20 m apart or as can be accommodated for the size of the depositional area being sampled.

Samples will be sieved through a 500 µm mesh size bucket sieve prior to preservation, in accordance with the Technical Guidance Document (EC 2012). The samples will be preserved using 95% alcohol diluted to 75% (Fisher Scientific HC1300) and labelled on the inside and outside of each sample container. Samples will be switched over to 95% alcohol within 48 hours of collection for longer-term preservation.

6.2.5.2 Sorting and Identification

Benthic invertebrates will be sorted and identified to the lowest practical level by a qualified taxonomist at Envirosphere Consultants Limited in Windsor, NS. For consistency, this is the same company that processed the BIC samples for baseline surveys in 2017 and 2018. The samples will be sub-sorted as required and a measure of sub-sorting efficiency will be provided if sub-sorting is required, in accordance with the Technical Guidance Document (EC 2012). A reference collection will be retained in archive for potential future taxonomic verification and calculations of sorting.

6.2.5.3 Data Analysis

BIC descriptors that are to be reported include four effect endpoints as per the MDMER and Technical Guidance Document (Environment Canada 2012):

- total invertebrate density (i.e., total number of individuals collected in a sample expressed per unit area);
- taxonomic (i.e., family) richness (i.e., number of distinct taxa, at the family level);
- Simpson's evenness index; and
- Bray-Curtis similarity index (revised methodology as recommended by EC in 2013).

Other metrics may be calculated to help interpret the monitoring data. These descriptors will also be determined at the family level for the purposes of the EEM program and include:

- Diversity index;
- Ephemeroptera-Plectoptera-Trichoptera (EPT) index;
- Taxon proportion; and
- Taxon presence/absence.

These will be reported for each area along with the minimum, maximum, median, mean, standard deviation and standard error values.

Differences in BIC metrics between reference and exposure areas will be assessed using ANOVA.

Multivariate analysis (i.e., Principal Component Analysis or Non-Metric Multidimensional Scaling and cluster analysis) may be used if statistically significant differences between sampling areas are observed. This analysis will assist in identifying factors that influence the variation and differences in community composition among areas. Multivariate analyses are useful to reduce the complexity of the data set to facilitate the identification of patterns and aid in interpretation of overall results.

6.2.5.4 Effect Determination

In accordance with the MDMER, an effect is a statistically significant difference in one of the four BIC effect endpoints (i.e., density, richness, evenness, and similarity) measured between an area exposed to effluent and a reference area. The null hypothesis for the control-impact study proposed is the following: there is no difference in the endpoint for BIC exposed to effluent, relative to the endpoint of BIC not exposed to the effluent. To reduce the likelihood of committing either a Type I or Type II error, a and β are each set to 0.10 for statistical and power analysis, as per the Technical Guidance Document (EC 2012).

If statistically significant differences are found between exposure and reference areas, the magnitude of the effect size will be calculated for each effect endpoint as a percentage of the reference mean and compared to the relevant critical effect size for the effect endpoint (Table 6.3).

6.2.6 Supporting Environmental Variables

Several environmental variables will be measured to aid in the interpretation of the BIC and fish data. Supporting environmental variables will include in situ surface water parameters such as dissolved oxygen (mg/L and %), pH, temperature (°C), and conductivity (µs/cm), which will be measured using a YSI2030 multi parameter probe, and turbidity (NTU), which will be measured using a Hach 2100Q turbidimeter.

Water samples will be collected from near surface and near bottom at each sampling location (exposure, reference) prior to collection of any other samples in an area. Water samples will be collected from each area for laboratory analysis for water chemistry and include pH, hardness, alkalinity, conductivity, aluminum, cadmium, iron, mercury, molybdenum, selenium, nitrate, chloride, chromium, cobalt, sulphate, thallium, uranium, phosphorus, manganese, and ammonia as outlined in Schedule 5, Section 4. Additional parameters such as general chemistry and other trace metals will be included to assist in interpreting the biological monitoring results.

For water sampling, clean pre-labeled sample bottles will be filled according to the instructions provided by the analytical laboratory (i.e., pre-rinsed or not rinsed). Samples will be treated with suitable preservatives to prevent spoilage as required. Water samples will be stored in coolers on ice prior to sample submission to the analytical laboratory.

A composite sediment sample from a depositional location will be collected from each area simultaneously with benthic invertebrate collection. Sediment samples will be stored in laboratory-issued sample bottles on ice and/or refrigerated at 4 °C until analysis. Sediment samples will be analyzed for particle size distribution, total organic carbon content (TOC), and total metal concentrations, including mercury. Sediment characteristics such as colour, odour, texture, and presence of debris will be recorded.

Blind duplicate samples consisting of a field sample will be collected in the same location as the parent sample. Duplicate samples will be collected to evaluate the homogeneity of the sample site and variation in the sample collection each time. Approximately 10% of the water samples and sediment samples submitted to the laboratory will be blind field duplicates as per the Technical Guidance Document (EC 2012).

Field blanks consisting of deionized water will be put through the sample collection process (i.e., decanted) and used to check potential sources of contamination of the sample (i.e., sample bottles, preservatives, handling) and will be transported, stored and analyzed in the same way as the field samples. Trip blanks consisting of deionized water will be unopened in the field and will be used to check contamination from sample bottles, caps, and preservatives during transport, storage, and analysis (EC 2012). Approximately 10% of the water samples will be field or trip blanks to check on field methods and sample handling as per the Technical Guidance Document (EC 2012).

In addition, the laboratory will conduct their internal QA/QC using laboratory blanks, laboratory duplicates, and certified reference materials.

Samples will be tracked using chain of custody forms. Forms will be double checked for accuracy and completeness before samples are submitted. Samples will be submitted at the earliest practical time within the allowable holding time for the requested analyses. All analytical work will be conducted by an laboratory accredited through the Canadian Association for Laboratory Accreditation (CALA).

The samples will be sent to Maxxam Analytics in Bedford, NS for analysis. Laboratory QA/QC reports and results from field and lab-based QA/QC (i.e., field and trip blanks and field duplicates) will be submitted with the Interpretive Report.

A habitat survey at each area will be undertaken to document and confirm previous surveys on aquatic habitat conditions at each sampling area. Location of each area will be recorded with a global positioning system (GPS) and photographs will be taken and included in the Interpretive Report.

6.2.7 General Quality Assurance and Quality Control

To confirm that data produced in support of the Touqouy Mine Phase 1 EEM Program are of acceptable and verifiable quality, and meet the specified data quality objectives as described in the Technical

Guidance Document (EC 2012), in addition to the discipline specific QA/QC requirements described in the previous sections (Section 6.2), the following QA/QC requirements will apply to the other aspects of the field program.

All field personnel will have appropriate training and experience with field equipment, objectives and field safety measures.

For each study component, the QA/QC program will include a work plan describing field sampling, sample handling, sample analysis, and data recording. These work plans will include standard operating procedures (SOPs) relevant to the biological sampling conducted. SOPs are proprietary material and will be available for viewing at the request of ECCC.

All field methods will be listed in a work plan that describes sampling equipment, protocols, and equipment maintenance and calibration to be followed. All equipment will be in good working order and calibrated as described in the work plan. Data will be collected electronically or on field forms to confirm that required data are collected. The sampling locations will be geo-referenced using GPS and photographs of the sampling areas will be taken.

A description of the QA/QC performed, including results, will be outlined in the Interpretive Report.

7.0 SUMMARY

In summary, this Study Design has been prepared to fulfill the requirements for a First Study Design in accordance with MDMER, including site characterization, a summary of baseline studies conducted prior to effluent discharge, and a description in how the biological studies will be conducted.

The biological components for the Phase 1 EEM study for Touquoy Mine will consist of:

- a lethal study respecting the fish population;
- a study respecting the benthic invertebrate community; and
- supporting environmental variables

Quality assurance and quality control measures that will be implemented for validity of the data have been outlined herein.

Fish tissue studies for mercury and selenium are not required based on concentrations of these parameters in mine effluent to date (end of June 2019). ECCC will be notified if effluent concentrations for these parameters up until July 19, 2019 result in a requirement to conduct a fish tissue study.

Effluent quality and water quality testing results will be used to assist in interpretation of results of the biological studies.

Biological sampling will be conducted at a nearfield exposure and at two reference locations in September to early October 2020, which is a suitable time of year for sampling of the two sentinel fish species and the benthic invertebrate communities. The exposure area in Scraggy Lake has been confirmed to have an effluent concentration above 1%. Long Lake is proposed as one of the reference locations and a second reference lake will be selected prior to the Phase 1 EEM.

The Phase 1 EEM Interpretive Report is due to be submitted by July 20, 2021.

8.0 REFERENCES

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Appendix A PLUME DELINEATION DATA, JUNE 2019

STUDY DESIGN FOR THE PHASE 1 ENVIRONMENTAL EFFECTS MONITORING PROGRAM FOR THE TOUQUOY MINE, NOVA SCOTIA

July 18, 2019

Table A.1 Raw Effluent Data Collected at Final Discharge Point and Wetland Discharge Location on June 7, 2019 at Touquoy Mine, NS

Wetland Discharge			Final Discharge Point		
Survey Date	Temperature (^{0}C)	Conductivity (µS/cm)	Temperature (^{0}C)	Conductivity (µS/cm)	Effluent Dilution (%)
16-Apr-19	7.6	2036	7.6	2134	95%
24-Apr-19	9.1	2080	9.0	2183	95%
30-Apr-19	9.6	2180	8.5	2118	103%
7-May-19	13.9	2458	11.2	2352	105%
16-May-19	8.7	1997	10.4	2158	93%
21-May-19	9.3	2013	10.0	2089	96%
28-May-19	10.9	2187	11.1	2242	98%
5-Jun-19	12.9	2387	12.7	2396	100%
11-Jun-19	18.6	2755	16.9	2669	103%
18-Jun-19	21.8	3027	19.9	2911	104%

Table A.2 Raw Data Collected During Plume Delineation Study on June 7, 2019 in Scraggy Lake, NS

Transect Location	Station	GPS Coordinates	Wind Conditions	Maximum Water Depth (m)	Crew	Water Depth (m)	Direction (down/up)	Water Temperature	Water Conductivity (mS/cm)	Water Conductivity (uS/cm)	Average Conductivity (uS/cm)	Mine Related Conductivity	Effluent Dilution
100	1	44.97023, -62.92028	light wind, still water	1.02	BB/RK	0	down	17.46	0.168	168	33	135	6%
							up	17.95	0.168	168	33	135	6%
						0.5	down	15.02	0.158	158	33	125	5%
							up	15.53	0.16	160	33	127	5%
100	2	44.97056, -62.91981	light wind, still water	3.46	BB/RK	0	down	16.24	0.162	162	33	129	5%
							up	13.32	0.16	160	33	127	5%
						0.5	down	15.63	0.16	160	33	127	5%
							up	16.7	0.157	157	33	124	5%
						1	down	14.45	0.157	157	33	124	5%
							up	14.37	0.155	155	33	122	5%
						1.5	down	13.07	0.151	151	33	118	5%
							up	13.01	0.15	150	33	117	5%
						2	down	12.68	0.149	149	33	116	5%
							up	12.58	0.149	149	33	116	5%
						2.5	down	12.62	0.149	149	33	116	5%
							up	12.58	0.149	149	33	116	5%
						3	down	12.53	0.15	150	33	117	5%
							up	12.5	0.151	151	33	118	5%
100	3	44.97089, -62.91933	light wind	4.1	BB/RK	0	down	16.23	0.158	158	33	125	5%
							up	16.15	0.156	156	33	123	5%
						0.5	down	15.84	0.158	158	33	125	5%
							up	15.68	0.158	158	33	125	5%
						1	down	15.13	0.157	157	33	124	5%
							up	15.12	0.156	156	33	123	5%
						1.5	down	13.16	0.151	151	33	118	5%
							up	13.15	0.151	151	33	118	5%
						2	down	12.7	0.149	149	33	116	5%
							up	12.65	0.149	149	33	116	5%
						2.5	down	12.61	0.149	149	33	116	5%
							up	12.59	0.151	151	33	118	5%
						3	down	12.52	0.171	171	33	138	6%
							up	12.52	0.178	178	33	145	6%
						3.5	down	12.72	0.228				
							up	12.5	0.121				
100	4	44.97112, -62.91890	light wind	1.63	BB/RK	0	down	16.4	0.155	155	33	122	5%
							up	16.34	0.154	154	33	121	5%
						0.5	down	16.34	0.153	153	33	120	5%
							up	16.22	0.156	156	33	123	5%
						1	down	14.76	0.156	156	33	123	5%
							up	15.01	0.155	155	33	122	5%
						1.5	down	13.28	0.153	153	33	120	5%
							up	13.25	0.151	151	33	118	5%
100	5	44.97137, -62.91863	light wind	0.87	BB/RK	0	down	6.77	0.157	157	33	124	5%
							up	17.01	0.159	159	33	126	5%
						0.5	down	16.81	0.158	158	33	125	5%
							up	16.82	0.158	158	33	125	5%
250	6	44.96932, -62.91889	still	0.805	BB/RK	0	down	14.79	0.157	157	33	124	5%
							up	14.89	0.156	156	33	123	5%
						0.5	down	14.2	0.155	155	33	122	5%
							up	14.2	0.155	155	33	122	5%

Table A.2 Raw Data Collected During Plume Delineation Study on June 7, 2019 in Scraggy Lake, NS

Transect Location	Station	GPS Coordinates	Wind Conditions	Maximum Water Depth (m)	Crew	Water Depth (m)	Direction (down/up)	Water Temperature	Water Conductivity (mS/cm)	Water Conductivity (uS/cm)	Average Conductivity (uS/cm)	Mine Related Conductivity	Effluent Dilution
250	7	44.96953, -62.91847	still	3.74	BB/RK	0	down	14.78	0.083	83	33	50	2%
							up	14.95	0.156	156	33	123	5%
						0.5	down	14.1	0.154	154	33	121	5%
							up	14.01	0.153	153	33	120	5%
						1	down	13.72	0.152	152	33	119	5%
							up	12.61	0.148	148	33	115	5%
						1.5	down	12.67	0.15	150	33	117	5%
							up	12.52	0.149	149	33	116	5%
						2	down	12.53	0.149	149	33	116	5%
							up	12.35	0.159	159	33	126	5%
						2.5	down	12.38	0.154	154	33	121	5%
							up	12.29	0.166	166	33	133	6%
						3	down	12.3	0.161	161	33	128	5%
							up	12.24	0.172	172	33	139	6%
						3.5	down	12.24	0.168	168	33	135	6%
							up	12.21	0.174	174	33	141	6%
250	8	44.96988, -62.91794	light wind	4.12	BB/RK	0	down	14.47	0.154	154	33	121	5%
							up	15.34	0.153	153	33	120	5%
						0.5	down	14.02	0.151	151	33	118	5%
							up	14.01	0.153	153	33	120	5%
						1	down	13.1	0.149	149	33	116	5%
							up	12.77	0.151	151	33	118	5%
						1.5	down	12.61	0.147	147	33	114	5%
							up	12.57	0.148	148	33	115	5%
						2	down	12.53	0.146	146	33	113	5%
							up	12.51	0.146	146	33	113	5%
						2.5	down	12.49	0.141	141	33	108	5%
							up	12.45	0.145	145	33	112	5%
						3	down	12.43	0.156	156	33	123	5%
							up	12.35	0.145	145	33	112	5%
						3.5	down	12.32	0.216	216	33	183	8%
							up	12.32	0.166	166	33	133	6%
						4	down	12.27	0.326	326	33	293	12%
							up	12.27	0.323	323	33	290	12%
250	9	44.97025, -62.91746	still, no wind	4.49	BB/RK	0	down	15.85	0.157	157	33	124	5%
							up	15.79	0.154	154	33	121	5%
						0.5	down	13.98	0.152	152	33	119	5%
							up	13.98	0.152	152	33	119	5%
						1	down	13.31	0.151	151	33	118	5%
							up	13.3	0.15	150	33	117	5%
						1.5	down	12.73	0.149	149	33	116	5%
							up	12.65	0.148	148	33	115	5%
						2	down	12.63	0.148	148	33	115	5%
							up	12.59	0.146	146	33	113	5%
						2.5	down	12.56	0.147	147	33	114	5%
							up	12.52	0.144	144	33	111	5%
						3	down	12.49	0.142	142	33	109	5%
							up	12.45	0.145	145	33	112	5%
						3.5	down	12.35	0.145	145	33	112	5%
							up	12.27	0.159	159	33	126	5%
						4	down	12.28	0.238	238	33	205	9%
							up	12.27	0.238	238	33	205	9%

Table A.2 Raw Data Collected During Plume Delineation Study on June 7, 2019 in Scraggy Lake, NS

Transect Location	Station	GPS Coordinates	Wind Conditions	Maximum Water Depth (m)	Crew	Water Depth (m)	Direction (down/up)	Water Temperature	Water Conductivity (mS/cm)	Water Conductivity (uS/cm)	Average Conductivity (uS/cm)	Mine Related Conductivity	Effluent Dilution
250	10	44.97054, -62.91701	light wind	3.78	BB/RK	0	down	15.82	0.154	154	33	121	5%
							up	15.6	0.152	152	33	119	5%
						0.5	down	14	0.152	152	33	119	5%
							up	13.98	0.152	152	33	119	5%
						1	down	13.57	0.152	152	33	119	5%
							up	13.48	0.151	151	33	118	5%
						1.5	down	13.06	0.15	150	33	117	5%
							up	12.94	0.149	149	33	116	5%
						2	down	12.81	0.148	148	33	115	5%
							up	12.72	0.147	147	33	114	5%
						2.5	down	12.59	0.148	148	33	115	5%
							up	12.56	0.148	148	33	115	5%
						3	down	12.4	0.149	149	33	116	5%
							up	12.4	0.148	148	33	115	5%
						3.5	down	12.3	0.154	154	33	121	5%
							up	12.29	0.156	156	33	123	5%
250	11	44.97086, -62.91652	still, no wind	1.84	BB/RK	0	down	15.5	0.153	153	33	120	5%
							up	15.48	0.154	154	33	121	5%
						0.5	down	15.05	0.154	154	33	121	5%
							up	15.18	0.153	153	33	120	5%
						1	down	13.67	0.151	151	33	118	5%
							up	13.68	0.149	149	33	116	5%
						1.5	down	13.07	0.145	145	33	112	5%
							up	13.06	0.147	147	33	114	5%